Fiscal Policy and Macroeconomic Performance: An Overview

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After two decades of relative neglect, fiscal policy is back at the center of the economics research agenda. The fiscal developments around the global financial crisis of 2007–09 are undoubtedly a major factor behind that comeback. The large fiscal stimulus packages adopted by many countries in the face of large adverse shocks have triggered an unusually heated debate among academics, policymakers, and commentators alike. At the center of the controversy lie some important questions:

—How effective is fiscal policy at stimulating the economy?

—What is the best design for a fiscal stimulus package? Should most of the weight be on government spending increases or tax reductions?

—Are automatic stabilizers enough, or is a discretionary stimulus needed?

—How does fiscal policy interact with monetary policy? Is there room for coordination?

—What are the possible consequences for the economy of a large rise in the debt-to-GDP ratio? And those of the fiscal consolidations aimed at stabilizing that ratio?

—Should countries adopt explicit fiscal rules?

The papers included in this volume, written by economists with a recognized expertise in the field, shed light on some of the issues above.

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The purpose of this introduction is twofold. First, we provide a quick overview of the modern macroeconomic literature on fiscal policy, focusing on the most significant papers and their main findings. Second, we provide a brief summary of the contributions contained in the volume and describe how they relate to each other and to the existing literature.

1. A Quick (and Partial) Overview of Some of the Issues and the Related Literature

Virtually all theoretical models of the economy predict that changes in fiscal policy, whether in the form of changes in government purchases or tax rates, will have some effect on the level of economic activity. The transmission channel differs dramatically among paradigms, however. We start by reviewing some benchmark results regarding the effects of tax changes and then turn our attention to government purchases. Next we describe the literature on large fiscal consolidations and their macroeconomic effects, followed by a discussion of fiscal rules. We conclude by briefly reviewing the literature on automatic stabilizers. Throughout, we do not attempt to provide an exhaustive survey of the literature, which is clearly beyond the scope of this introduction, but aim instead at identifying some of the issues that have been the subject of research in recent years and some of the key related references.

1.1 The Macroeconomic Effects of Tax Changes

A key theoretical benchmark in the literature on the effects of taxes is given by the so-called Ricardian equivalence result (Barro, 1974), which can be simply stated as follows: the timing of the taxation required to finance a given exogenous path of government spending has no aggregate real effects on output, employment, or capital accumulation. Thus, a tax cut today (financed by issuing debt) will not affect the path of consumption or the labor supply: households will simply save the additional disposable income and use the (capitalized) proceeds to pay the higher future taxes required to repay the debt. Several (unrealistic) assumptions must be satisfied in order for Ricardian equivalence to hold in its starkest form: (a) taxes must be lump sum; (b) households must have an infinite horizon; and (c) households must have unconstrained access to perfect capital markets (and be able to borrow and lend at the same rate as the government).

If taxes are instead distortionary (for example, they are levied on capital or labor income), the timing of taxes matters, for it affects the current incentives to save and supply labor relative to the future. In that context, we would expect a tax cut to increase the labor supply by increasing the after-tax real wage and real interest rate, thus leading to an increase in employment and output (for example, Braun, 1994; McGrattan, 1994). The quantitative importance of such effects, however, hinges critically on the wage elasticity of labor supply, as well as agents' willingness to substitute intertemporally.[1]

If current households have a finite horizon, they will anticipate that part of the future tax burden will fall on future generations, which will lead them to increase consumption and reduce the resources devoted to capital accumulation (Diamond, 1965; Blanchard, 1985).[2]

Finally, if households (or a significant fraction thereof) are subject to binding borrowing constraints due to capital market imperfections, their consumption will be more sensitive to current disposable income than implied by a the permanent-income hypothesis.[3] As a result, a tax cut will generally imply an increase in consumption, in response to the immediate rise in disposable income. In an economy where output is determined by aggregate demand, the increase in consumption will lead to an expansion in output and employment, ceteris paribus. The expansion in output will further raise disposable income and consumption, generating a multiplier effect. Over time, however, other effects may arise through the supply side (even if taxes are lump sum), which may mitigate or even fully neutralize the initial expansionary impact (see, for example, Elmendorf and Mankiw, 1999, for a discussion).

In the presence of nominal rigidities (and the consequent monetary nonneutralities), the impact of an exogenous tax change on the aggregate economy will be mediated by the induced response

1. Prescott (2004) argues that differences in distortionary taxation are the main explanation for the differences in hours worked per person across countries. His simulations rely on higher labor supply elasticities than typically uncovered by the empirical evidence.

2. Even if households have an infinite horizon, the same will be true if they expect higher future tax liabilities to fall partly on future taxpayers (as in the case of population growth). See, for example, Weil (1989).

3. The same is true if capital markets are perfect but a fraction of consumers are myopic or just follow a simple rule of thumb that makes them consume their current income.

of the monetary authority and, specifically, by the implied path of real interest rates. To the extent that a tax cut leads to an expansion in output and a rise in inflationary pressures, a monetary authority following a conventional Taylor rule will respond by raising nominal and real rates, which will lower the investment and consumption of Ricardian households (and possibly net exports as well, through the likely real appreciation), thus dampening the initial expansionary effects of the tax cut.

A vast literature seeks to provide evidence on the Ricardian equivalence hypothesis by assessing the relevance of either its assumptions or its predictions. The nature of the phenomenon being studied, where (unobservable) expectations potentially play a central role, implies important challenges for that empirical work. Thus, the observation of an increase in consumption in response to a tax reduction should not necessarily point to the failure of Ricardian equivalence, for it may have been caused by another factor correlated with the tax cut (for example, a contemporaneous or anticipated reduction in government spending). Despite these difficulties and the lack of clear evidence for or against Ricardian equivalence, most economists tend to view it as a theoretical benchmark, with limited relevance in the real world. As argued by Elmendorf and Mankiw (1999), "most economists are incredulous about the assumptions that are needed to support the Ricardian view."

Finally, two key papers seek to identify exogenous tax changes and estimate their quantitative effects. Blanchard and Perotti (2002) use a structural vector auto regression (SVAR) approach that relies on U.S. tax code information to control for the endogenous tax response to GDP changes. An unexpected exogenous tax increase is shown to cause a significant output decline that builds over time, with a maximum multiplier ranging from 0.78 to 1.33 depending on the specification. That decline in output is associated with a decline in both private consumption and investment. Blanchard and Perotti find that anticipated tax changes have negligible effects before they are implemented.

Romer and Romer (2010) use an alternative empirical approach to learn about the effects of tax changes. In particular, they address some of the hurdles facing traditional econometric analysis by focusing exclusively on legislated tax changes that can be defined as exogenous on the basis of the narrative evidence (that is, the record in public documents on the motivation underlying the adopted tax legislation). Their estimates of the effects of a tax change on output are large and highly significant: a tax increase of one percent of GDP reduces output over the next three years by nearly three percent, a tax multiplier substantially larger than that uncovered by Blanchard and Perotti.[4] That estimated effect is robust to a variety of alternative specifications and (as in Blanchard and Perotti, 2002) is shown to be associated with declines in both consumption and investment. The decline in the latter is particularly strong.

1.2 The Macroeconomic Effects of Changes in Government Spending

The impact of changes in government spending on aggregate output has been the subject of much research in recent years, partly spurred by the controversy regarding the fiscal stimulus packages put together in response to the crisis.[5] Much of that research has focused on the size of the multiplier, that is, the change in GDP resulting from a $1 increase in government spending. Both in theory and in practice, the size of the multiplier will generally depend on a number of factors, including whether the change in government spending is more or less persistent, whether it is tax or deficit financed, and whether it takes the form of a change in transfers or direct government purchases of goods and services; in the latter case, it also depends on whether those purchases affect the marginal utility of private consumption or the marginal product of labor or some other input employed by private firms.

In traditional Keynesian theory—as reflected in undergraduate textbooks—a change in government spending affects output and employment through its impact on aggregate demand. An increase in government purchases directly affects one of the components of aggregate demand and leads to an immediate one-for-one increase in output. The resulting rise in disposable income brings about an increase in consumption and, accordingly, a further rise in output, which triggers further rounds of consumption and income rises. As a result, the multiplier is well above one. In the case of a rise in transfers, the effect is predicted to be smaller, since transfers do

4. Favero and Giavazzi (2012) shed some light on the reasons for the differences in the two papers' estimates of the size of the tax multiplier. Their proposed estimation approach combining the VAR and narrative methods yields results closer to the VAR literature. Romer and Romer (2010) provide an alternative interpretation of those differences.

5. See Ramey (2011a) for a recent survey of the literature.

not have a direct impact on aggregate demand but rather only work through their impact on disposable income and consumption (which will rise less than transfers if part of the latter is saved). Since this framework does not account for supply constraints, spending multipliers can be quite large, rendering fiscal policy a highly effective stabilization tool.

The neoclassical approach to fiscal policy, as exemplified by the relevant applications of the real business cycle (RBC) model (for example, Baxter and King, 1993), emphasizes several channels through which government purchases influence output that are ignored by the textbook Keynesian framework.[6] First, an exogenous rise in government purchases shifts the aggregate labor supply schedule outward, while leaving aggregate labor demand unchanged in the short run. The expansion in labor supply results from the higher marginal utility of consumption due to the decline in the latter variable as a result of both wealth and substitution effects. The extent of that effect will be influenced by the degree of substitutability between private and public spending in households' preferences. The labor demand schedule will shift over time as a result of the increase or decrease in the capital stock. Whether the capital stock increases or decreases depends on a number of factors, including the persistence of fiscal shocks. Finally, aggregate labor demand may also expand if government purchases are productive, that is, if they raise the private marginal product of labor. This may be the case for public investment and the resulting accumulation of public capital.

As emphasized by Baxter and King (1993), the size of the government purchases multiplier is very sensitive to the assumptions on the nature of the intervention (see above). If the rise in government purchases is financed by distortionary taxes, the multiplier can easily turn negative. On the other hand, persistent increases in public investment financed through lump-sum (or deficit-financed) taxes can have very large long-run multipliers if public capital is highly productive. For regular (that is, nonproductive) government purchases financed through lump-sum taxes, the short-run multiplier is generally below one, with consumption typically falling. The multiplier at longer horizons can

6. In the neoclassical framework, transfers are generally modeled as negative lump-sum taxes, and hence they have no impact if Ricardian equivalence holds. See the discussion above.

attain values above unity if the capital stock rises sufficiently, which in turn requires a sufficiently persistent—or even permanent—increase in government purchases.

The introduction of nominal rigidities, as found in the New Keynesian model, has two important implications for the size of the government purchases multiplier. First, labor demand is no longer constrained to correspond to the marginal product of labor, since output and thus employment are now demand determined.[7] Second, the extent of the increase in aggregate demand resulting from a rise in government purchases will not be independent of how monetary policy is conducted and, in particular, how the latter responds to that fiscal intervention. Yet, as discussed in Galí, López-Salido, and Vallés (2007), if the central bank follows a conventional Taylor-type rule, the outcome of a change in government purchases is hardly different from that found in the RBC, with relatively small multipliers. Only in the case of a weak nominal interest rate response (with a consequent decline in the real rate) can the multiplier attain values significantly above one (Woodford, 2011). That scenario will clearly be relevant when monetary policy hits the zero lower bound on the nominal interest rate, as discussed in Eggertsson (2011) and Christiano, Eichenbaum, and Rebelo (2011).

An alternative approach that opens the door to potentially large government spending multipliers consists in assuming that a fraction of households behave in a non-Ricardian fashion, consuming all their current labor income every period. Galí, López-Salido, and Vallés (2007) show, in the context of an otherwise standard New Keynesian model, that the spending multiplier is increasing in the relative weight of those non-Ricardian households. If the latter are sufficiently important in the economy, and if prices are sufficiently sticky, aggregate consumption will rise in response to an increase in government purchases, and the multiplier will be well above unity.

The empirical studies on the aggregate effects of government spending fail to reach a consensus on the size of the multiplier and the impact on other variables like consumption. As in the case of tax changes, the main challenge lies in being able to identify an exogenous change in government purchases. Most of the existing evidence relies on SVAR models, with different papers using alternative identification schemes. Blanchard and Perotti (2002)

7. Formally, price markups may adjust, driving a wedge between real wages and the marginal product of labor.

identify exogenous shocks to government spending by assuming that the latter variable is predetermined relative to the other variables included in the VAR.[8] They find that a positive shock to government purchases leads to a persistent rise in that variable and generates a large positive response of output, with the associated multiplier being larger than (but close to) one. The fiscal expansion is associated with large (and significant) increases in consumption, but negative (and significant) decreases in investment.[9]

Perotti (2005) applies the methodology of Blanchard and Perotti (2002) to several OECD countries. He emphasizes the evidence of subsample instability in the effects of government spending shocks, with the responses in the 1980s and 1990s being more muted than in previous decades. Mountford and Uhlig (2009), who use a VAR with sign restrictions, uncover a multiplier for (deficit-financed) government purchases well below unity, with evidence of a strong crowding out of both residential and nonresidential investment.

Ramey (2011b) criticizes the above VAR approaches to identifying government purchases shocks, on the grounds that most changes in government spending are anticipated, but they are not captured as such by the VAR (given the restricted information set). That shortcoming, she argues, invalidates many of the inferences drawn from those methods.

Ramey and Shapiro (1998) use a narrative approach to identify shocks that raise military spending, which they codify by means of a dummy variable (widely known as the Ramey-Shapiro dummy). They find that nondurable goods consumption displays a very small, though slightly significant decline, while durables consumption falls persistently after a brief, quantitatively large rise on impact. They also find that the product wage decreases, even though the real wage remains essentially unchanged. Following a similar approach, Edelberg, Eichenbaum, and Fisher (1999) point to a fall in real wages, an increase in nonresidential investment, and a mild and delayed fall in the consumption of nondurables and services, though durables consumption increases on impact in response to a Ramey-Shapiro episode. Overall, empirical work using that approach has uncovered relative small multipliers, which very seldom rise above unity.

8. Fatás and Mihov (2001) and Galí, López-Salido, and Vallés (2007) follow a similar approach and obtain similar results.

9. Estimated multipliers in Fatás and Mihov (2001) and Galí, López-Salido, and Vallés (2007) are larger, with smaller or insignificant effects on investment.

After a systematic analysis and comparison of the size of the multipliers uncovered by much of the recent literature, Ramey (2011a) concludes that "despite significant differences in samples, experiments and identification methods, most aggregate studies estimate a range of multipliers from around 0.6 to 1.8" with "the range within studies… [being] almost as wide as the range across studies."

1.3 Fiscal Consolidations

Fiscal consolidations can be defined as episodes of large, discretionary government spending cuts or tax hikes (or both) aimed at ending an unsustainable debt path. The recent literature on fiscal consolidations was initiated by Giavazzi and Pagano (1990), who describe two episodes in which such fiscal consolidations appeared to have had expansionary effects on economic activity: Denmark in the early 1980s and Ireland in the late 1980s. Such outcomes were at odds with the predictions of the theory and the bulk of the evidence on the effects of fiscal policy in normal times. Alesina and Perotti (1997) analyze the success and macroeconomic consequences of a large number of fiscal consolidations undertaken by OECD countries over the period 1960–94. After defining the success of a fiscal consolidation in terms of its ability to lead to a protracted period with smaller structural primary deficits or debt-to-GDP ratios, they show that fiscal adjustments that rely on expenditure cuts (in particular, cuts in transfer programs and the public wage bill) are more successful, on average, than those based on tax increases. They also find that successful consolidations tend to be expansionary, while unsuccessful ones generally have contractionary effects. In the former case, the expansionary effects are generally associated with an investment boom and an improvement in relative labor unit costs, due to significant real wage containment, as well as an expansion of net exports and profitability.[10]

In subsequent work, Perotti (1999) finds evidence of a negative correlation between consumption and government spending during episodes of fiscal consolidation (and hence large spending cuts), but only in circumstances of fiscal stress (defined by unusually high debt-to-GDP ratios). In normal times, the estimated effects have the opposite sign, that is, consumption increases in response to a rise in government purchases.

10. See also Alesina and Ardagna (1998).

Ardagna (2004) revisits the evidence in Alesina and Perotti (1997), using formal econometric tools (as opposed to simple descriptive statistics) to control for a number of factors. She concludes that the likelihood that a fiscal adjustment will succeed in reducing the debt-to-GDP ratio is increasing (nonlinearly) in the size of the adjustment and GDP growth, but it does not depend on the relative weight of tax hikes and spending cuts in the adjustment (contrary to Alesina and Perotti, 1997). She confirms that, other things equal, GDP growth is higher the larger the decrease in primary spending (especially when the cuts are focused on public employment and the wage bill). That expansionary effect is enhanced if accompanied by an increase in money growth or a decline in short-term interest rates, but it is not affected significantly by exchange rate movements. In a follow-up paper using a longer sample period and more countries, Alesina and Ardagna (2009) obtain similar qualitative results. However, as in the original paper (Alesina and Perotti, 1997), they find stronger evidence that composition effects play a role in determining whether a fiscal adjustment succeeds in reducing the debt-to-GDP ratio, which is more likely in expenditure-based adjustments.

The above papers all use variations in cyclically adjusted budgets (or its components) to identify fiscal consolidations. In IMF (2010), fiscal consolidation episodes are selected on the basis of policy actions, independently of their ex post impact on the cyclically adjusted budget balance, and on the basis of narrative evidence pointing to tax hikes or spending cuts that are implemented with the deliberate goal of reducing the budget deficit. This alternative approach to identifying fiscal consolidations yields several results that differ significantly from the earlier literature. In particular, both governing spending cuts and tax hikes are estimated to have a contractionary effect on output. The contraction is dampened by reductions in interest rates and in the value of the domestic currency. The contractionary effects are larger for tax-based adjustments and smaller for those based on spending cuts. The latter are estimated to be slightly expansionary when the consolidation relies on reductions in transfers. Finally, the contractionary impact appears to be smaller for higher levels of perceived sovereign risk.

1.4 Fiscal Policy Design

The previous sections have summarized recent research aimed at understanding the macroeconomic effects of exogenous changes in government spending or taxes, both in theory and in practice. That avenue is useful for analyzing the effectiveness of different fiscal instruments and the channels through which their effects are transmitted, but it is not the only perspective through which fiscal policy can be assessed. One alternative is to consider the endogenous component of fiscal policy, that is, on fiscal policy as a function of the state of the economy. The focus on the endogenous component of fiscal policy naturally brings a normative perspective to the analysis, since it raises the question of how fiscal policy should be conducted. This tradition encompasses two approaches. The first explores the derivation and characterization of the optimal fiscal policy, while the second analyzes simple fiscal policy rules and their macroeconomic and welfare consequences. Next we briefly overview some key papers and results from the two approaches.

1.4.1 Optimal tax and debt policy

The literature on optimal fiscal policy generally focuses on the problem of optimal taxation given an exogenous path of government purchases and no availability of lump-sum taxes. Judd (1985) and Chamley (1986) derived a classic result in the context of a deterministic neoclassical growth model: under the optimal fiscal policy, the capital income tax rate converges toward zero (and for a suitable utility function, it will attain that value after one period).

Lucas and Stokey (1983) analyze optimal taxation policy in a stochastic model featuring exogenous government expenditures, with both taxes and government debt payoffs contingent on the state of nature (given by the realization of government spending in their model) and no capital accumulation. They show that optimal tax rates and debt display serial correlation properties similar to those of government expenditures. In contrast, Barro (1979) finds, in the context of a partial equilibrium model with one-period risk-free debt as the only asset, that tax rates and debt would follow random walk processes under the optimal policy, independently of the properties of government expenditures. Aiyagari and others (2002) use a general equilibrium setup identical to Lucas and Stokey (1983) but with noncontingent government debt only. Under some restrictions on preferences and the amount of assets the government can accumulate, they show that tax rates and debt follow near unit root processes, independently of the serial correlation properties of government expenditure. While this result is reminiscent of Barro

(1979), the authors find strong contemporaneous responses of taxes and debt to spending shocks (as in Lucas and Stokey, 1983).

Chari, Christiano, and Kehoe (1994) quantitatively explore the properties of optimal taxes in a calibrated RBC model, with capital accumulation, shocks to technology and government spending, and state-contingent debt. They show that the optimal policy implies a positive but nearly constant tax rate on labor income (with its limited variation inheriting the serial correlation of government spending), while the ex ante tax rate on capital income is also very stable and has a mean close to zero (being equal to zero in the case of separable preferences). State-contingent returns on government debt—or, alternatively, state-contingent capital income tax rates—are the main shock absorbers.

Chari, Christiano, and Kehoe (1991) analyze a monetary version of the same framework under the assumption of noncontingent nominal debt. Unexpected changes in the price level provide the appropriate ex post real payments on debt, making the latter effectively contingent in real terms, as in Lucas and Stokey (1983). Schmitt-Grohé and Uribe (2004) point to the fragility of the previous result when nominal rigidities are introduced. They show that the gains from using unexpected inflation or deflation to make debt effectively state contingent are largely offset by the costs associated with price instability, even if the degree of nominal rigidities is relatively small. The optimal policy mix in their environment implies a stable near-zero inflation rate and near random walk behavior in government debt and taxes (as in Aiyagari and others, 2002).

A number of recent papers endogenize government spending when deriving optimal fiscal policy, usually under the assumption that government services yield some utility. Thus, Adam (2011) introduces an endogenous government spending decision in an environment similar to that in Schmitt-Grohé and Uribe (2004), focusing on the optimal fiscal policy response to technology shocks as a function of the initial level of (nominal, noncontingent) government debt. When the latter is zero, the optimal policy requires that government spending adjusts one to one with any change in tax revenues, while keeping the debt level and distortionary tax rates unchanged. When the initial debt level is positive, only part of the increase in tax revenues is matched by an increase in government spending, with both the tax rate and the debt level declining permanently, as in Barro (1979). A second-order approximation to the equilibrium dynamics under the optimal policy, results in the optimal level of debt gradually converging to zero.

Finally, Galí and Monacelli (2010) analyze optimal monetary and fiscal policy analysis with endogenous government spending in the context of a New Keynesian model of a currency union in which member countries are subject to idiosyncratic technology shocks. They show that government spending will optimally deviate, in a countercyclical fashion, from a policy of efficient provision of utility-yielding public services in order to compensate for the lack of an autonomous monetary policy.

1.4.2 Simple rules

Although much of the recent research centers on monetary policy, some papers examine the macroeconomic consequences of alternative rules and empirically characterize the fiscal rules followed by governments in practice. We briefly summarize some of that research next.

Leeper (1991) analyzes the importance for macroeconomic outcomes of the policy mix, as defined by some key properties of the monetary and fiscal rules in place. Conventional macroeconomic models assume that the fiscal authority follows a passive rule, that is, one that guarantees that the intertemporal budget constraint of the government is satisfied given any path of interest rates, output, and other variables. In that case, an active monetary policy (that is, one that reacts with sufficient strength to inflation) will be ultimately responsible for controlling the price level. On the other hand, under a regime characterized by active fiscal policy (that is, one that does not in itself guarantee the sustainability of debt dynamics) and a passive monetary policy, inflation control falls fully under the responsibility of the fiscal authority, giving rise to the so-called fiscal theory of the price level. Woodford (1998) provides a related analysis in the context of a model with nominal rigidities. In subsequent work, Davig and Leeper (2007) show how an economy's equilibrium properties are affected by stochastic switches in the nature of monetary and fiscal policy. In such an environment, the economy's response to a given shock depends not only on the fiscal and monetary policy regimes in place at the time of the shock, but also on the expected duration of those regimes and the nature of the regimes that may replace them in the future.

The extent to which simple fiscal policy rules can approximate the optimal monetary and fiscal policies has been the subject of some analysis in the literature. For example, Schmitt-Grohé and Uribe (2006) show that the economy's responses to technology shocks under the optimal policy can be closely approximated by a simple rule that makes the income tax rate respond to its own lagged value and to the deviations of government liabilities and output from their respective steady state values under the optimal policy, combined with a Taylor-type rule for monetary policy. The implied welfare losses are very small, provided that the coefficients on both government liabilities and output are optimally chosen. That approximation is particularly good when technology shocks are the main source of fluctuations, but not so much when fiscal shocks are dominant. In addition to the theoretical literature on simple fiscal policy rules, a small empirical literature has also emerged aimed at estimating those rules for different countries and historical periods. A frequent objective is to assess the sustainability of fiscal policy. Bohn (1998) constitutes an early example in this tradition: he estimates a fiscal policy rule for the United States and shows that the surplus responds positively to the debt-to-GDP ratio with sufficient strength to guarantee that the latter variable displays some mean reversion.

Another purpose of estimating fiscal policy rules is to establish the degree of countercyclicality of fiscal policy, by measuring the sensitivity of deficits (or the revenue and spending components) to output gap fluctuations. Countercyclicality is partly related to the presence of so-called automatic stabilizers, rather than to deliberate discretionary policy decisions to stabilize the cycle. Isolating that discretionary component poses an important challenge, as does the need to control for the biases that may result from reverse causality (that is, the effect of exogenous fiscal shocks on output). Examples of papers seeking to characterize empirically the response of fiscal policy to cyclical developments include Gavin and Perotti (1997) for Latin America, Lane (2003) for a sample of 22 OECD countries, and Galí and Perotti (2003) for euro area countries.

Finally, the residual from estimated fiscal policy rules can provide a measure of nonsystematic fiscal policy. Fatás and Mihov (2003) show that countries with less volatility in the residual (which they interpret as signaling a smaller role for discretionary policy) also display less macroeconomic instability and higher average growth. Related evidence using data for U.S. states can be found in Fatás and Mihov (2006).

Finally, another branch of the literature on fiscal policy explores the impact of government size on macroeconomic volatility. Galí (1994) shows that several measures of government size, including tax revenues and government spending as a fraction of GDP, are strongly negatively correlated with measures of output volatility across OECD countries. That observation is shown to be at odds with the predictions of a standard RBC model. Fatás and Mihov (2001) find that such a relationship is robust to the inclusion of a variety of controls and alternative detrending and estimation approaches. They also show that an even stronger negative relationship between government size and output volatility obtains across U.S. states.

2. Overview of the Book

Ten contributions were presented during the Fourteenth Annual Conference of the Central Bank of Chile, on Fiscal Policy and Macroeconomic Performance. They were organized into three sections. The first assessed the effects of fiscal policy on macroeconomic outcomes. Tommaso Monacelli, Roberto Perotti, and Antonella Trigari focused on the effects of tax cuts on the labor market. Joachim Voth analyzed the extent to which fiscal retrenchment can take place before civil unrest is triggered. Rodrigo Caputo and Miguel Fuentes examined the long-run effects of fiscal transfers and investment on the real exchange rate in a broad panel of countries. Finally, Mauricio Villafuerte, Pablo López-Murphy, and Rolando Ossowski presented an examination of fiscal policies among resource exporters in Latin America and the Caribbean.

The second section included research on the interactions of fiscal and monetary policy. Gauti Eggertsson analyzed how the fiscal multiplier is affected by the degree of coordination between the fiscal and monetary authorities. Giancarlo Corsetti questioned the conventional wisdom that fiscal policy is more expansionary under a fixed exchange rate than under a floating regime. Finally, Luis Felipe Céspedes, Jorge Fornero, and Jordi Galí explored the effects of Chilean fiscal policy on consumption and income using a dynamic stochastic general equilibrium (DSGE) framework that relaxes the assumption of Ricardian equivalence.

The final section focused on fiscal policy in emerging market economies. Jeffrey Frankel discussed the structural spending rule adopted by Chile in 2001. Eduardo Engel, Christopher Neilson, and Rodrigo Valdés presented a welfare analysis of the effects of Chile's fiscal rule. Michel Strawczynski and Joseph Zeira examined the cyclicality of fiscal policy in a broad set of emerging market economies and assessed whether the observed dynamics can be characterized using Aguiar and Gopinath's (2007) distinction of permanent and temporary shocks. We now proceed to briefly summarize each of the the contributions.

Which is more effective atreducing unemployment—increasing government spending or reducing taxes? Does it make a difference if policymakers change income taxes or business taxes? Monacelli, Perotti, and Trigari (in this volume) address these relevant questions by estimating the effect of exogenous changes in taxes on the U.S. unemployment rate along the lines of the narrative approach of Romer and Romer (2010). Following Perotti (2010), they argue that the discretionary and the automatic components of changes in tax revenues are likely to have different effects on output, which must be taken into account when estimating the effects of tax changes on the economy. They estimate an instrumental variable version of the Mertens and Ravn (2009) equation that accounts for the dynamic response of the macroeconomic variables of interest (such as output, unemployment, government spending, and interest rates) to changes in the discretionary part of tax revenues. They argue that this methodology provides a better estimation of the effects of tax changes on the economy than Romer and Romer's (2010) approach. More specifically, Monacelli, Perotti, and Trigari (in this volume) base their estimation on the data set from Perotti (2010), which disaggregates the aggregate tax shocks into four main categories (personal, corporate, social security, and indirect taxes) and also distinguishes between receipts and liabilities. They show that an increase in tax receipts of one percent of GDP has a sizeable positive impact on the unemployment rate and a negative impact on hours worked, labor market tightness, and the probabilty of finding a job. The negative effect on GDP lies in the mid-range of other values found in the literature. They indicate that this depends on a series of methodological details, involving both the econometric specification and the estimation method. Finally, they also show that the unemployment multiplier is larger for business taxes than for personal income taxes.

The austerity measures implemented by the Greek government in 2010 were followed by strikes and riots. This situation does not seem completely new, at least from a South American perspective. Voth (in this volume) studies the extent to which budget cuts are directly related to surging social unrest in a group of 11 South American countries for the period 1937–95. He uses data collected by Banks (1994) on the number of political assassinations, general strikes, riots, and anti-government demonstrations. Using these variables, he constructs an aggregate measure called chaos to capture social unrest that corresponds to the first principal component of the four variables. Voth finds strong evidence that fiscal austerity (cuts in government expenditure) is associated with periods of violent protest: the larger the fiscal adjustment, the greater the risk of riots, demonstrations, assassinations, and revolutions. Surprisingly, he finds that increases in fiscal revenues have a similar effect to expenditure changes. This may be explained by episodes of simultaneous tax and spending increases that reduce the level of unrest. One possibile explanation is that budget cuts and social unrest may be explained by a common factor, such as hard times. When he controls for economic growth, the results mostly remain unchanged, suggesting that the omitted variable problem may not be that severe.

Theoretical models tend to indicate that government consumption is negatively correlated with the real exchange rate, that is, higher government consumption tends to appreciate the real exchange rate. This is usually the result of a higher share of nontradables in government consumption than in private consumption. Empirical evidence tends to support this claim. Caputo and Fuentes (in this volume) test the effects of government expenditures on the real exchange rate for a group of 55 developing and developed economies for the period 1980–2007. In addition to considering the impact of government consumption on the real exchange rate, they assess the effect of the other two components of fiscal expenses—namely, government transfers and investment—on the real exchange rate. Their results suggest that changes in both government consumption and public investment appreciate the real exchange rate significantly, with the long-run elasticity being close to one. They also find that government transfers appear to have no impact on the real exchange rate.

The implementation of fiscal policy is particularly challenging in countries where commodity-related fiscal revenues are significant, since commodity prices are subject to great fluctuations. The recent behavior of commodity prices, which recorded a significant increase in 2004–08 followed by a drastic fall in 2009, is a good example of such volatility. Villafuerte, Lopez-Murphy, and Ossowski (in this volume) examine the cyclicality properties of fiscal policy for a group of nonrenewable-resource-exporting countries (NRECs) in Latin America and the Caribbean during the economic and resource price cycle of the last decade. The countries included in the study are Bolivia, Chile, Ecuador, Mexico, Peru, Trinidad and Tobago, and

Venezuela. For these countries, fiscal revenues from nonrenewable sources represented between 20 and 57 percent of total fiscal revenues in 2005–09. Based on their estimations, the authors argue that fiscal policy was predominantly procyclical in these countries during the boom. They also indicate that in the 2009 downturn, some countries implemented a countercyclical fiscal policy, while others experienced a procyclical stance. Finally, countries that displayed a more conservative fiscal policy in 2003–08 implemented more expansionary fiscal policies, on average, during the 2009 crisis.

The global financial crisis of 2008 generated an aggressive response from central banks around the world. In some cases, monetary policy rates were reduced to their effective lower bounds. Rapid output contraction gave rise to the fear of a liquidity trap within the policy horizon. As discussed by Krugman (1998), to avoid a liquidity trap, the government should just commit to a higher future money supply. If this commitment lacks credibility, fiscal policy may provide as a powerful stabilization tool, as argued by Christiano, Eichenbaum, and Rebelo (2011). In his contribution to this volume, Eggertsson studies the role of coordination between an (independent) central bank and the government in avoiding a liquidity trap scenario. Using a standard New Keynesian economy subject to the zero lower bound on the nominal interest rate and with costly taxation, he shows that the coordination of fiscal and monetary policy is key for increasing the credibility of future inflation announcements. If raising taxes is costly, inflation may be a good alternative for reducing public debt. The announcement of future inflation supported with increases in government spending can be highly credible if the central bank shares, to some extent, the government's objective function (coordination). In this case, the deficit spending multiplier (that is, the effect of increasing nominal debt on output) is high, which adds to the classical real government spending multiplier. Eggertsson claims that it was precisely Roosevelt's commitment to inflate the price level to its pre-Depression level, with the backing of fiscal expansion, that explains the relatively quick recovery of the U.S. economy after 1933 compared with the protracted stagnation of the Japanese economy in 1992–2006.

A conventional view in international economics is that fiscal policy is more effective under fixed exchange rates than under flexible exchange rates. Under flexible exchange rates, an increase in government spending (or a reduction in taxes) will generally lead to a rise in the interest rate, which will tend to appreciate the domestic currency. Overall, exports fall, as do investment and consumption. Under a credible fixed exchange rate regime, the interest rate cannot respond (since it must match the foreign interest rate, which does not change), so there is no crowding out of government spending. Corsetti, Kuester, and Muller (in this volume) argue that this conventional wisdom depends crucially on the medium-term fiscal regime under consideration. They consider a fiscal regime in which, after an initial fiscal stimulus, both spending and taxes are adjusted so as to stabilize debt. In this case, the long-term real interest rate tends to fall if agents anticipate a contraction in government spending in the near future. As this is expected to cause a slowdown of inflation, under floating rates private agents also expect the central bank to cut policy rates. In this scenario, long-term real interest rates may actually fall at the time of the fiscal expansion, instead of increasing. Thus, the conventional wisdom does not hold.

As we discussed in the previous section, the existence of non-Ricardian households is a key element for explaining potentially large government spending multipliers. If non-Ricardian households play a crucial role in explaining the transmission of government spending shocks, they should have a relatively higher importance in economies where the fraction of non-Ricardian households is potentially larger, that is, developing countries. Céspedes, Fornero, and Galí (in this volume) study the effects of government spending shocks in Chile, an emerging market economy that follows a structural balance fiscal rule. The empirical evidence indicates that the fiscal multiplier is positive and large in the Chilean economy. The positive consumption multiplier that emerges from their empirical analysis suggests the presence of non-Ricardian effects. The authors develop a small open economy model to study the channels through which these shocks are transmitted to the economy, along the lines of Galí, López-Salido, and Vallés (2007) and Coenen, McAdam, and Straub (2008). They show that the specification of a fiscal policy rule that approximates the Chilean rule leads to consumption and output fiscal multipliers that are positive in the short run, in a way consistent with the evidence.

Between 2005 and 2008, Chile accumulated fiscal surpluses equivalent to nearly 25 percent of GDP. The fiscal surpluses have their origin in an increase in the price of copper: the average copper price for that period was close to 300 percent higher than at the beginning of the decade. However, while the higher copper price may explain the higher fiscal revenues received by the Chilean government, it clearly does not explain why those additional revenues were saved. Fiscal policy in Latin American countries tends to be clearly procyclical, as documented by Gavin and Perotti (1997). Frankel (in this volume) studies the fiscal policy framework in Chile in order to explain its distinctive behavior compared to other Latin American commodity exporters. Fiscal policy in Chile is implemented using a structural balance rule. Under this rule, if effective copper prices are above the long-run trend or if the economy is in a boom (where effective output is above potential output), the government must save the difference generated in fiscal revenues. Frankel provides evidence that official forecasts will generally be overly optimistic if not insulated from politics, and the problem can be worse when the government is formally subject to budget rules. He argues that the key innovation that has allowed Chile to achieve countercyclical fiscal policy and to run surpluses in booms is not the structural budget rule itself, but the creation of a regime that transfers the responsibility for estimating long-run trends in copper prices and GDP to independent expert panels.

While the structural balance rule implemented in Chile has been useful for improving the management of copper windfall revenues, it is not necessarily the optimal rule. Engel, Neilson, and Valdés (in this volume) study the optimal design of the spending rule for a government that has volatile revenues from an exogenous source, such as a flow from a natural resource. They analyze policies for a government with a precautionary saving motive, which has to decide how much to transfer from volatile copper revenues to impatient agents who differ in their private incomes and who consume all available income. Crucially, the government has limited space for borrowing against future revenue and has access to an imperfect technology for targeting transfers, such that a fraction of the transfers go to richer households. The authors concentrate on the implementation of social insurance, assuming that output is exogenous. For their purpose, countercyclical actions reflect the government's interest in increasing transfers at times when household consumption is low and government spending has a higher marginal utility. Engel, Neilson, and Valdés show that in this setup, the gains from moving from a balanced budget rule to an optimal rule are significant. Optimal spending is countercyclical, and this countercyclicality is higher when government expenditures are less targeted because the inefficiencies of poor targeting are less costly. Simpler rules, such as the structural balance rule, also provide welfare gains.

Finally, institutions may play a significant role explaining the procyclicality of fiscal policy in Latin America. Strawczynski and Zeira (in this volume) study a different channel that may explain this behavior: the characteristics of business cycles in these economies. Following the work of Aguiar and Gopinath (2007), they test whether developed and emerging economies react differently to persistent shocks to output. Their results indicate that while government expenditure in developed economies is not affected by permanent shocks, emerging countries tend to implement a procyclical fiscal policy when facing permanent shocks to per capita GDP.

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Taxes and the Labor Market

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One of the defining features of the financial crisis of 2008–09 has been its persistent impact on the U.S. labor market, with the unemployment rate roughly doubling from early 2008 through mid-2010. This has ignited an intense debate on the appropriate stimulus response of fiscal policy. The debate has revolved around two main issues: the relative merits of higher government spending versus tax cuts; and the suitability of labor income versus capital income tax cuts. In Monacelli, Perotti, and Trigari (2010), we address part of the debate related to the first point, particularly in relation to estimating the size of the unemployment multiplier of government spending. In this paper, we focus on the effects of tax variations on the labor market.

The idea that tax cuts are likely to be a more effective stimulus device than higher government spending is widespread in both the business and the academic community. This idea, however, often remains vague, because proponents typically do not distinguish between the expansionary effects of tax cuts on gross domestic product (GDP) and their alleged, more specific, implications for the

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unemployment rate and the labor market as a whole. For instance, Alesina and Zingales argue that "tax cuts have a much better effect on job creation than highway rehabilitation," but propositions of this sort are virtually untested in the literature.[1]

Advocates of measures geared toward a cut in capital income taxes have mainly proposed two types of intervention. The first is a reduction in capital gains taxes. The idea underlying this proposal is that this recession is unique because it originates from credit markets, where investors are still reluctant to lend to risky firms. A reduction in capital gains taxes would boost the willingness of investors to take risks.[2] Skeptics of this proposal, however, doubt the effectiveness of variations in capital gains taxes, specifically in terms of job creation. The second type of intervention that has been advocated is a reduction in depreciation allowances: firms that purchase new machines and other capital goods would be able to write them off immediately, instead of over many years.[3] Some argue, however, that the latter measure is likely to have a limited impact given the current climate of exceptionally low interest rates. Instead, these analysts insist on options mostly geared toward cuts in payroll taxes.[4] The argument is that a cut in payroll taxes would boost output and employment both by increasing demand for goods and services and by providing incentives for additional hiring. Others also note that firms are hoarding a large share of profits, but still perceive the cost of labor to be too high.[5]

Most of the recent debate on the alleged merits of tax cuts has revolved around whether to extend the tax cuts enacted under President George W. Bush. These tax cuts refer to two laws passed in 2001 and 2003 that reduced tax rates across the board on income, dividends, and capital gains, as well as on other specific categories. The Obama administration has recently passed a temporary two-year extension of most of the Bush cuts as part of a larger economic plan. Supporters of this measure argue that a failure to extend the cuts would have implied an actual increase in taxes for the population as

1. Alberto Alesina and Luigi Zingales, "Let's Stimulate Private Risk Taking," *Wall Street Journal*, 21 January 2009. p. A15.

2. This argument is made, for instance, by Alesina and Zingales in the *Wall Street Journal* editorial cited above.

3. See, for instance, the *Wall Street Journal* editorial by R. Glenn Hubbard, September 10, 2010.

4. CBO (2010).

5. See, for instance, Nouriel Roubini, "What America Needs Is a Payroll Tax Cut," *Washington Post*, 17 September 2010.

a whole by the end of 2010.[6] According to the Congressional Budget Office, however, extending all of the Bush tax cuts may have little bang for the buck, the equivalent of a 10- to 40-cent increase in GDP for every tax dollar foregone. The argument (a classic one) is that the Bush tax cuts mostly go to higher-income households, who have a relatively low marginal propensity to consume.[7] Of eleven potential stimulus policies recently examined by the CBO, an extension of all of the Bush tax cuts seems to imply the lowest stimulus per tax dollar foregone.[8] This has led some analysts to argue that the government could have more effectively stimulated the economy by letting the high-income tax cuts expire and using those savings for a combination of a job-creation tax credit and continued state fiscal assistance, which would have allegedly generated "three times as much additional economic activity as using them to extend the high-income tax cuts" (Marr, 2010).[9] Taking the CBO estimates literally, each of these measures is "estimated" to have roughly about three times the impact on GDP as continuing the Bush tax cuts.[10]

Different views about the extension of the tax cuts also depend on the perceived tradeoff between stimulus today and sustainability tomorrow. As reported by Gale and Harris (2010), former Obama administration budget director Peter Orszag has endorsed extending the Bush tax cuts for both middle-income taxpayers and the wealthy, but only for two years: temporary extension of the tax cuts "would keep the economy humming during the recovery," but a more permanent extension of the tax cuts, even if limited to middle-income households, "is simply unaffordable because of the impact on the deficit." Alan Greenspan, former chairman of the U.S.

6. For instance, Rep. McConnell has reportedly said that "only in Washington could someone propose a tax hike as an antidote to a recession." Some Senate Democrats such as Kent Conrad of North Dakota, Evan Bayh of Indiana, and Ben Nelson of Nebraska have also argued "against raising taxes on anyone during a fragile economic recovery" (Gale and Harris, 2010). Similarly, Bill Rys, tax counsel for the National Federation of Independent Business, a small-business group, has argued that "the best thing to do is to get rid of uncertainty, and that includes the cliff we're falling off with all these [tax] provisions that are expiring" (J. Weisman and J. D. McKinnon, "Obama to Push Tax Break," *Wall Street Journal*, 6 September 2010).

7. In work in progress, Monacelli and Perotti (2010) explore (both empirically and theoretically) the issue of whether "pro-poor" tax cuts (that is, tax cuts favoring households in the lower brackets of the income distribution) are more expansionary than tax cuts that redistribute in favor of the rich.

8. See CBO (2010, table 1).

9. See also William G. Gale, "Five Myths about the Bush Tax Cuts," *Washington Post*. 1 August 2010.

10. See CBO (2010, table 1).

Federal Reserve, called an extension of the Bush tax cuts without corresponding spending reductions "disastrous."[11]

These quotations do only partial justice to the complex ramifications of the current debate on the appropriate size and composition of the response of fiscal policy to the Great Recession. That debate, however, almost invariably relies on rather unstructured empirical evidence on the effects of tax changes on the macroeconomy, let alone on the labor market. For example, CBO (2010) reports that "low and high estimates of multipliers for a given policy were chosen, on a judgmental basis, to encompass most economists' views about the effects of that type of policy."

As exemplified by the above discussion, tax changes can occur for a variety of reasons, including as an endogenous reaction to the state of the economy (as is mostly the case in the current recession). But to gauge the economic and quantitative significance of any tax measure, one needs to identify those changes that happen for reasons unrelated to current (or anticipated) developments in the economy.

In this paper, we study the effect of *exogenous* variations in taxes on the U.S. unemployment rate and on several other labor market variables. Our estimates are based on a revised version of the Romer and Romer (2010) narrative record of exogenous tax innovations.[12] There are two main differences in our data set relative to that of Romer and Romer: first, while they use data on tax liabilities, we track the quarterly exogenous changes in receipts generated by each tax bill; second, we distinguish between different types of taxes, including personal, corporate, indirect, and social security taxes and several subcomponents of each of these.[13] Using this disaggregation, we begin to address some of the policy issues quoted above, although not yet at the level of detail that one might like: for instance, there is not enough variation in the postwar time series to address issues like the relative merits of capital gains taxation versus employment tax credits.

We also use a different empirical methodology than Romer and Romer. Following Perotti (2010), we show that accounting for the difference between automatic and discretionary tax changes is crucial for obtaining an unbiased measure of the effects of tax changes. By doing so, we find estimates of the effects of tax shocks that are typically in between the extremely large effects estimated by Romer

11. See Gale and Harris (2010).

12. We do not address the distinction between anticipated and unanticipated tax innovations; see Mertens and Ravn (2009).

13. See Perotti (2010) for more details.

and Romer (2010), and the much smaller (and often statistically insignificant) effects estimated by Favero and Giavazzi (2010).

We obtain the following main results. First, an increase in tax liabilities of one percent of GDP has a sizeable positive impact on the unemployment rate and a sizeable negative impact on GDP, hours worked, employment, labor market tightness, and the probability of finding a job. For instance, under our preferred empirical specification, the unemployment rate increases by 0.50 percentage points after six quarters, while GDP falls by 1.2 percent. Second, we find that the data set matters. When we employ the original Romer and Romer (2010) specification but with our data set, the size of virtually all estimated multipliers decline substantially in absolute value. Third, we find that the multiplier on private investment is particularly large and persistent, with investment contracting by about 5 percent after six and twelve quarters. Fourth, the effect on GDP and on labor market variables of shocks to business taxes is typically larger than the effect of shocks to labor income taxes. In the conclusions, we discuss some of the possible theoretical implications of this result.

The outline of the paper is as follows. In the next section, we present our estimation methodology. Section 2 then briefly discusses the data, and section 3 presents the main results. In section 4, we show the effects of the main types of taxes. Section 5 concludes.

1. Estimates of Discretionary Taxation

In this section we introduce our methodology to estimate the effects of discretionary taxation.[14]

1.1 Romer and Romer (2010) and Favero and Giavazzi (2010)

Romer and Romer (2010) estimate an equation of the following type:

$$y_t = a(L)\,\tau_t + \varepsilon_t, \tag{1}$$

14. See Perotti (2010) for more details on the methodology. Chahrour, Schmitt-Grohé, and Uribe (2010) use a dynamic stochastic general equilibrium (DGSE) model to compare a tax shock identification strategy based on a structural vector auto regression (SVAR) to one based on narrative records. They conclude that the different tax multipliers obtained from the SVAR and narrative approaches do not depend on differences in the transmission mechanism, but rather reflect either a failure to identify the same tax shock or small sample uncertainty.

where y_t is the variable of interest, τ_t is a measure of tax shocks constructed by Romer and Romer based on the original documentation accompanying tax bills, and $a(L)$ is a lag polynomial of order J (in Romer and Romer, $J = 13$, that is, $a(L)$ includes powers 0 to 12 of the lag operator L). For future reference, we call this the Romer-Romer one-equation specification. Romer and Romer typically find that in response to a tax shock of 1 percentage point of GDP, output declines by up to three percent within three years. Many economists consider these effects to be implausibly large.

Favero and Giavazzi (2010) argue that these results are due to an erroneous specification of the regression to be estimated. They argue that equation (1) cannot be derived from the correct truncated moving average representation of any underlying vector autoregression (VAR). Let the vector $\tilde{\mathbf{X}}_t$ include n endogenous variables of interest—say, output y_t, government spending g_t, the interest rate i_t, government revenues s_t, and a labor market variable such as the unemployment rate. One should then treat the Romer-Romer tax shocks as exogenous variables in a reduced-form VAR in $\tilde{\mathbf{X}}_t$. Formally, this corresponds to the following model:

$$\tilde{\mathbf{X}}_t = B(L)\tilde{\mathbf{X}}_{t-1} + \mathbf{\Gamma}\tau_t + \tilde{\mathbf{u}}_t, \tag{2}$$

where $B(L)$ is a lag polynomial of order 4, $\mathbf{\Gamma}$ is a $(n - 1)$ vector, and $\tilde{\mathbf{u}}_t$ is a vector of reduced-form residuals. Favero and Giavazzi estimate equation (2) by ordinary least squares (OLS), and they argue that the correct impulse responses are obtained by simply tracing the dynamic effects of a shock to τ_t of one percentage point of GDP. For future reference, we call equation (2) the Favero-Giavazzi OLS specification.

If one is only interested in the effects of the Romer-Romer tax shocks, there is no need to go beyond this reduced-form specification, provided that Romer and Romer's two identifying assumptions are satisfied: τ_t is orthogonal to $\tilde{\mathbf{u}}_t$, and τ_t is unpredictable using lagged variables in the information set of the econometrician. Favero and Giavazzi find that a one-percentage-point-of-GDP realization of τ_t causes output to decline by less than one percent, and the effect is often insignificant.

The correct truncated moving average representation of equation (2) is

$$\tilde{\mathbf{X}}_t = C(L)\tau_t + D(L)\tilde{\mathbf{X}}_{t-J} + \tilde{\eta}_t, \tag{3}$$

where $C(L)$ is a lag polynomial of order J, $D(L)$ is of the same order as $B(L)$, and $\tilde{\eta}_t$ is a moving average of $\tilde{\mathbf{u}}_t$. As Favero and Giavazzi (2010) argue, a comparison of equation (1) with equation (3) shows that Romer and Romer's equation (1) does not correspond to the first equation of the truncated moving average representation of the original VAR, because Romer and Romer omit the lagged values of the endogenous variables.[15]

1.2 Discretionary and Automatic Tax Changes

Perotti (2010) argues that the specification adopted by Favero and Giavazzi is incorrect if one wants to capture the dynamic effects of the Romer-Romer tax shocks. Changes in tax revenues are the combination of discretionary changes to taxation (which reflect intentional actions by the policymakers, like changes in tax rates, depreciation allowances, deductions, and so on) and automatic changes to revenues (which reflect the effects of output, inflation, and so forth on tax revenues), for given tax rates. Therefore, tax revenues can be given by the following expression:

$$s_t = \underbrace{\tau_t}_{\text{discretionary}} + \underbrace{(\phi \mathbf{X}_t + \mu_t)}_{\text{automatic}}, \tag{4}$$

where τ_t (that is, the Romer-Romer tax shocks) captures the changes in discretionary taxation, $\mathbf{X}_t$ is a vector of endogenous variables that includes the same variables as $\tilde{\mathbf{X}}_t$ except s_t, and ϕ is a $[1 \times (n-1)]$ vector of coefficients. For simplicity, we refer to the term $\phi\mathbf{X}_t + \mu_t$ as the automatic component of tax changes.

Perotti (2010) argues that the discretionary and the automatic components of changes in tax revenues are likely to have different effects on output. There are at least two reasons for this. First, discretionary changes are more distortionary, because they consist of changes in both tax rates and tax rules. Second, discretionary tax changes are likely to be more persistent. To see this, suppose taxation is defined with reference to trend or potential output, so that deviations of output from the reference level sum to zero over the cycle. In this case, if agents are not liquidity constrained, the automatic component of taxation should have no effect on the

15. Romer and Romer also estimate a version of (1) that includes lags 1 to 4 of y_t, but this does not address the criticism raised by Favero and Giavazzi.

agents' behavior, because neither tax rates nor the present value of tax payments change.[16]

In light of this distinction, the correct specification of the model is not equation (2), but equation (4) combined with the VAR:

$$\mathbf{X}_t = B(L)\mathbf{X}_{t-1} + C(L)\tau_t + D(L)(s_t - \tau_t) + u_t, \tag{5}$$

where $D(L)$ is a lag polynomial of order 5. Combining equations (4) and (5) yields

$$(I - \mathbf{D}_0\phi)\mathbf{X}_t = [B(L) + \phi D'(L)]\mathbf{X}_{t-1} + C(L)\tau_t + D(L)\mu_t, \tag{6}$$

where $\mathbf{D}_0$ is the vector of coefficients of $D(L)$ when $L = 0$ and $D'(L)$ is a lag polynomial of order 4, defined as $D(L) - \mathbf{D}_0$.

After rearranging, equation (6) yields:

$$\mathbf{X}_t = F(L)\mathbf{X}_{t-1} + G(L)\tau_t + H(L)\mu_t + v_t, \tag{7}$$

where

$$F(L) \equiv (I - \mathbf{D}_0\phi)^{-1}[B(L) + \phi D'(L)],$$

$$G(L) \equiv (I - \mathbf{D}_0\phi)^{-1}C(L),$$

$$H(L) \equiv (I - \mathbf{D}_0\phi)^{-1}D(L), \text{ and}$$

$$v_t = (I - \mathbf{D}_0\phi)^{-1}u_t.$$

Mertens and Ravn (2010) perform an OLS regression of $\mathbf{X}_t$ on its lags and on τ_t and its lags, thus treating the term $H(L)\,\mu_t + v_t$ in equation (7) as the error term. We refer to the specification in equation (7) as the Mertens-Ravn OLS specification.

The Mertens-Ravn OLS approach gives biased estimates because μ_{t-i} is likely to be correlated with $\mathbf{X}_{t-i}$. The solution is to take μ_t and its lags out of the error term and include them explicitly as regressors in equation (7). This can be done through an instrumental variable estimation of equation (4), which allows us to recover an

16. One could argue that a purely cyclical source of changes in revenues could matter if individuals are moved into different tax brackets, so that the average marginal income tax rate changes. This effect is however likely to be second order.

estimate of μ_t.[17] The natural instruments for the variables in $\mathbf{X}_t$ in equation (4) are lags of $\mathbf{X}_t$ and lags of τ_t. We call this the Mertens-Ravn IV specification. The Mertens-Ravn IV and OLS estimates are similar, and both display much stronger effects on all endogenous variables than the Favero-Giavazzi OLS specification. Both these observations are relatively easy to explain in our context.

To illustrate why the Favero-Giavazzi OLS specification is likely to lead to attenuated estimates of the effects of a tax shock, we use equation (7) to replace the vector $\mathbf{X}_t$ in equation (4). This gives

$$s_t = \phi F(L)\mathbf{X}_{t-1}[1 + \phi G(L)]\tau_t + [1 + \phi H(L)]\mu_t + \phi v_t. \tag{8}$$

If we stack equations (7) and (8) and then collapse the polynomials in μ_t and the terms in v_t in the error terms of each equation of the resulting system, we can almost reproduce the Favero-Giavazzi reduced-form specification of equation (2), except that the lags of s_t in the latter are replaced by lags of τ_t in equation (8).

Consider therefore an OLS estimation of the Favero-Giavazzi specification (2), when the true model is given by equations (7) and (8). There are two sources of bias in the Favero-Giavazzi OLS approach. The first is the same as in the Mertens-Ravn OLS approach: the lags of μ_t are likely to be correlated with the lags of $\mathbf{X}_t$. The second source of bias stems from the inclusion of lags of s_t instead of lags of τ_t. The difference between s_{t-i} and τ_{t-i} has two components. The first is $\phi\mathbf{X}_{t-i}$, which gets incorporated in the polynomial $\phi F(L)\mathbf{X}_{t-1}$ on the right-hand side of equation (8) and does not cause any harm; the second component, μ_{t-i}, introduces a classic error-in-variable problem, which typically biases estimated coefficients toward zero. The solution to both problems consists once again in taking μ_t and its lags out of the error term, generating the Favero-Giavazzi IV estimates. In fact, the Favero-Giavazzi IV estimates and the Mertens-Ravn IV estimates are numerically identical if exactly the same instruments are used to estimate equation (4),.

To illustrate why the Mertens-Ravn OLS and IV estimates are very close to each other, we set $D(L) = 0$ in equation (5), so that automatic tax changes have no effects. In this case, the Mertens-Ravn OLS responses are consistent because lagged values of μ_t do not appear in the error term. Thus, the fact that the Mertens-Ravn

17. This requires a third identifying assumption, in addition to Romer and Romer's assumptions: namely, v_t should be uncorrelated with current and past values of μ_t.

OLS and IV responses are similar is an indication that the effects of automatic tax changes are negligible.

Favero-Giavazzi OLS responses continue to be inconsistent, because this specification uses lags of s_t instead of τ_t. If instead $D(L) = C(L)$, so that the two components of tax changes have the same effects, then the Favero-Giavazzi OLS responses are consistent, because s_t is the right variable to have in the system. The intuition is clear: in this case, there is no need to decompose lags of s_t into the discretionary and automatic components.

1.3 Back to Romer and Romer

The original Romer-Romer approach, as exemplified by equation (1), has problems in small samples because it omits some terms of the truncated moving average representation. Favero and Giavazzi's version of the truncated moving average representation, equation (3), includes these terms but has the problem that it does not allow for different effects of the discretionary and automatic components of tax changes. The correct truncated moving average representation can be derived from equation (7) and takes the following form:

$$\mathbf{X}_t = V(L)\tau_t + W(L)\mathbf{X}_{t-J} + \eta_t, \tag{9}$$

where $V(L)$ is a lag polynomial of order J, $W(L)$ is of the same order as $B(L)$, and η_t is a moving average of μ_t and v_t. Henceforth we call this the augmented Romer-Romer OLS specification. This specification differs from equation (3) in that it does not includes s_t among the endogenous variables.

Once again, an OLS estimate of equation (9) generates biased impulse responses because of the correlation between lags of μ_t in the error term and lags of $\mathbf{X}_t$. The solution, as usual, is to take lags of μ_t out of the error term; we denote the resulting specification the augmented Romer-Romer IV specification.

2. The Data

Perotti (2010) presents a new set of data that extends the Romer-Romer data in several dimensions. That paper provides full details on the construction of the data; here we summarize the main points. First, the aggregate tax shocks are divided into four main categories (personal, corporate, social security, and indirect taxes), as well as several subcategories. We exploit this disaggregation in section 4. Second, whereas Romer and Romer collect data on liabilities, Perotti (2010) collects data on both receipts and liabilities, whenever the distinction is made in the sources. In this paper, we use receipts, although the difference in effects between receipts and liabilities is small.

Third, Romer and Romer typically report the effect of a tax legislation as the first full-year effect of liability changes after enactment, and they attribute that number to the quarter of enactment. There are cases, however, in which a tax legislation manifests its effects gradually over several quarters. For instance, accelerated depreciation typically causes a large change in the time profile of receipts, but a small change in their present discounted value: receipts decline initially but increase later. Using the first full-year effect would therefore provide a distorted picture of the effects of the tax measure. Whenever possible, Perotti (2010) follows the effects of tax legislation over time.

Finally, while Romer and Romer attribute all the effects of retroactive changes to the first quarter of enactment, Perotti (2010) keeps track of the effects of retroactive measures over time. This can make a considerable difference, particularly in the case of corporate income taxation.

3. Estimates

In this section, we present the results of our empirical analysis, based on a battery of alternative specifications and decompositions of the data set.

3.1 Specifications

To summarize the discussion of the previous section, we estimate the following four specifications:

—Romer-Romer one-equation specification:

$$z_t = a(L)\tau_t + \varepsilon_t, \tag{10}$$

where $a(L)$ is of order 13 and z_t is the variable of interest;

—Augmented Romer-Romer specification:

$$\mathbf{X}_t = A(L)\tau_t + B(L)\mathbf{X}_{t-13} + \varepsilon_t, \tag{11}$$

where $A(L)$ is of order 13 and $B(L)$ of order 4 and where the vector $\mathbf{X}_t$ includes the log change of real per capita output Δy_t, the log change of real primary government spending per capita Δg_t, the first difference of the interest rate Δi_t, and the first difference of a labor market variable, each considered in turn (see more below);[18]

—Favero-Giavazzi specification:

$$\tilde{\mathbf{X}}_t = \alpha\tau_t + B(L)\tilde{\mathbf{X}}_{t-1} + \varepsilon_t, \tag{12}$$

with $B(L)$ of order 4; and

—Mertens-Ravn specification:

$$\mathbf{X}_t = A(L)\tau_t + B(L)\mathbf{X}_{t-1} + \varepsilon_t, \tag{13}$$

where $A(L)$ and $B(L)$ are of order 5 and 4, respectively.

All four specifications also include a constant. To maximize comparability with Romer and Romer (2010), in the baseline case we estimate all these specifications in first differences. All the specifications, except the Romer-Romer one-equation specification, are estimated by both OLS and IV, as discussed above. In the latter case, the set of regressors includes the moving average (lags 0 to 4) of the series μ_t obtained by IV estimation of equation (4), using as instruments lags 1 to 4 of the variables included in the vector $\mathbf{X}_t$, and lags 0 to 4 of τ_t.[19]

In all cases the initial shock is a realization of the Romer-Romer tax shock of 1 percentage point of GDP. We report both 68 percent confidence bands, which have been used extensively in the recent empirical fiscal policy literature, and the more traditional 95 percent confidence bands.[20] Standard errors are obtained by bootstrapping with 1,000 replications. We display both the point estimates of the

18. As suggested above, this is a multidimensional extension of the original Romer-Romer one-equation regression, with the addition of lags 13 to 16 of the endogenous variables, as it should be if the moving average representation is truncated correctly.

19. In the case of the Favero-Giavazzi specification, the set of instruments also includes lags 1 to 4 of s_t and only lag 0 of τ_t.

20. In their original work, Romer and Romer mostly display 68 percent confidence bands.

impulse responses and the median response of the replications. In most cases, the two impulse responses are indistinguishable in the figures.

3.1.1 Sample

The sample of Perotti's (2010) data on τ_t is 1945:1 to 2008:2 (the sample of Romer-Romer data is 1947:1 to 2006:2). The other constraints on the sample are the series on the log change in GDP, government spending, and revenues per capita, which start in 1948:2.[21] With four lags of the endogenous variables as instruments, the estimated series μ_t starts in 1949:2; since at least four lags of the endogenous variables appear in each specification, the earliest starting date of an IV estimate is 1950:2.

3.1.2 Labor market variables

We consider the following labor market variables: the unemployment rate, the log of unemployment, and the log of the labor force (the latter two variables divided by the population);[22] the probability of finding a job (calculated using data on unemployment and short-term unemployment), labor market tightness (the ratio of vacancies to unemployment), the log of vacancies (as a share of the population), and the separation rate; the log of employment and hours in the private sector and in manufacturing, all as shares of the population;[23] the log of the real product wage in manufacturing and in the business sector;[24] and the markup in manufacturing and in the nonfinancial business sector.

3.2 Results

This subsection presents the results of our estimating the four specifications identified above. For the Romer-Romer one-equation

21. The national income and product account (NIPA) data on the levels of these variables start in 1947:1, but the Federal Reserve economic data (FRED) on population start in 1948:1. The interest rate is defined as the average cost of servicing the debt, and it is constructed by Favero and Giavazzi (2010) by dividing net interest payments at time t by the federal government debt held by the public at time $t-1$.

22. Here and in what follows, "population" stands for "population age 16 and above."

23. Total nonfarm employment and civilian employment behave almost exactly like private employment; the same is true for hours.

24. These are obtained by dividing nominal wages by the producer price index.

specification, we only report the multipliers. This allows us to focus on the impulse responses to shocks to taxes for the three main alternative methodologies of interest.

3.2.1 Favero-Giavazzi OLS specification

Figure 1 displays responses from a Favero-Giavazzi OLS specification. Private consumption and private investment all decline, but by much less than estimated by Romer and Romer; GDP even increases slightly, although with very large standard errors. All labor market variables also move very little, and the results are never significant at the 95 percent level of confidence. The unemployment rate increases by a mere 0.15 percentage points at the peak, and the response is entirely insignificant even at the 68 percent level. As we argued above, if the discretionary and automatic components of fiscal policy do indeed have different effects, we would expect an attenuated response to a discretionary tax shock.

Figure 1. Favero-Giavazzi OLS specification

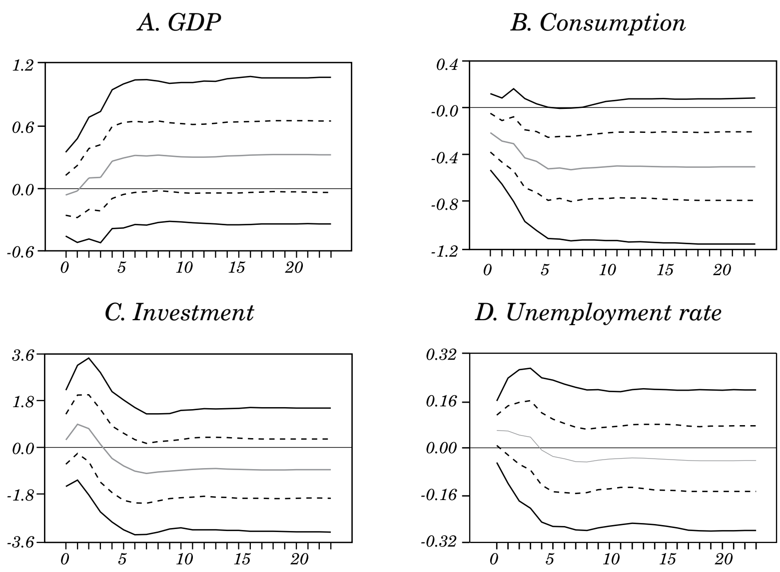


Figure 1. (continued)

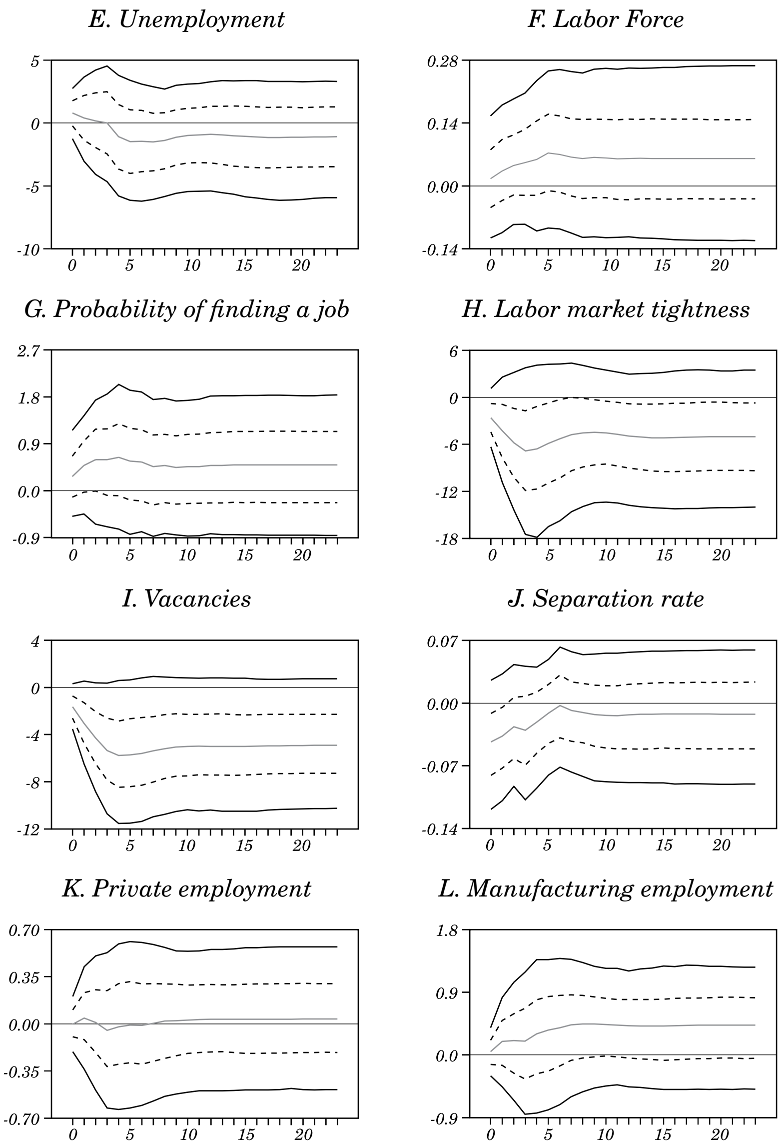
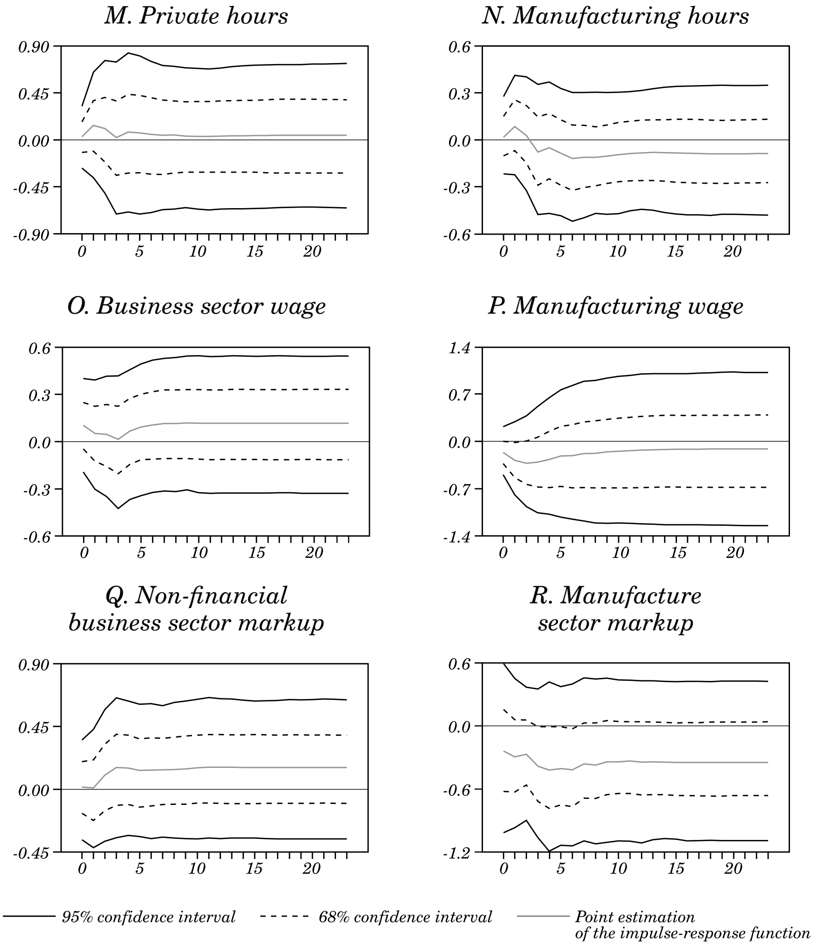


Figure 1. (continued)



Source: Authors' calculations based on Favero and Giavazzi (2010).

3.2.2 Mertens-Ravn IV specification

Figure 2 displays responses from the Mertens-Ravn IV specification. The responses are much stronger than under the Favero-Giavazzi specification. GDP falls by 1.2 percent after six quarters, less than half the decline estimated by Romer and

Romer, but still much more than the Favero-Giavazzi estimate. Private consumption falls by 0.7 percent and private investment by about 5 percent, which again is in between the Romer-Romer and Favero-Giavazzi estimates. The standard error bands are now much tighter. The GDP and private investment responses are significant at the 95 percent level, while the consumption response is only significant at the 68 percent level. Private investment also declines, but the response is significant only at the trough of 3 percent after three quarters.

Figure 2. Mertens-Ravn IV Specification

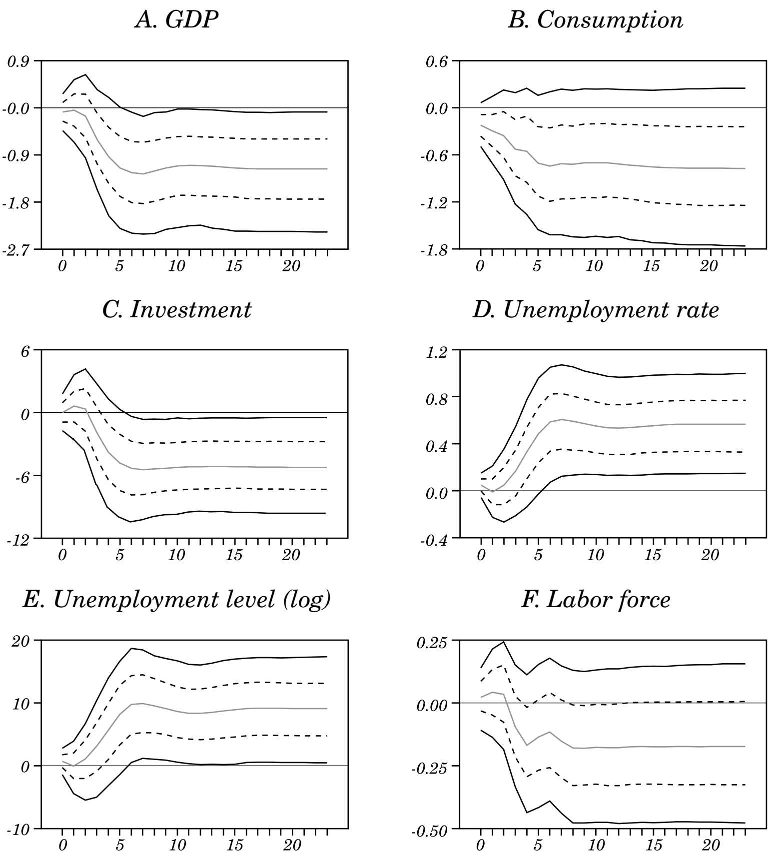


Figure 2. (continued)

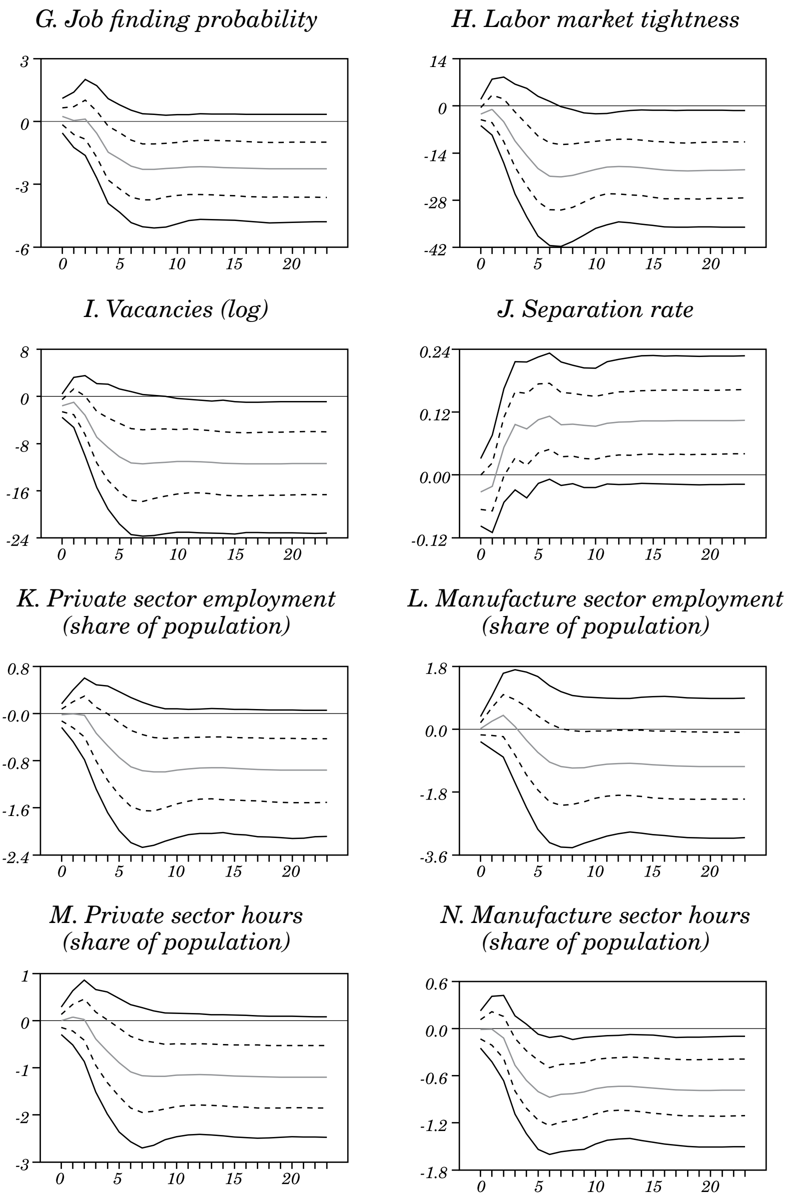
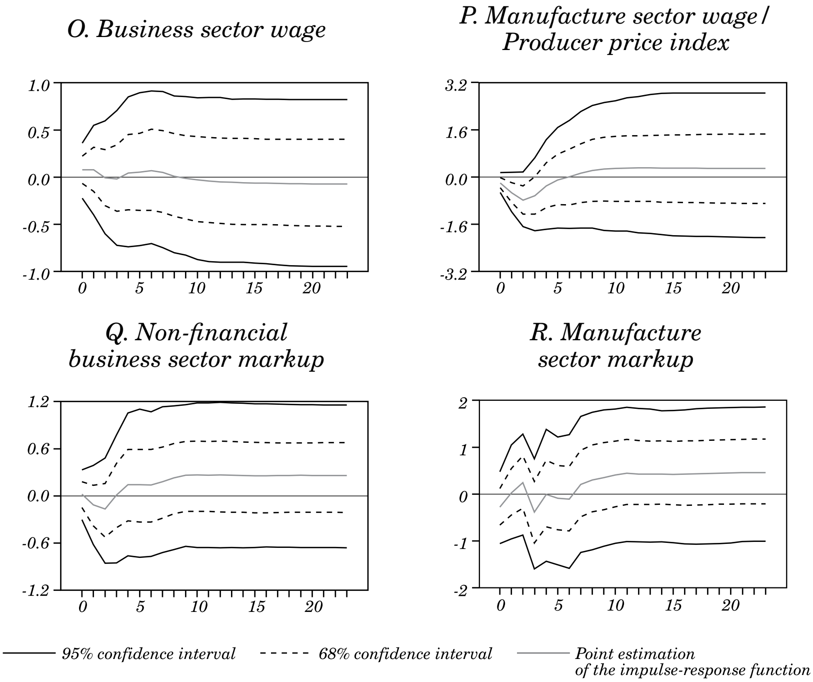


Figure 2. (continued)



Source: Authors' calculations based on Mertens and Ravn (2009).

Qualitatively, all labor market variables move in a direction that is economically meaningful.[25] In all cases (with the exception of the real wage and the markup), the responses are significant or nearly significant at the 95 percent level, usually after a few quarters. The unemployment rate increases gradually, reaching a peak of about 0.6 percentage points after six quarters and then stabilizing at that level. Panels E and F show that most of the action comes from the increase in unemployment, but there is also a decline of the labor force participation by about 0.2 percent, although the drop is significant only at the 68 percent level.

25. We do not employ a formal theoretical model in this version of the paper, but these results are all qualitatively consistent with a benchmark real business cycle (RBC) model with search and matching frictions in the labor market. For example, Monacelli, Perotti, and Trigari (2010) use an RBC model to study the effects of government spending. See more below on this point.

The job-finding probability falls gradually, reaching a peak reduction of about three percentage points after two years. Similarly, labor market tightness falls gradually by almost 20 percent after two years. This decline is due in almost equal measure to a decrease in vacancies and to an increase in unemployment (see panel E and panel I). The separation rate increases by about 0.15 percentage point after one year. This implies that both the hiring and the separation margin contribute considerably to the decrease in employment.

Panels K through N display the responses of private and manufacturing employment and hours. Hours decline by about 1 percent in both sectors; both are significant at the 95 percent level. Virtually all the response of hours is due to the extensive margin: employment tracks hours almost exactly. Finally, the real wage and the markup in manufacturing and in the business sector (panels O through R) move little, and the standard errors tend to be large.

The OLS estimates of all these responses obtained under the Mertens-Ravn specification (not shown) are very similar to the IV estimates displayed here; as discussed above, this is consistent with a small effect of the automatic component of tax changes, captured by $D(L)$. In contrast, the IV responses of the Favero-Giavazzi specification (also not shown) are different from the corresponding OLS responses displayed in figure 1: this is consistent with a large difference between the effects of the discretionary and automatic components of tax changes.[26]

3.2.3 Augmented Romer-Romer moving average specification

For comparison, we display the responses of the augmented Romer-Romer OLS moving average specification in figure 3. This is a multidimensional extension of the original Romer-Romer one-equation regression. The responses are often slightly stronger than the Mertens-Ravn IV responses, and the standard error bands tighter. In particular, unemployment increases more, and hours, employment, and GDP decline more. There is also more evidence of an increase

26. As discussed above, Favero-Giavazzi IV responses are very similar to Mertens-Ravn IV responses, and they are numerically identical if the same instruments are used to estimate equation (4).

in the product wage, particularly in manufacturing, where it rises by 2 percent after two years and is significant at the 95 percent level. These results are consistent with Perotti (2010), who shows that Mertens-Ravn IV responses of output are often in between the large responses estimated by Romer and Romer (based on a single-equation approach rather than an augmented Romer-Romer specification as here) and the small responses estimated by Favero and Giavazzi.

Figure 3. Augmented Romer and Romer OLS Specification

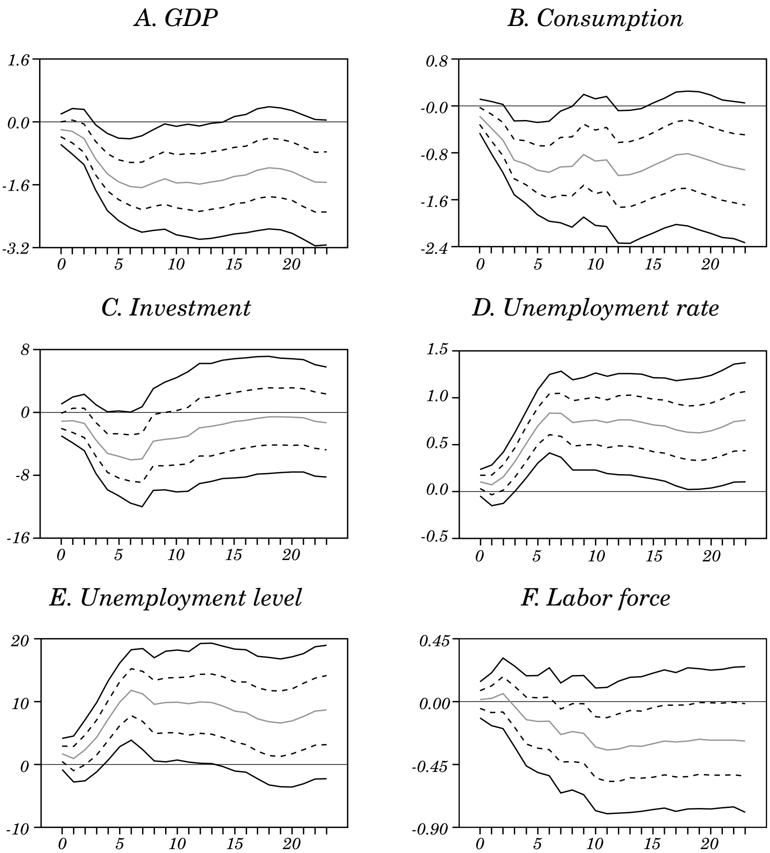


Figure 3. (continued)

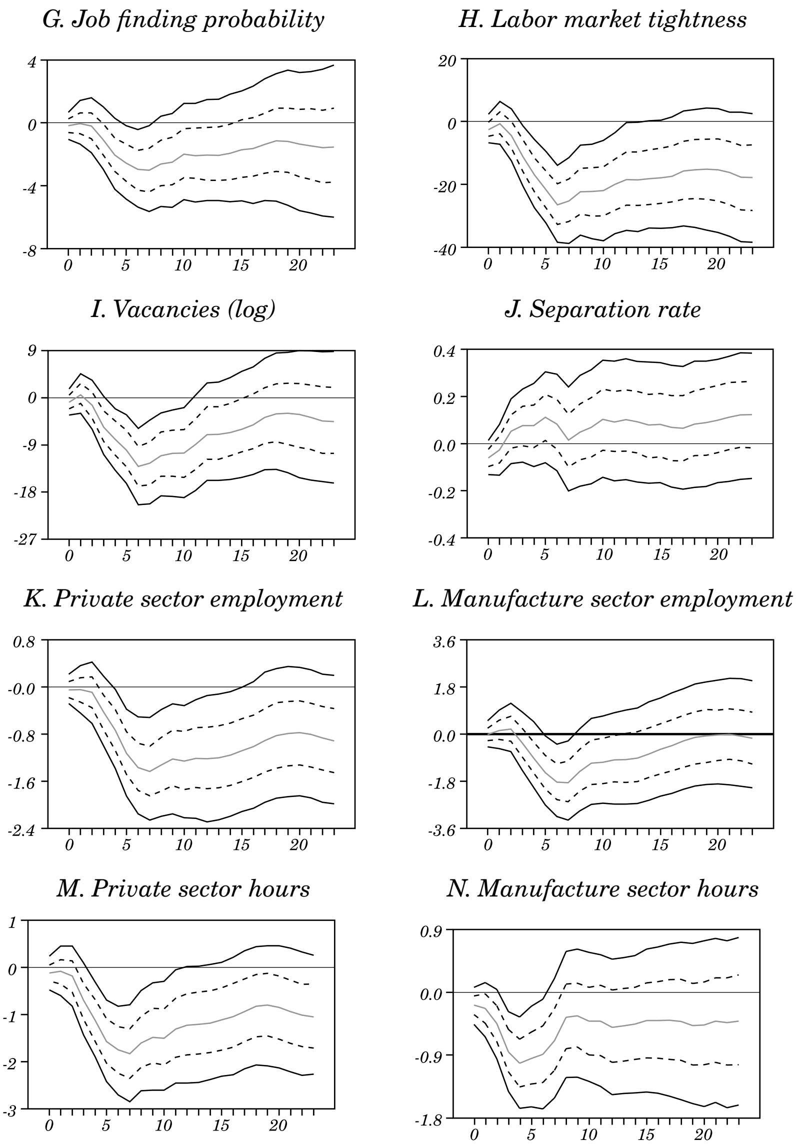
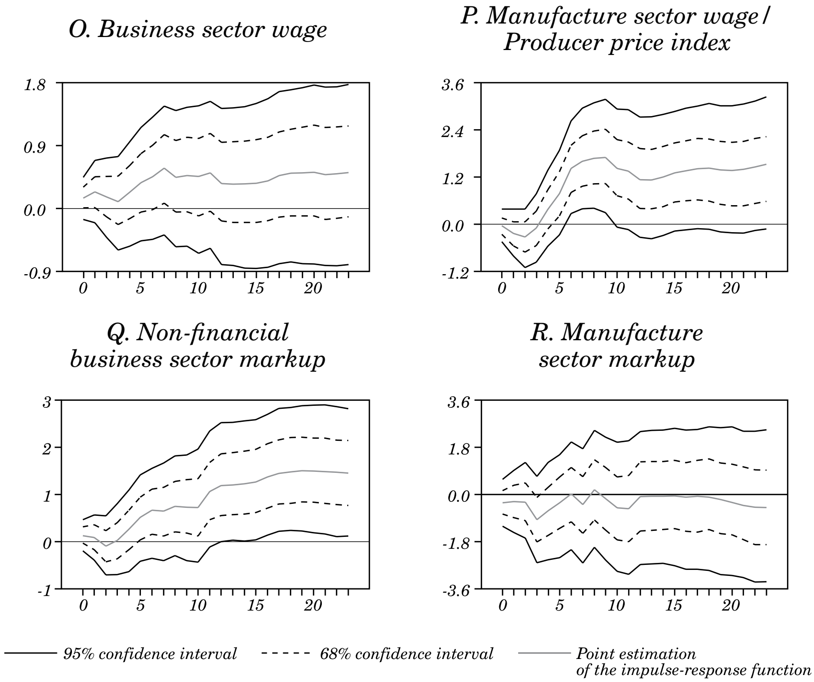


Figure 3. (continued)



Source: Authors' calculations based on Romer and Romer (2008).

3.2.4 Multipliers

Table 1 summarizes the main results in terms of tax multipliers. It displays the point estimates of the impulse responses of the main variables of interest, at six and twelve quarters, for the three alternative methodologies: Favero-Giavazzi OLS, Mertens-Ravn IV, and augmented Romer-Romer OLS moving average. We also show the responses from the Romer-Romer one-equation specification, estimated both with the original Romer-Romer data and with our data. Recall that the underlying tax shock is normalized to 1 percentage point of GDP.

Four observations stand out. First, the Romer-Romer one-equation specification delivers much stronger responses than the other three specifications. With the original Romer-Romer data on the

Table 1. Tax Multipliers under Alternative Specifications[a]

Variable and response time	*Romer-Romer OLS one-equation*		*Augmented Romer-Romer OLS*	*Favero-Giavazzi OLS*	*Mertens-Ravn IV*
	Romer-Romer data	*Our data*			
Unemployment rate					
Six quarters	0.32 *	0.30 *	0.70 **	−0.05	0.49 *
Twelve quarters	1.10 *	0.67 **	0.74 **	−0.05	0.54 **
Job finding probability					
Six quarters	−1.98 *	−0.78	−2.56 **	0.57	−1.79 *
Twelve quarters	−4.76 *	−2.51 *	−2.09 **	0.46	−2.17 *
Private employment					
Six quarters	−0.44 *	−0.59 *	−1.13 **	−0.01	−0.75 **
Twelve quarters	−2.07 *	−1.35 **	−1.22 **	0.03	−0.94 *
Business wage					
Six quarters	−0.58 *	0.11	0.37	0.09	0.05
Twelve quarters	−0.51 *	0.17	0.51	0.12	0.04
Private investment					
Six quarters	−3.56 *	−1.63	−5.58 **	−0.71	−4.67 *
Twelve quarters	−9.69 *	−3.30	3.01	−0.84	−5.11 *
GDP					
Six quarters	−1.17 **	−0.82 *	−1.52 **	0.34	−1.15 *
Twelve quarters	−2.74 **	−1.73 **	−1.54 **	0.35 *	−1.10 *

Source: Authors' elaboration.
* Statistically significant at the 32 percent level. ** Statistically significant at the 5 percent level.
a. See section 3.1 for the details of the alternative specifications.

tax shocks, the unemployment effect at twelve quarters is 1.10, the GDP effect −2.74 (as in Romer and Romer, 2010), and the investment effect an impressive −9.69 percent. These numbers are about two to three times larger than the Mertens-Ravn IV effects.

Second, the tax data do make a difference: when we use our own estimates of the tax shocks, the effects on virtually all variables decline in absolute value, although they usually remain larger than in the Mertens-Ravn IV specification. For the rest of the results, we use our estimates of the tax shocks.

Third, the augmented Romer-Romer specification (that is, the multivariate extension of the Romer-Romer one-equation specification) still tends to deliver higher estimates of the unemployment and GDP effects than the Mertens-Ravn IV specification. In contrast, the Favero-Giavazzi specification features much smaller and often insignificant multipliers. Under our preferred specification (Mertens-Ravn IV), the unemployment rate rises by 0.54 percentage points after six quarters, whereas GDP falls by 0.93 percent; the responses at twelve quarters are almost identical. Noticeably, both the unemployment and the GDP multipliers estimated under the Mertens-Ravn IV specification are a bit smaller than the corresponding multipliers of government spending that we estimated in Monacelli, Perotti, and Trigari (2010).

Fourth, the investment multiplier is sizeable both in the Mertens-Ravn IV specification and in the augmented Romer-Romer specification (after six quarters, −3.88 percent and −2.93 percent, respectively, although in the latter case it is estimated rather imprecisely). Once again, the effect on investment under the Favero-Giavazzi specification is smaller and not statistically significant at both horizons.

4. Labor and Corporate Income Taxes

One benefit of the dataset we use is that it allows us to distinguish between different types of taxes. In particular, we identified four main tax categories and several subcategories:

—Personal taxes (which disaggregates into the subcategories of tax rates, deductions and allowances, tax credits, capital gains tax, depreciation, earned income tax credit, rebates, estate and gift taxes, and other taxes);

—Corporate income taxes (which disaggregates into tax rates, employment credit, investment tax credit, depreciation, and other taxes);

—Indirect taxes; and

—Social security taxes (including tax rates, earnings base, and other taxes).

The sum of all these items is the aggregate taxes that we have used in the exercises so far. We now regroup these taxes into three main categories:

—Labor income taxes: personal income taxes (excluding capital gains taxes and depreciation allowances) and social security taxes;

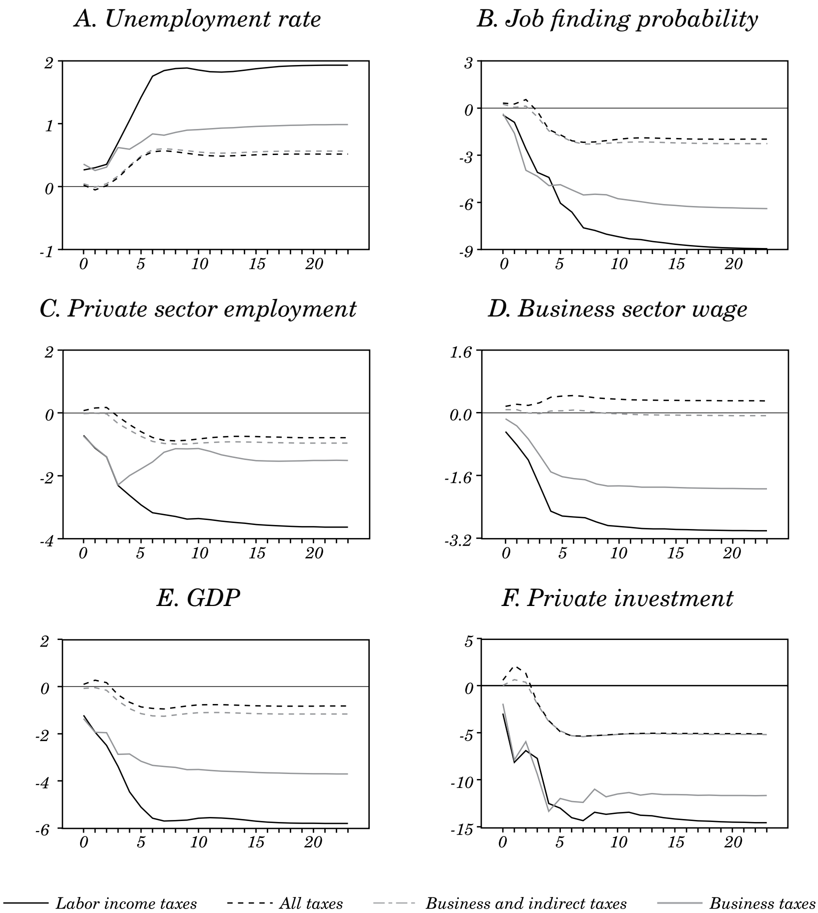
—Business taxes I: corporate income taxes, personal capital gains, and personal depreciation allowances; and

—Business taxes II: business taxes I plus indirect taxes.

Figure 4 displays the results. We only display the responses of the main variables: for instance, we have seen that the impulse responses of tightness and vacancies track the response of the job-finding probability very closely, so we only display the latter. The effects of labor income taxes are virtually identical to those of all taxes combined. In contrast, the effects of the two types of business taxes are stronger, particularly under the second definition; the first definition tracks the second closely in the first year, but it then returns to the stochastic trend more quickly. Under the second definition, a shock to business taxes raises the unemployment rate by twice as much as a similar shock to labor income taxes; it also causes a larger decline in the job-finding probability, employment in the private sector, GDP, and private investment by twice as much or more. Finally, it causes a 3 percent decline in the business sector wage, which does not move in response to a shock to labor taxes or total taxes.

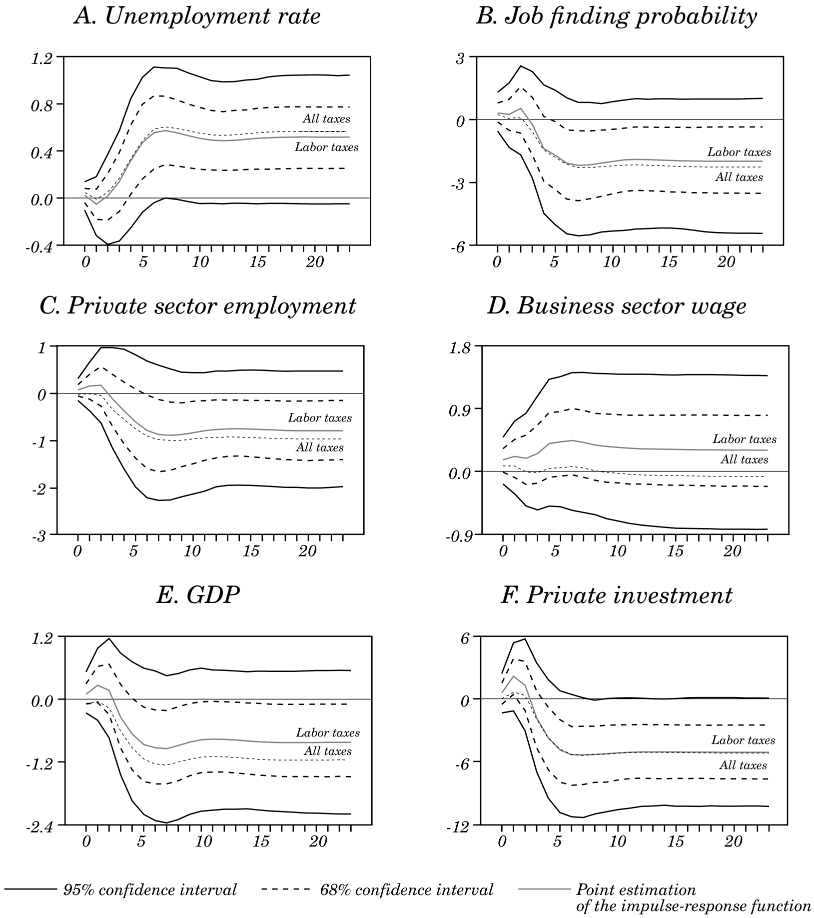
Figures 5 and 6 display the responses to shocks to labor income taxes and to the second definition of business taxes, respectively, now including their 68 and 95 percent standard error bands. The figures also display the responses to shocks to total taxes (the dashed line). Here again, the responses to labor income taxes differ minimally from the responses to total taxes, and the standard errors are only slightly larger. With corporate income taxes, the responses are always significant at the 95 percent level; they are also significantly different from the responses to total taxes at the same level of confidence.

Figure 4. Different Types of Taxes: Mertens-Ravn IV Specification



Source: Authors' calculations based on Mertens and Ravn (2009).

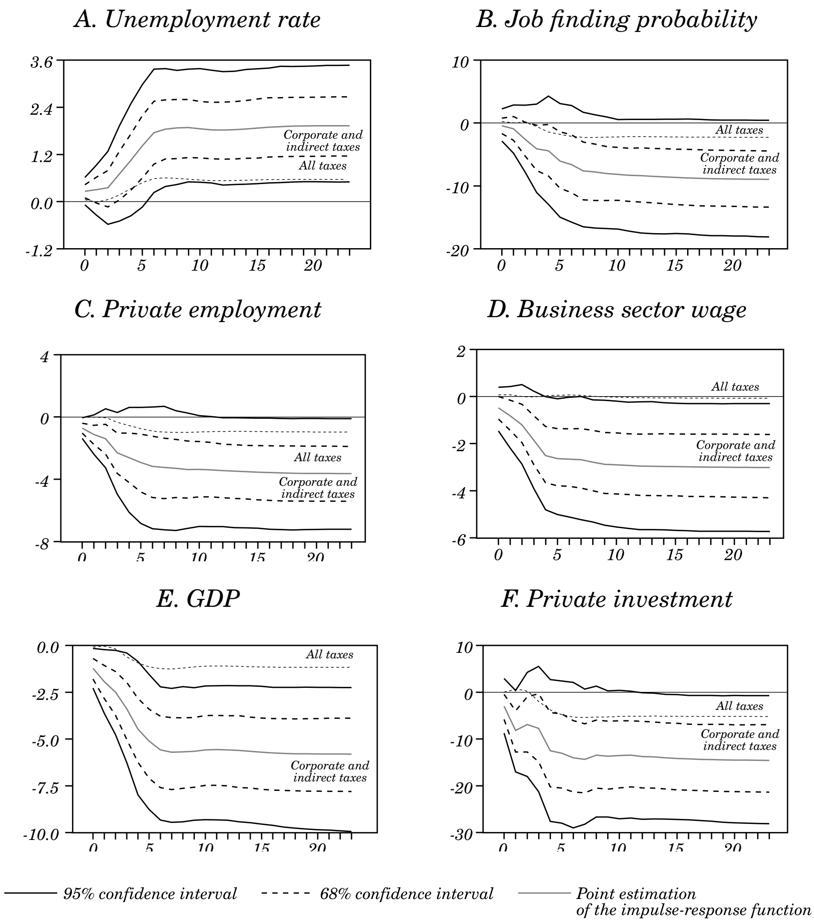
Figure 5. Labor Taxes: Mertens-Ravn IV Specification[a]



Source: Authors' estimations.

a. The dashed lines graph the responses to shocks to total taxes.

Figure 6. Business Taxes: Mertens-Ravn IV Specification[a]



Source: Authors' elaboration.

a. The dashed lines graph the responses to shocks to total taxes.

5. Conclusions

We have investigated the effects of exogenous variations in taxes on a series of macroeconomic variables, with special emphasis on the unemployment rate and the labor market. Our analysis differs from the seminal contribution of Romer and Romer (2010) in three main respects: first, we extend their data set of narrative records of exogenous tax innovations; second, we show that methodological assumptions on both the specification and the estimation of the empirical model are crucial for quantifying the size of the tax multipliers; and third, we devote special attention to the labor market implications of the changes in taxes.

We have shown that an increase in tax receipts of one percent of GDP has a sizeable positive impact on the unemployment rate and a negative impact on hours worked, labor market tightness, and the probability of finding a job. The negative effect on GDP is also sizeable, but in the mid-range of other values found in the literature. We have shown that this depends on a series of methodological details, involving both the econometric specification and the estimation method. We have also shown that the unemployment multiplier is larger for business taxes than for personal income taxes, although the former is estimated a bit more imprecisely than the latter.

Obtaining larger unemployment multipliers from business taxes than from personal income taxes poses a series of interesting theoretical challenges. In Monacelli, Perotti, and Trigari (2010) we build an RBC model with search and matching frictions to analyze the effects of variations in government purchases. In that model, we establish that changes in government spending affect the hiring rate via variations in the value of nonwork relative to work activity, which in turn affects the surplus from the job matching process. Importantly, the relative value of nonwork activity captures not only the marginal value of leisure, but also the broader value of all nonmarket activities, including home production and unemployment benefits.

One can employ the same model to analyze the labor market effects of exogenous changes in a variety of distortionary taxes. For example, variations in wage income taxes would also affect the hiring rate via their effect on the relative value of nonwork activity. However, changes in employers' payroll taxes, which are classified among the business taxes in our empirical analysis, would have exactly the same effect on surplus and hiring. Nash bargaining renders those two taxes effectively undistinguishable in the model.

Several other tax categories can be modeled within the baseline theoretical framework. For example, we can introduce investment and employment tax credits as directly affecting the cost of hiring a worker (as either a subsidy per vacancy or a subsidy per new hire). More generally, mapping our tax categories in the data into model counterparts requires some thinking, but the model easily lends itself to this exercise. Furthermore, while there is already extensive work on the steady-state effects of various taxes and subsidies in the baseline search and matching model, the study of their dynamic effects over the business cycle is quite limited. We plan to explore these issues in future research.

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Tightening Tensions: Fiscal Policy and Civil Unrest in South America, 1937–95

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On 1 May 2010, the Greek Prime Minister George Papandreau announced a set of drastic austerity measures. May Day itself saw clashes between police and demonstrators. On 5 May, a general strike paralyzed the country; armed demonstrators fought street battles with police. A bank burned down, and numerous demonstrators and policemen were injured. By the standards of antigovernment protests, the May 2010 incidents in Athens were mild. Many countries have seen severe rioting and political violence following budget cuts. In this paper, I examine the extent to which social unrest is clearly associated with fiscal austerity. Do riots, antigovernment demonstrations, political assassinations, and attempts at revolutionary overthrow become more common if governments push through tax hikes and spending cuts?

I analyze this question for South America during the period 1937–95. The continent's notoriously volatile politics, combined with large swings in fiscal conditions, make it a particularly appealing laboratory for exploring the link between fiscal adjustment and social instability. From the popular protests that led to the fall of the de la Rúa administration in Argentina to the so-called Caracazo in Venezuela, austerity measures have played a prominent role in numerous cases of mass protest (Sonntag, Maingón, and Biardeau, 1992; Handelman and Sanders, 1981). Cuts in expenditure are particularly strongly correlated with violent forms of protest and attempts to overthrow the government, whereas fiscal adjustment through tax increases is less clearly associated with unrest than

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expenditure cuts. This suggests a reason why budget adjustments—even if associated with better macroeconomic performance (Alesina and others, 2002)—are not very common in practice.[1] The relationship between austerity and unrest is apparent in countries with both autocratic and democratic regimes: countries do not need a minimum level of political development to show a clear-cut correlation between unrest and fiscal contractions.

The relationship between fiscal adjustment and antigovernment violence has strengthened in recent decades. The link is weaker in the data before the mid-1970s and stronger thereafter. It seems likely that improving institutions, greater freedoms to associate and for the press, and a higher degree of democratic participation after the mid-1970s in a number of countries have resulted in mass protests becoming another form of bargaining with the government.

Related literature includes work on the nature and timing of fiscal adjustments, as well as the causes of social unrest. That immiseration is the driving force behind violent upheavals is a common theme in the political science literature since at least the days of Karl Marx. The Weimar Republic's demise in the 1930s is often cited as a warning. In a bid to gain competitiveness on world markets, the German government under Chancellor Heinrich Brüning cut public expenditure (including civil servant pay) and introduced major tax hikes (Bracher, 1978). Street fighting between communists and Nazi Party supporters, riots, and political murders followed, and these events arguably prepared the ground for Hitler's *Machtergreifung* in 1933.[2] More generally, several authors have examined the interplay of fiscal consolidation and social unrest in interwar Europe (Eichengreen, 1996; Feldman, 1997; Maier and Knapp, 1975; Wirsching, 2003). France in the 1930s, in particular, is a case of political violence increasing in times of fiscal austerity.

This paper also connects with research on the determinants and feasibility of fiscal adjustment. Research by Alesina and others (2002) suggests that fiscal contractions can be expansionary. Related work by Alesina, Perotti, and Tavares (1998) also argues that there is no penalty for the government—it neither loses popularity nor reduces its chances of reelection. Sharp adjustments may even be rewarded by the electorate. This is in line with the finding by Kraemer (1997)

1. See also the recent reassessment in by the IMF (2010).

2. The extent to which economic factors drove voters into the arms of the Nazi Party is controversial (Falter, 1991; King and others, 2008).

that fiscal expansions in Latin America prior to elections do not increase a government's chances of staying in power.

If these findings are taken at face value, they raise the question of why fiscal adjustments are ever delayed—without a penalty at the ballot box or in the national accounts, why aren't fiscal adjustment implemented instantly and vigorously? The findings in the papers by Alesina and different coauthors imply that the typical cost of adjustments may be low, measured in terms of growth or electoral success. At the same time, the expenditure cuts of the type favored by Alesina and others (2002) sharply raise the risk of major social upheaval—at least in South America during the period 1937–95. This is in line with the argument in a classic paper by Alesina and Drazen (1991), who argue that stabilizations are often delayed because social groups engage in a war of attrition. For the argument to work, adjustment has to be costly, and while it is postponed, parties fight over which group will bear its brunt. While Alesina and Drazen do not address unrest and its causes directly, it is straightforward to think of street protests and mass violence as part of the negotiation process that ultimately decides the shape and size of austerity measures. Part of the answer is suggested by studies that examine the relative strength of the ruling government. Stein, Talvi, and Grisanti (1999) argue that in Latin America, more fragmented political systems—as proxied by the size of electoral districts—are associated with greater levels of public spending.[3] A government's parliamentary backing has a similar effect. Woo (2003) finds that instability and unrest are clearly associated with higher levels of public debt. This implies either that countries with more debt are less stable politically or that instability makes it harder to achieve budget discipline. Neto and Borsani (2004) find that government stability is associated with greater fiscal prudence, as are the level of parliamentary support and a conservative orientation of the ruling party.

The study closest in spirit to this paper is by Paldam (1993), who studies nine balance-of-payments crises in seven South American countries.[4] Most of these were associated with attempts to lower inflation. Governments—sometimes with help from the International Monetary Fund (IMF)—pushed through spending cuts and saw a rise in protests in response. Paldam uses an event-study

3. There is also evidence that countries with presidential systems have smaller governments (Persson and Tabellini, 2005).

4. Paldam's study is discussed extensively in Haggard, Lafay, and Morrisson (1995).

methodology and compares the 26 weeks before the announcement of budget adjustments with the 55 weeks thereafter. His outcome variables include strikes, protest demonstrations, and changes in government composition (or regime change). Surprisingly, Paldam finds that protests decline after adjustment measures are introduced (before returning to pre-adjustment levels later). At the same time, government changes spike about ten weeks after new budget measures are implemented. Paldam also argues that democratic regimes experience more violent protests than autocracies. For Africa, Morrison, Lafay, and Dessus (1994) analyze IMF interventions and fiscal adjustments. They find that economic stabilization programs can be politically risky. Within six months of an adjustment program, strike activity escalates.[5] The study finds that increases in relative prices—through new taxes, the end of food subsidies, devaluations, and public tariff changes—are likely to raise the level of political agitation. On the other hand, expenditure cuts, especially those for public investment, have no discernible effect. Another study by the Organization for Economic Cooperation and Development (OECD) examines the effects of aid and monetary adjustments on strikes and demonstrations (Haggard, Lafay, and Morrisson, 1995). It finds that increases in aid reduce unrest and that IMF interventions and monetary tightening increase it.

Other related literature includes work on the interaction between distributional outcomes, political change, and the potential for political violence. Acemoglu and Robinson (2000) argue that Western societies extended the franchise to heed off the threat of revolution. Boix (2003) builds a more general model in which inequality and asset specificity modifies the trade-off between opting for violence or accepting the status quo. In either case, if the threat of violent overthrow is credible, it seems plausible that various forms of violent mass protests can be used as a form of collective bargaining over distributional outcomes.

The social psychology literature generally emphasizes the importance of comparison effects and of low social distance between favored and unfavored groups (Berkowitz, 1972). Other papers analyze the importance of peer effects in overcoming participation thresholds (Cole, 1969). This suggests that the larger the network of potential protesters, the more probable it is that they participate in mass actions.

5. The estimated coefficients are small (around 0.15), and the authors do not test for significance.

I proceed as follows. Section 1 summarizes the data, and Section 2 presents the main results. Section 3 examines the robustness of these findings, and the final Section concludes.

1. Data and Context

Neither quantifying violent protests nor measuring fiscal adjustments is a simple task.[6] In this paper, I use data collected by Banks (1994) on the number of political assassinations, general strikes, riots, and antigovernment demonstrations. While the data set was compiled from the 1960s onward as part of a large-scale data collection effort at the University of Binghamton, it covers earlier periods based on contemporary publications. It is based on information on political and economic conditions originally published in *The Statesman's Yearbook*. The yearbook was first published in 1863, following suggestions by prime ministers Robert Peel and William Gladstone, and was meant to contain "a statistical, genealogical, and historical account of the states and sovereigns of the civilized world." Conflict data itself were gleaned from the *New York Times* and are available from 1919 onward. I also use data on economic variables from the Banks (1994) data set, which is based on data from the United Nation's *Statistical Yearbook* and *Pick's Currency Yearbook*. Finally, data on institutional quality come from the Polity IV data set (Marshall, Jaggers, and Gurr, 2010).

I use data for 11 South American countries—Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Suriname, Uruguay, and Venezuela. Not included are Guyana and French Guyana, the former because data on control variables were not available, the latter because it is an overseas territory of France and thus is not subject to the same political dynamics. The starting date in the 1930s is the earliest from which data on unrest and output per capita are available for a reasonable number of countries.

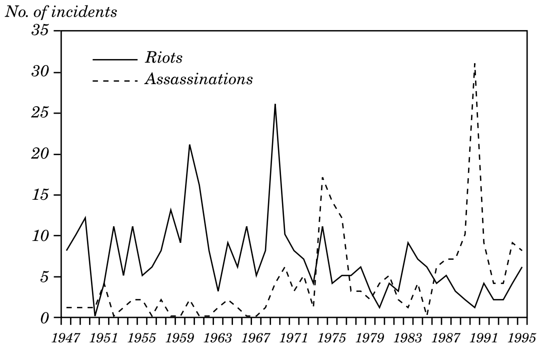
On average, for each country during a ten-year period, the data show 6.9 riots, 6.0 antigovernment demonstrations, 4.0 assassinations, and 3.4 attempts to overthrow the government in a violent fashion (that is, revolutions). The probability of unrest did not remain constant over time. I plot the patterns in figures 1 and 2. The most striking feature of each time series is its volatility—the

6. For methodological considerations, see IMF (2010).

number of riots or assassinations may be low for several years, before suddenly reaching a very high level in a single year. Riots were more common in South America in the 1950s and 1960s than in later years. While the average frequency in normal years has not changed much from the five to eight recorded in the immediate post-war era, there are fewer peaks. In the period from 1937 to 1970, there were nine years with more than ten riots in the sample; after 1970, there was only one.

Politically motivated assassinations show the opposite pattern. There were relatively few in the immediate post-war period. Typical years show zero or one murder of a politician, while bad years have two to three. This changed dramatically after the mid-1970s. Even quiet years now register three to five assassinations, and there are two peaks with murder frequency surging above ten per year.

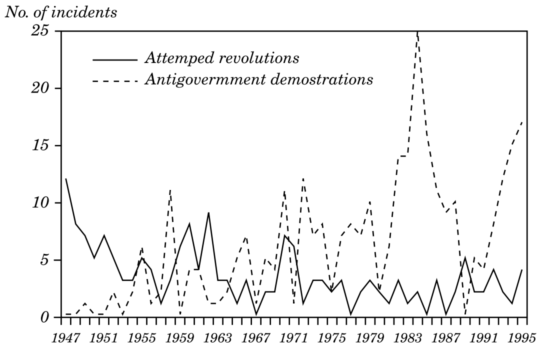
Figure 1. Riots and Assassinations in South America, 1937–95[a]



Source: Banks (1994).
a. The figure graphs the mean sample value by year.

The history of antigovernment demonstrations and of coups and revolutions—attempted or successful—is similarly volatile. Figure 2 gives an overview. Antigovernment demonstrations have been on an increasing trend since the 1930s. For most of the 1950s and 1960s, there were three to five of them per year, with values above five a rare occurrence. Since 1970, there have been more than ten years with more than ten antigovernment demonstrations, with an all-time peak of 25 in 1984.

Figure 2. Revolutions and Demonstrations in South America, 1937–2005[a]



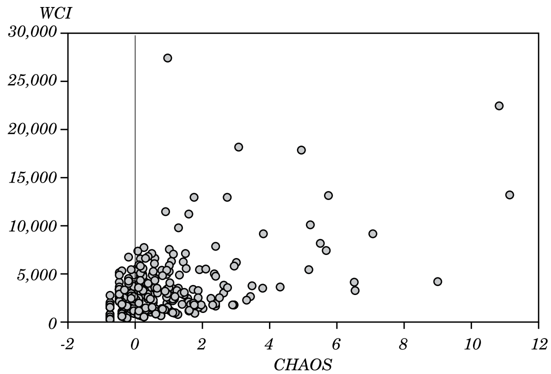
Source: Banks (1994).
a. The figure graphs the mean sample value by year.

Attempts at revolution have been declining. The immediate post-war era saw a high number, with 12 recorded attempts at overthrowing the existing government in 1948. The 1950s and 1960s also continued to be marked by violent attempts at overturning the established order, with revolutionary episodes in the early 1960s and early 1970s. Since the mid-70s, revolutions have become rare, with no years registering a frequency higher than five.

The Banks data set contains an aggregate measure of unrest—the weighted conflict index (henceforth, WCI). It combines the different series on unrest in the Banks data set by adding them up with different weights. Assassinations, for example, receive a weight of 24, while purges count almost four times as much (86). Antigovernment demonstrations receive the highest score (200). The weights were not chosen based on statistical analysis; they reflect the assessment of Banks and his team. Subsequent analysis uses this indicator.

In addition, I construct an aggregate measure based on principal component analysis, using a subset of the time series collected by Banks. Of the eight indicators compiled in the Banks database, only five are closely related to the issue of interest here—social unrest that can reflect opposition to or protests against government spending cuts. These variables are antigovernment demonstrations, general strikes, riots, assassinations, and revolutions. In contrast, purges are attempts by the authorities to silence the opposition. Government

Figure 3. Comparison of Indicators: WCI versus CHAOS



Source: Author's elaboration based on Banks (1994) dataset.

crises may have many origins and rarely reflect public unrest as a result of fiscal adjustments.[7] Finally, acts of guerrilla warfare often reflect long-running military conflict between different ethnic groups or attempts by foreign powers to undermine the government. While some degree of popular support is clearly necessary for the guerrilleros to succeed, it is not clear that the frequency of guerrilla warfare maps closely onto levels of popular support, at least at an annual frequency. Moreover, fiscal adjustments in a single year are unlikely to lead to sufficient disillusionment for such a radical course of action.

I use principal component analysis to extract a common factor to the unrest captured by the five variables of interest—antigovernment demonstrations, general strikes, riots, assassinations, and revolutions. The first principal component explains 38 percent of the total variance. All factors enter with a positive loading. Riots, assassinations, and general strikes have relatively high scoring coefficients. The first principal component (henceforth, CHAOS) and the weighted conflict score from the Banks data set (WCI) are highly but not perfectly correlated (0.6, significant at the 1 percent level).

Figure 3 compares the two aggregate measures of unrest—WCI and CHAOS. While they are positively correlated, they clearly do not capture exactly the same variation in the data. For example, Brazil

7. There are clearly exceptions to this, such as Argentina in 2001.

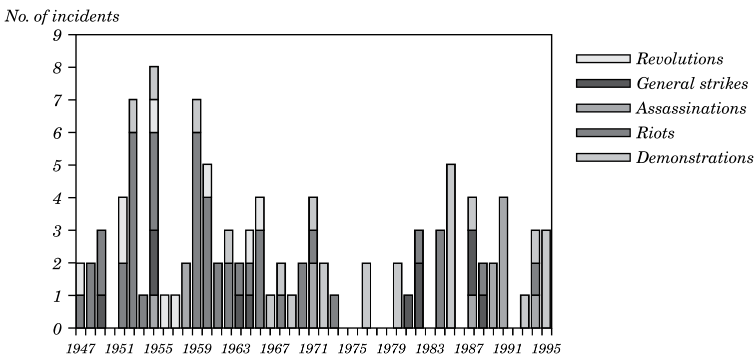
in 1969 registers a WCI score of over 27,000, while only showing a CHAOS indicator of 0.875. This is because a wave of guerrilla attacks and purges swept the country in 1969—Banks registers 14 guerrilla actions and 34 purges.

1.1 Brazil

Since independence, Brazil experienced numerous acts of politically inspired violence. The 1920s saw several attempts by junior officers to usurp power. In 1930, Getúlio Vargas seized power and established a dictatorship, which became increasingly autocratic after an attempted communist uprising in 1935. After the Allied victory in 1945, a military coup deposed Vargas and returned Brazil to democracy. A sequence of populist governments held power until the 1960s, when another military coup ushered in a 21-year-long military dictatorship. Civilians have governed since 1985, and all change of office has been peaceful since then (Levine, 2003).

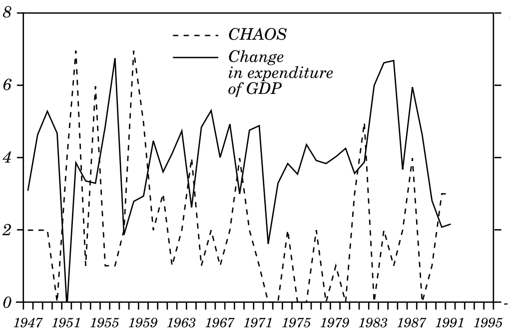
The conflict series for Brazil is dominated by riots, which occurred with some frequency in the 1950s and 1960s (figure 4). The years of military dictatorship show relatively fewer incidents overall, with no attempts at revolutionary overthrow. General strikes are also conspicuously rare in 1964–75. Austerity measures increased after 1975 and were one of the factors behind the rise in militancy (Frieden, 1992). The late 1970s were also marked by strong and

Figure 4. Unrest in Brazil, 1947–95



Source: Banks (1994).

Figure 5. Social Unrest and Changes in Expenditure in Brazil, 1947–95



Source: Author's elaboration based on Banks (1994) dataset and UN Statistical Dataset.

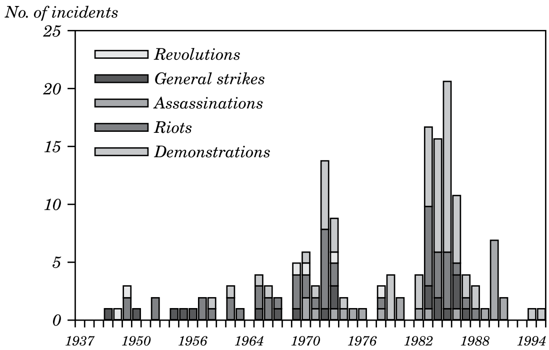
effective strikes, which were instrumental in bringing military rule to an end (Antunes and Wilson, 1994; Payne, 1991). The return to democracy saw a rise in protests, including several assassinations in the early 1990s.

To what extent can the ebb and flow of political violence and social unrest in Brazil be explained by economic conditions—in particular, government spending? Historians of labor unrest in Brazil have sometimes disputed the role of economic factors (Sandoval, 1993). While each incident in the data set undoubtedly has highly specific causes, I find a negative correlation between expenditure changes and the aggregate measure of unrest (CHAOS). Figure 5 shows both time-series. For the sample as a whole, the correlation coefficient is –0.17; for the period before 1965, it is –0.35. Based on the evidence presented so far, there is some reason to suggest that changes in national expenditure have had predictive power for the level of unrest documented for Brazil.

1.2 Chile

Chile's early political history was generally less volatile than that of many other Latin American countries. This changed in the 1920s, when Marxist groups gained influence. A military coup in 1925 ushered in a period of rapid government turnover, which lasted until constitutional rule was restored in 1932. The following twenty

Figure 6. Unrest in Chile, 1937–95



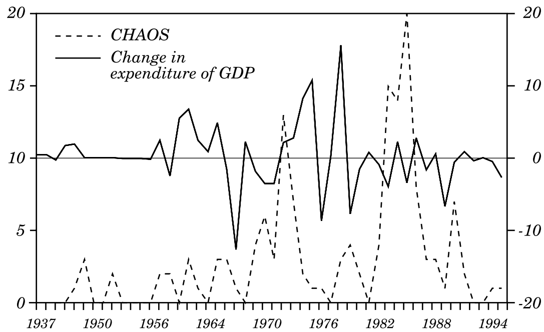
Source: Banks (1994).

years saw a variety of coalition governments, many dominated by the radical party (Collier and Sater, 2004). Under Jorge Alessandri, elected in 1958, the conservatives gained power once more. From 1964 onward, a left-leaning government under Eduardo Frei Montalva pursued a series of reforms. These included generous social programs, plans for agricultural reform, and large-scale housing projects.

The data show only a handful of strikes and riots in Chile in the 1950s and early 1960s. Unrest increased under the Frei government, with left-wing militants strengthening their position. In 1970, Salvador Allende was elected president. In addition to embarking on a major program of social reform, Allende expanded the state's role in the economy and nationalized the banking system. The Allende years show a rise in the frequency of riots, attempted overthrows of the government, and antigovernment demonstrations. At the same time, government spending increased massively, with particular emphasis on social programs (Collier and Sater, 2004). Unrest peaked in the years prior to the military putsch that overthrew the Allende government and brought General Augusto Pinochet to power.

The military dictatorship coincides with relatively few incidents in the Banks data series, as is apparent in figure 6 (murders of dissidents and activists are not counted). The next wave of unrest arrived between the referendum of 1980, which consolidated Pinochet's power, and the referendum of 1988, which ushered in the end of the Pinochet regime. The year 1983 saw the founding of the Manuel Rodríguez Patriotic Front (MRPF), which attempted to organize armed resistance

Figure 7. Social Unrest and Changes in Expenditure in Chile, 1937–95



Source: Author's elaboration based on Banks (1994) dataset and UN Statistical Dataset.

against the Pinochet regime (Ensalaco, 2000). During the period, riots and demonstrations were commonplace, with 15 antigovernment demonstrations in 1985 alone. The years after the return to democracy in 1991 saw a low level of violence, only interrupted by a spike in political assassinations in 1991 itself (including the murder of Senator Jaime Guzmán, a former confidant of General Pinochet, by the MRPF).

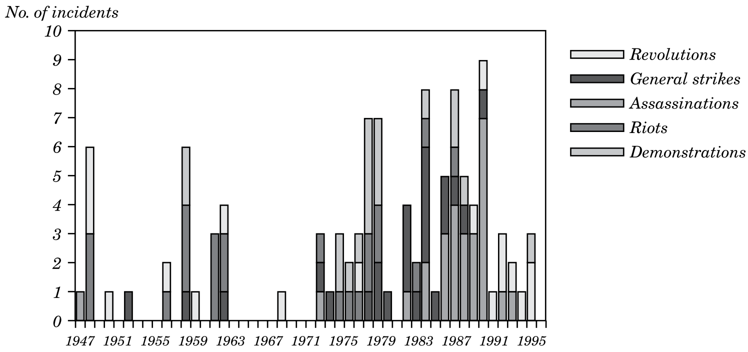
The link between fiscal austerity and instability is not readily apparent in the case of Chile (see figure 7). Sharp declines in central government spending did not coincide with the peaks in unrest; periods of normal increases in expenditure coincide with major upheaval. While much of the historical literature on Chile stresses the extent to which worker militancy was fuelled by economic concerns, there is no clear evidence in favor of a direct, strong link between budget cuts and unrest: the correlation coefficient is negative (0.07) but insignificant.[8]

1.3 Peru

Peru's history since the 1930s is marked by frequent alterations between civilian and military rule. Levels of violence were heightened by the presence of guerrilla movements, some of them with strong

8. Salazar (2006).

Figure 8. Unrest in Peru, 1937–95



Source: Banks (1994).

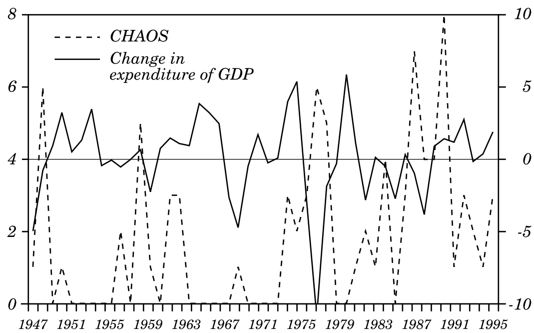
links to the drug trade. From its founding in the 1930s, the Alianza Popular Revolucionaria Americana (APRA) militated in favor of social reform and an internationalist agenda (Thorp and Bertram, 1978). One of its main competitors was the Communist Party of Peru. APRA candidates after World War II won elections, but military intervention stopped them from taking office. From the 1960s onward, communist guerrilla movements caused increasing levels of violence. The years 1968–80 saw another period of military government. APRA returned to power when Alan García became president in 1985. A period of hyperinflation and increasing civil war against the Shining Path guerrillas followed. The administration of Alberto Fujimori, elected in 1990, brought inflation under control. It also dissolved Congress against constitutional rules and pushed through major reforms. A crackdown on the Shining Path insurgency was largely successful, but it resulted in several massacres.

During its post-war history, Peru experienced two major waves of social unrest according to the measure used in this paper. Figure 8 plots the developments over time. There was a surge in riots and demonstrations in the mid- to late 1970s, as the military rule was coming to an end; the late 1980s witnessed numerous political murders. Even at its peak, the overall level of unrest was low compared with, say, Chile. Upheavals in the late 1970s were associated with a debt crisis and a need to refinance external borrowing. IMF support came in exchange for austerity measures.

The 1977 agreement on debt refinancing resulted in large price increases for food and gasoline, which promptly provoked large-scale demonstrations (Handelman and Sanders, 1981).[9] Paldam (1993) also classifies 1982 and 1990 as years of economic crisis, with high inflation and widespread terrorism. In 1989, several thousand Peruvians crossed the border into Chile to buy bread, which had become largely unavailable in Peru.

Figure 9 plots changes in expenditure and my preferred measure of unrest side by side. The figure provides some evidence of an inverse movement of the two series in the late 1960s. In the main, there is little inverse movement for small changes in expenditure, but large fiscal adjustments, such as in the late 1970s, coincided with major increases in unrest. After the overthrow of General Juan Velasco, many of his economic policies were reversed, and the fishing industry, newspaper, and other firms were denationalized. The subsequent government under General Francisco Morales also returned government to civilian control and introduced budget measures to reduce borrowing (Alexander and Parker, 2007). Overall, the correlation coefficient of –0.3 (significant at the 4 percent level) suggests that budget cuts increased labor unrest and antigovernment protests.

Figure 9. Social Unrest and Changes in Expenditure in Peru, 1937–95



Source: Author's elaboration based on Banks (1994) dataset and UN Statistical Dataset.

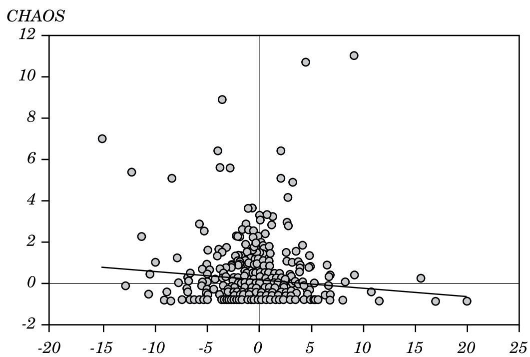
9. There is some evidence that the unrest of the summer of 1977 led directly to the transition to democracy, as President Morales decided to stave off the prospect of further unrest by announcing a timetable for restoring constitutional rule.

2. Main Results

To what extent do budget cuts go hand-in-hand with surging social unrest? This Section tests the relationship rigorously. I find strong evidence that fiscal austerity is associated with periods of violent protest—the larger the fiscal adjustment, the greater the risk of riots, demonstrations, assassinations, and revolutions. The patterns are weaker, however, for general strikes. The fiscal adjustments most likely to lead to social unrest are not driven by poor growth: changes in policy stance, not bad ties, are most likely to create instability and chaos.

Figure 10 plots the basic relationship. On the *y* axis is the first principal component of antigovernment demonstrations, general strikes, riots, assassinations, and revolutions (CHAOS); the *x* axis represents the change in government expenditure relative to GDP. The regression does not control for fixed effects or other factors, such as GDP growth. While social unrest varies hugely across time and space, figure 10 demonstrates that there is a higher chance of major unrest if expenditure cuts are severe. Periods of spending increases, on the other hand, are typically associated with fewer antigovernment demonstrations, strikes, assassinations, riots, and revolutions. The message from the simple analysis in figure 10, then, is that social peace can be bought—government spending is a useful tool in restraining

Figure 10. The CHAOS Variable and Changes in Government Expenditure



Source: Author's elaboration based on Banks (1994) dataset.

the militancy of the opposition and the extent to which opposition forces can garner mass backing for violent action.

2.1 Aggregate Results

Next, I examine the relationship between adjustments and unrest econometrically. In particular, I estimate fixed-effect panel regressions of the type

$$\ln\left(U_{it}\right) = \alpha_i + \beta\Delta\left(EXP/Y\right)_{it} + \gamma\mathbf{X}_{it} + \varepsilon_{it}, \qquad (1)$$

where U is one of the measures of instability in the data set, $\Delta(EXP/Y)$ is the change in central government expenditure relative to GDP, and $\mathbf{X}$ is a vector of control variables. The fixed-effect coefficients, α_i, are designed to capture the combined effect of two factors. First, the Banks data set relies on newspaper reporting of unrest. The level of news coverage may well have a country-specific component, with the same disturbance being more likely to be reported in a larger country than in a small one. Second, countries may differ in the level of unrest that should be expected in an average year, reflecting factors such as ethnic heterogeneity, the level of legitimate political participation, and the acceptability of violence more generally.

As a first pass, the dependent variables used are the two composite measures of unrest—CHAOS and WCI. Table 1 gives the results for CHAOS. Column (1) demonstrates that there is a statistically significant effect of expenditure changes (relative to GDP) on the level of unrest. An expenditure cut of 3.65 percent of GDP—equivalent to a one-standard-deviation change—would increase unrest by 0.2, or roughly 15 percent of a standard deviation of CHAOS. The effect is large—expenditure cuts by one standard deviation will raise expected levels of unrest (CHAOS) from the average in Brazil (2.1) to the average for Bolivia (2.3). Economic growth also cuts the level of unrest, and the effect is significant at the 95 percent level. When growth declines by a full standard deviation, unrest rises by 0.12 points, or half the distance between Brazil and Bolivia.

Revenue increases have a similar effect to expenditure changes. At first glance, it may appear paradoxical that there is no evidence that higher taxes lead to more unrest. Since much spending is redistributive—and arguably was so in South America for much of its postwar history—the negative coefficient on $\Delta(REVENUE/Y)$

Table 1. Unrest and its Determinants: CHAOS[a]

	Sample				
Explanatory variable	*All* (1)	*All* (2)	*All* (3)	*Polity IV* < –5 (4)	*Polity IV* ≥ –5 (5)
Δ(*EXP*/*Y*)	−0.057***			−0.091**	−0.059***
	(−3.21)			(−2.30)	(−3.09)
Δ(log *Y*)	−0.012**	−0.012**	−0.009*	−0.040***	0.005
	(−2.22)	(−2.13)	(−1.76)	(−3.50)	(0.87)
Δ(*REVENUE*/*Y*)		−0.036*			
		(−1.92)			
Δ(*BUDGET BAL*/*Y*)			0.052**		
			(2.01)		
Constant	0.231***	0.233***	0.218***	0.655***	0.068
	(3.36)	(3.36)	(3.15)	(3.89)	(0.96)
Summary statistic					
No. observations	473	473	473	123	323
R^2	0.029	0.015	0.016	0.115	0.033

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The dependent variable is CHAOS. All regressions were run with fixed country effects; *t* statistics are in parentheses.

may simply pick up episodes of simultaneous tax and spending increases, with the latter reducing the level of unrest.[10] Increasing budget deficits are also a good way to prevent violent protests. The coefficient on the change in the budget balance, Δ(*BUDGET BAL*/*Y*), is positive, indicating a decline in unrest when the budget sinks more into the red. While regressions (1) and (3) are somewhat successful in identifying a link between unrest and austerity, the low R^2 clearly cautions against overinterpreting the results. Many other factors unrelated to budget measures are clearly involved in creating civil unrest and violent conflict in a society.

Some authors have found that unrest is less common in autocracies (Paldam, 1993). to explore this possibility, I subdivide the sample based on a country's Polity IV score; the results are reported in columns (4) and (5) of table 1. Roughly a quarter of the country-year observations have scores below –5, indicating a highly authoritarian regime. In both subsamples, expenditure cuts are associated with more unrest. The coefficient is somewhat smaller in the group of countries with more open institutions, but both coefficients are significant at conventional levels. Also, one cannot reject the null hypothesis that the size of the coefficients is the same.

I find broadly similar results when using the WCI as the dependent variable (see table 2). Column (1) suggests a clear negative impact of changes in expenditure relative to GDP, measured as Δ(*EXP*/*Y*). WCI varies from 0 to 27,312, with a standard deviation of 2,504. The standard deviation of expenditure changes relative to GDP is 3.65. The estimated coefficient then implies that a one-standard-deviation cut in expenditure increases unrest by 226, or about 10 percent of a standard deviation of the dependent variable. The coefficient is significant at the 10 percent level. GDP growth also cuts unrest, but the effect is not significant. Here, a one-standard-deviation change induces a change of 295 units in the WCI, slightly larger than the effect of expenditure cuts. The overall R^2 shows that neither expenditure changes nor economic growth can explain a high share of the total variation in unrest in the sample.

Revenue changes have no clear impact on unrest in column (2). The estimated coefficient is negative, but not significant at conventional levels. In column (3), changes in the government budget

10. If I estimate with expenditure and revenue jointly, there is a small, insignificant, and positive coefficient for revenue.

Table 2. Unrest and Its Determinants: WCI[a]

	Sample				
Explanatory variable	*All* *(1)*	*All* *(2)*	*All* *(3)*	*Polity IV < –5* *(4)*	*Polity IV ≥ –5* *(5)*
$\Delta(EXP/Y)$	–63.74*			–42.60	–83.48**
	(–1.76)			(–0.48)	(–2.52)
$\Delta(\log Y)$	–14.33	–14.49	–11.78	–8.54	–20.08*
	(–1.29)	(–1.30)	(–1.07)	(–0.33)	(–1.91)
$\Delta(REVENUE/Y)$		–52.94			
		(–1.37)			
$\Delta(BUDGET\ BAL/Y)$			36.20		
			(0.69)		
Constant	1,986.7***	1,991.5***	1,974.7***	2,229.2***	1,792.2***
	(14.11)	(14.11)	(13.98)	(5.84)	(14.38)
Summary statistic					
No. observations	473	473	473	123	323
R^2	0.01	0.007	0.004	0.002	0.030

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The dependent variable is WCI. All regressions were run with fixed country effects; *t* statistics are in parentheses.

balance are positively associated with unrest, but the effect is not tightly estimated. Finally, columns (4) and (5) estimate the effect of budget cuts for two groups of countries—those with high Polity IV scores and those with relatively low ones. For the part of the sample with low scores, there is some evidence that expenditure cuts lead to unrest, but the effect is not significant and the coefficient smaller than in column (1). Countries with higher scores for the level of openness and democracy, on the other hand, show a much clearer association of expenditure cuts with violent protests.

2.2 Different Forms of Instability

Next, I examine the individual components of the composite conflict indicators summarized above. For four of the five variables in the data set (used for constructing CHAOS), there are negative and significant coefficients on the expenditure variable, indicating that increases in government spending are associated with lower levels of unrest (see table 3). The coefficients for assassinations and demonstrations are significant at the 99 percent and 95 percent levels, respectively; those on riots and revolutions are significant at the 90 percent level. General strikes, on the other hand, show a positive (if insignificant) coefficient. Growth cuts unrest for all variables except general strikes, but the coefficient is only well estimated for riots, revolutions, and demonstrations.

2.3 Inflation and Deflation

In this section, I explore the effect of inflation and deflation to ascertain whether the patterns described above are independent of the monetary environment. In column (1) of table 4, I use all observations in the sample, but add a control for the rate of exchange rate decline (where positive values indicate depreciation of a country's currency). The dependent variable is CHAOS, as before. Controlling for inflationary developments in this way does not change the results. Both the coefficient size and its statistical significance are not affected in a major way. When the sample is restricted to the 61 country-year observations with high inflation, expenditure has a strong and highly significant effect on social instability. The coefficient is more than three times larger than in the sample as a whole, and it is more statistically significant.

Table 3. Different Measures of Instability and Expenditure Cuts[a]

Explanatory variable	*Assassinations* *(1)*	*General strikes* *(2)*	*Riots* *(3)*	*Revolutions* *(4)*	*Demonstrations* *(5)*
$\Delta(EXP/Y)$	-0.0575^{***}	0.0095	-0.0309^{*}	-0.0146^{*}	-0.0413^{**}
	(−3.30)	(0.69)	(−1.66)	(−1.67)	(−2.29)
$\Delta(\log Y)$	−0.0006	0.0011	-0.0169^{***}	-0.0052^{*}	-0.0095^{*}
	(−0.12)	(0.27)	(−2.96)	(−1.93)	(−1.72)
Constant	0.388^{***}	0.461^{***}	0.782^{***}	0.357^{***}	0.671^{***}
	(5.71)	(8.61)	(10.77)	(10.48)	(9.55)
Summary statistic					
No. observations	473	473	473	473	473
R^2	0.023	0.001	0.022	0.013	0.016

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. All regressions were run with fixed country effects; t statistics are in parentheses.

Table 4. Expenditure Cuts and Unrest: Inflationary and Deflationary Periods[a]

	Sample			
	All	*Inflationary period*[b]	*Deflationary period*[c]	*Neither inflationary nor deflationary*
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*
$\Delta(EXP/Y)$	−0.0516***	−0.1850***	0.0934	−0.0295
	(−2.85)	(−3.42)	(0.89)	(−1.50)
			[0.584]	
$\Delta(\log Y)$	−0.0142**	−0.0028	−0.0007	−0.0220***
	(−2.53)	(−0.24)	(−0.66)	(−3.31)
			[−0.356]	
Δ*EXCHANGE RATE*	0.0677			
	(1.38)			
Constant	0.259***	0.330*	0.136	0.251***
	(3.66)	(1.77)	(0.43)	(3.18)
			[0.41]	
			[0.41]	
Summary statistic				
No. observations	456	61	26	386
R^2	0.037	0.207	0.063	0.033

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. All regressions were run with fixed country effects; *t* statistics are in parentheses and bootstrapped standard errors in square brackets.
b. An inflationary period is defined as a period in which the exchange rate decline vis-à-vis the U.S. dollar is in the top 5 percent of the sample, that is, above 66 percent per year.
c. An inflationary period is defined as a period in which there is an absolute increase in the exchange rate vis-à-vis the dollar.

A large literature stresses that inflationary periods are often driven by weak governments trying to satisfy the competing claims of different groups in society; using the printing press in such an environment is easier than hiking taxes (Feldman, 1997). Stabilizing after periods of high inflation often requires massive increases in the primary surplus (Fischer, Sahay, and Végh, 2002). If distributional struggles are particularly severe during inflationary periods, it makes sense that expenditure cuts are fiercely resisted, as reflected by the steep increase in social unrest. For the sample of inflationary episodes, a large share of the total variation in unrest can be explained by expenditure and output changes—the R^2 rises to over 0.2, versus 0.02 to 0.03 in other specifications.

In contrast, deflationary periods show no direct effect on the relationship between expenditure changes and politically motivated violence. The coefficient in column (3) is positive and not statistically different from zero. Since the number of observations for deflationary episodes is small, I also bootstrap the standard errors in column (3). While not all the standard errors are of similar size, the conclusion is not materially affected: there is no clear link between expenditure cuts and unrest during periods of deflation.

When excluding both inflationary and deflationary periods (equation 4), I find a negative but insignificant coefficient. One cannot reject the hypothesis that the coefficient is the same as in the full sample. Lack of identifying variance probably limits the extent to which one can document a connection between austerity measures and budget cuts, but it would be a mistake to claim that the difference between the insignificant coefficient in column (4) and the significant one in column (1) is itself significant.[11]

3. Robustness and Extensions

This Section examines the robustness of the main finding so far of a strong, significant link between budget cuts and civil unrest. A potentially important issue is omitted-variable bias. While the issue cannot be resolved definitively in the absence of a convincing instrument, it seems likely that this is not a major obstacle. Another obvious concern relates to the stability of the link over time. Finally, I test for nonlinearities in the data and examine the robustness of the main finding using extreme bounds analysis.

11. Gelman and Stern (2006).

3.1 Omitted-Variable Bias

The main concern with the equations estimated above is not reverse causality—few governments would implement budget cuts as a consequence of social unrest. What is of greater concern is potential omitted-variable bias. If, for example, economic hard times produce a large increase in unemployment, a fall in government revenue, and budget cuts, then an upsurge of violent protests may be less inspired by changes in government spending itself than by the rising immiseration of the population resulting from the economic crisis. This is of particular concern since fiscal policy is widely believed to be highly procylical in emerging markets.[12]

In the absence of a compelling instrument, one cannot isolate the exact factor driving the rise in instability. The fact that budget cuts remain highly significant even when controlling for economic growth suggests that the omitted-variable problem cannot be too severe. Adding the square of GDP growth to control for nonlinearities does not change the result—both WCI and CHAOS remain highly significant and negative, and the size of the coefficient is unaffected.

3.2 Stability over Time

The assumptions underlying regressions of the type estimated in this paper are heroic. Antigovernment demonstrations in Argentina under Peron would have the same meaning as those against President Alfonsin; a political murder of a government official in Chile would carry the same information about social unrest as in Brazil.

In table 5, I subdivide the sample at 1975 to examine the robustness of these findings. There is no significant association between expenditure changes and unrest in the aggregate. While revolutions are clearly associated with budget cuts, general strikes follow the opposite pattern, in a highly significant manner. Most other variables, while showing a negative coefficient, are not statistically significant.

The period after 1975 shows a much clearer association between budget cuts and unrest. General strikes are now also negatively associated with fiscal expenditures, in contrast to the pattern observed in the earlier period. The coefficients for most variables are substantially

12. Talvi and Végh (2005); Ilzetzki and Végh (2008). For a skeptical view, see Jaimovich and Panizza (2006).

Table 5. Observations before and after 1975[a]

Period and explanatory variable	*CHAOS*	*Assassinations*	*General strikes*	*Riots*	*Revolutions*	*Demonstrations*
A. Before 1975	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
$\Delta(EXP/Y)$	−0.0088	−0.0065	0.0374*	−0.0153	−0.0348**	−0.0131
	(−0.40)	(−0.72)	(1.92)	(−0.50)	(−2.52)	(−0.81)
$\Delta(\log Y)$	−0.0211*	0.0054	−0.0043	−0.0438***	−0.0104	−0.0066
	(−1.79)	(1.09)	(−0.40)	(−2.62)	(−1.38)	(−0.75)
Constant	0.103	0.123***	0.343***	1.170***	0.483***	0.401***
	(1.03)	(2.95)	(3.81)	(8.23)	(7.55)	(5.37)
Summary statistic						
No. observations	262	262	262	262	262	262
R^2	0.013	0.007	0.015	0.028	0.032	0.005
B. After 1974	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
$\Delta(EXP/Y)$	−0.104***	−0.104***	−0.025	−0.043**	0.007	−0.071**
	(−3.76)	(−3.08)	(−1.33)	(−2.30)	(0.73)	(−2.11)
$\Delta(\log Y)$	−0.016**	−0.008	0.002	−0.012***	−0.003*	−0.015*
	(−2.41)	(−1.02)	(0.40)	(−2.70)	(−1.83)	(−1.92)
Constant	0.485***	0.724***	0.646***	0.472***	0.230***	1.022***
	(4.63)	(5.63)	(9.27)	(6.68)	(6.57)	(8.07)
Summary statistic						
No. observations	211	211	211	211	211	211
R^2	0.081	0.047	0.011	0.051	0.022	0.034

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. All regressions were run with fixed country effects; *t* statistics are in parentheses.

larger and highly significant. The only exception is revolutions, which become less responsive to economic conditions after 1974. This may suggest that discontent before 1975 was more likely to spill over into rebellions, possibly in the form of communist-backed insurgencies. With the decline of Soviet and Cuban influence, combined with rising democratization in many South American countries, discontented groups in society found other ways of expressing themselves.

3.3 Regime Durability

Tables 1 and 2 offered some support for the idea that the effect of fiscal adjustments on unrest does not depend on the level of political development. The evidence suggested that countries with high or low Polity IV scores showed very similar coefficients for expenditure changes. Polity IV scores, which range from –10 to 10, are calculated as the difference between a country's democracy and autocracy scores. These scores aggregate a number of variables, including the competitiveness and openness of executive recruitment, constraints on the executive, the regulation of participation, and the competitiveness of participation (Marshall, Jaggers, and Gurr, 2010).

Another variable that is popular in the political economy literature is constraints on the executive (Acemoglu, 2005). This is one of the factors in the Polity scoring system, and it is arguably of great importance for economic political transitions, since it captures the extent to which might makes right. Regimes with low constraints on the executive may require mass protests and the like to influence policy. Regime durability is a separate dimension of a country's political setup. It counts the number of years since a three-point change on the Polity IV scale. Countries with a high value show substantial stability of the political system.

Table 6 gives the results for subdividing the sample at the median of the distribution for both constraints on the executive and durability. For both high and low values, there are significant effects of budget adjustments. For relatively unconstrained countries, the effect is larger, and growth matters; for countries with strong checks and balances, there is a clear effect of budget adjustments, but none of economic growth.

Durability shows a different pattern. Where durability is low (specifically, less than six years have passed since the last major regime change) the effect of fiscal adjustment is strong. When a

Table 6. Fiscal Adjustment and Unrest: Constraints on the Executive and Durability[a]

	Constraints on the Executive		*Durability*	
Explanatory variable	*Low (<3)* *(1)*	*High (≥3)* *(2)*	*Low (<6)* *(3)*	*High (≥6)* *(4)*
$\Delta(EXP/Y)$	−0.0932**	−0.0605***	−0.0639***	−0.0225
	(−2.52)	(−3.21)	(−2.64)	(−0.87)
$\Delta(\log Y)$	−0.0384***	0.0009	−0.0093	−0.0126*
	(−3.46)	(0.15)	(−1.03)	(−1.87)
Constant	0.528***	0.123*	0.216**	0.241**
	(3.58)	(1.71)	(2.14)	(2.59)
Summary statistic				
No. observations	157	316	230	243
R^2	0.089	0.033	0.033	0.017

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The t statistics are in parentheses.

country's political order has seen few changes for an extended period, the effect is weaker and not tightly estimated.[13] Growth seems to matter more for cutting violence in more durable regimes, but the two coefficients are not different from each other.

3.4 Censored Data

The data on instability are derived from counting events, such as the number of strikes and demonstrations. This means that the main indicators, as well as WCI, are truncated at zero. It is not clear that the panel versions of the linear probability model used so far capture the data adequately. To address the issue, I estimated panel Poisson regressions that take the censoring implicit in the use of nonnegative count data directly into account.

Table 7 presents the results. The significance of the main results is not affected. WCI, the aggregate measure proposed by Banks, shows a strongly negative and significant effect under Poisson, as does every other variable, with the exception of general strikes. This last measure of unrest was also not significant under panel ordinary least squares (OLS) (table 3). Overall, there is no evidence that violations of the normality assumption might have been driving the significance of results.

3.5 Asymmetry between Budget Cuts and Increases

So far, the regression analysis implicitly assumed that the effect of changes in expenditure on unrest does not depend on the sign of the change. That is, cutting expenditure will increase unrest as much as a rise in spending will cut it. This is not an obvious assumption. It is a well-known finding in behavioral economics that humans tend to react more strongly to losses than to gains (Kahnemann and Tversky, 1991). To examine this issue further, I ran separate regressions for the part of the distribution of expenditure changes that is greater or smaller than zero.

Table 8 gives the results. The coefficient on expenditure changes is negative for both the positive and negative part of the distribution, but the effect is much more pronounced for expenditure cuts. For the aggregate indicator of instability from the Banks data set, the

13. The standard error in equation (4) is so large that the coefficient on $\Delta(\text{EXP}/Y)$ is not significantly different from the one in equation (3).

Table 7. Panel Poisson Regressions: Count Variables[a]

Explanatory variable	*WCI* (1)	*Assassinations* (2)	*General strikes* (3)	*Riots* (4)	*Revolutions* (5)	*Demonstrations* (6)
$\Delta(EXP/Y)$	-0.034^{***}	-0.139^{***}	0.019	-0.042^{***}	-0.048^{**}	-0.006^{***}
	(−109.30)	(−7.30)	(0.99)	(−2.76)	(−1.97)	(−3.80)
$\Delta(\log Y)$	-0.0077^{***}	−0.0018	0.0022	-0.0230^{***}	-0.0152^{**}	-0.0141^{***}
	(−81.82)	(−0.27)	(0.39)	(−5.07)	(−2.23)	(−2.96)
No. observations	473	463	473	463	425	463

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The *t* statistics are in parentheses.

coefficient for cuts is approximately twelve times larger than for expenditure increases. For CHAOS, it is six times larger. Also, the negative coefficient for expenditure increases is not significant, while the coefficient for cuts is in both cases (strongly so for CHAOS). While this finding is not direct confirmation of gain-loss asymmetry, it is compatible with such an interpretation.

Table 8. Responses of Instability to Budget Cuts and Increases[a]

Explanatory variable	*WCI*		*CHAOS*	
	(1)	*(2)*	*(3)*	*(4)*
$\Delta(EXP/\mathrm{Y})$	−12.03 (−0.20)		−0.05 (−1.02)	
$\Delta(\log Y)$	−15.21 (−1.30)	−15.56 (−1.02)	−0.05*** (−2.86)	−0.02 (−0.92)
$\Delta(\ /Y) \leq 0$		−148.8* (−1.89)		−0.31** (−2.46)
Constant	1,869.4*** (9.58)	1,798.7*** (7.67)	2.11*** (9.16)	1.65*** (4.68)
No. observations	231	242	231	242

Source: Author's elaboration.
* Statistically significant at the 10 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 1 percent level.
a. The *t* statistics are in parentheses.

3.6 Interpretation: The Timing of Protest

Paldam (1993), using weekly data, finds that protests peak while budget measures are discussed and decline after budget adjustments are implemented. The data in this study are yearly and thus cannot speak to the precise timing of protests. Assuming that Paldam's finding holds more generally, this would suggest the following interpretation of the main results of this study. Budget cuts are still closely related with social unrest, but instability would not be a consequence of popular outrage after the effects of adjustments make themselves felt. Rather, riots, strikes, and the like are a form of bargaining between different social parties over the cost of adjustment. Once the decisions are taken and implemented, unrest declines.

4. Conclusions

Social unrest can be powerful in undermining government credibility. Street protests and violent demonstrations can force political leaders from office, as happened in the case of the de la Rúa government in Argentina in 2001. Riots, antigovernment demonstrations, general strikes, and political assassinations are driven by a multitude of factors, many of them specific to the country in question. Nevertheless, casual empiricism suggests that a significant amount of social unrest can be explained by economic factors.

In this paper, I examined the effect of budget cuts on social unrest in Latin America for the period 1937–95, using a variety of indicators. There is clear evidence that reductions in spending clearly and strongly increase the risk of unrest. While the share of strikes, assassinations, riots, and demonstrations that can be explained by budget cuts is not very high, the relationship is robust for countries with both democratic and autocratic structures. All indicators of unrest except general strikes are significantly and negatively associated with government expenditure. There is some evidence that the effect of budget cuts in times of inflation is particularly pronounced and that normal times without rapid price increases only see a mild association between austerity and anarchy. Constraints on the executive do not matter for the strength of the link, but a regime's durability—the length of time since the last significant change in its political fabric—does: countries with a longer history of stability show a much weaker link between budget cuts and chaos. There is also clear evidence for a discontinuous increase in the effect of budget cuts. Extreme movements in measures of unrest are more readily explained by austerity measures than relatively mild upticks in upheaval.

These results provide a rationale for why governments often find it hard to cut expenditures. While unrest is a relatively low probability event—even in this sample of South American countries over the last 70 years—there is a nonzero probability that austerity will fan the flames of discontent, leading to violent antigovernment protests. They may also offer a perspective on why public indebtedness differs so much around the globe and even among countries with relatively similar levels of economic development (Alesina and Perotti, 1995).

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Government Spending and the Real Exchange Rate: A Cross-Country Perspective

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There is no consensus about the economic implications of real exchange rate (RER) misalignments. Some authors argue that keeping the real exchange rate away from its equilibrium level creates distortions in the relative prices of tradable and nontradable goods, generating misleading signals to economic agents (Edwards, 1989). This, in turn, induces a suboptimal allocation of resources across sectors that has a negative impact on growth. Others argue that sustained RER overvaluations are an early warning indicator of possible currency crashes (Krugman, 1979; Frankel and Rose, 1996; Kaminsky and Reinhart, 1999). Furthermore, large and medium RER overvaluations can end abruptly, with nominal devaluations that lead to a drastic adjustment of relative prices and a decline in the aggregate growth rate of the economy (Goldfajn and Valdés, 1999; Aguirre and Calderón, 2005). On the other hand, Rodrik (2008) argues that in the presence of institutional and market failures, sustained RER depreciations increase the relative profitability of investing in tradables and act in second-best fashion to alleviate the economic cost of these distortions. That is why episodes of undervaluation are strongly associated with higher economic growth.

Independent of the consequences of RER misalignments, the concept itself requires the definition of the equilibrium RER. Edwards

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(1989) argues that the equilibrium RER is the real rate that guarantees the internal and external balance of the economy. In this setup, the equilibrium RER depends, in the long run, on a set of fundamental variables that reflect the equilibrium in the domestic goods market and the sustainability of the current account. Edwards (1989), Obstfeld and Rogoff (1995), and Faruqee (1994) provide theoretical underpinnings for the type of fundamentals to be considered. These include the relative productivity of the tradables and nontradables sectors (that is, the Balassa-Samuelson effect), the terms of trade, government consumption, and the net foreign asset position of the economy.

The relationship between the RER and its fundamentals has been estimated for single countries and for a set of countries using panel cointegration techniques (for example, Aguirre and Calderón, 2005; Galstyan and Lane, 2009; Lee, Milesi-Ferretti, and Ricci, 2008). Most studies find a correlation between the RER and its long-run determinants. In particular, an increase in the relative productivity of the tradables sector, better terms of trade, and an improvement in the net foreign asset position of the economy induce an RER appreciation. An increase in government consumption has the same effect, with a semi-elasticity ranging from 0.3 to 2.9.

Empirical papers assess the impact of one particular component of fiscal spending: namely, government consumption of goods and services. The impact of two other important components, transfers and investment, has been neglected. Those components are an important fraction of total government expenses in most countries, accounting for 19 percent and 2 percent, respectively, of overall fiscal expenditure in member countries of the Organization for Economic Cooperation and Development (OECD) in the last 30 years.

The purpose of this paper is to assess the impact of government investment and fiscal transfers on the determination of the RER. Galstyan and Lane (2009) develop a two-sector, small open economy model in which an increase in government consumption is associated with real appreciation, while an increase in government investment has an ambiguous effect on the RER. This depends on the effect of government investment on the relative productivity of the tradables sector. Galstyan and Lane (2009) provide empirical evidence for 19 OECD countries. They conclude that in some countries government investment tends to be associated with an increase in the relative productivity of the the tradables sector, whereas for others the opposite is true. They do not find, however, a direct effect of government investment on RER determination.

In this paper, we estimate a relationship between the RER and its fundamentals for a set of countries from 1980 to 2009. In addition to considering the impact of government consumption on the RER, we assess the impact of the other two components of fiscal expenses, namely, government transfers and investment. Our results suggest that in developed countries, changes in government transfers and public investment do not generate a significant change in the RER. For developing economies, however, government transfers tend to appreciate the RER, whereas government investment tends to depreciate it. For both set of countries, government expenditures tend to appreciate the RER, although the impact is comparatively larger in developing economies. Finally, the effect of a country's net external asset position on the RER is statistically significant only in the case of developing countries.

The rest of the paper is organized as follows. Section 1 discusses the concept of the RER and present the behavioral equilibrium exchange rate model that links the behavior of the RER to a set of long-run determinants (or fundamental variables). In section 2, we empirically implement this model and discuss how the fundamental variables are constructed. Section 3 presents the empirical results, and section 4 concludes.

1. The Real Exchange Rate and Economic Fundamentals

As in Bayoumi, Lee, and Jayanthi (2005), for a given a set of weights for country i on partner countries (W_{ij} for $j \neq i$), the real exchange rate (RER) indices are calculated as a geometric weighted average of bilateral real exchange rates between the home country and its trade partners. Specifically, the RER index of country i is computed as

$$\mathrm{RER}_t = \Pi_{j\neq i}\left(\frac{P_i E_i}{P_j E_j}\right)^{W_{i,j}},$$

where j refers to trade partners, P denotes to the consumer price index (CPI), and E_i and E_j are the bilateral nominal exchange rates of country i and j against the U.S. dollar (measured in U.S. dollar per local currency).

An increasingly dominant view is that over the business cycle, the RER tends to move toward an underlying equilibrium value determined by real factors, usually defined by some version of purchasing power parity. In particular, while the exchange rate is unpredictable in the short term, there is some consensus on the fact that the RER's behavior at medium to long horizons can be explained, to some degree, by the evolution of a set of fundamentals (Lee, Milesi-Ferretti, and Ricci, 2008; Engel, Mark, and West, 2008).

In practice, the RER like any other relative price is determined by a set of fundamental variables, like any other relative price. The extensive literature on the determinants of the RER that includes Edwards (1989), Froot and Rogoff (1995), Obstfeld and Rogoff (1995), and Faruqee (1994). Based on this literature, we adopt the so-called single-equation approach, which relates the RER to a particular set of fundamentals in a reduced form. This specification has a long tradition in empirical international finance and has been used extensively in empirical applications. Under this specification, two types of fundamentals can be distinguish—those that affect the RER from a flow perspective and those that affect it from a stock perspective. Taking into account the stock and flow fundamental variables, an empirical equation for the RER can be expressed as follows:

$$\log \mathrm{RER}_t = \beta_0 + \beta_1 \log \mathrm{TNT}_t + \beta_2 \log \mathrm{ToT}_t + \beta_3 \left(\frac{\mathrm{NFA}}{\mathrm{GDP}}\right) + \beta_4 \left(\frac{G}{\mathrm{GDP}}\right) + \mu_t. \tag{1}$$

We consider three flow variables. The first is the relative productivity between the traded and nontraded sectors, denoted as TNT. This variable has a negative impact on the RER. In particular, with labor mobility and wage equalization across sectors, an increase in productivity in the traded goods sector raises the real wage in both sectors, leading to an increase in the relative cost and price of nontraded goods. As a result, the RER tends to appreciate. This is the Balassa- Samuelson hypothesis.

The second variable is the terms of trade, ToT. This variable has a negative impact on the RER. In particular, an increase in ToT raises disposable income and hence the demand for both traded and nontraded goods. Given the fact that tradable goods prices are given, an increase in ToT tends to increase the relative price of nontraded goods, which appreciates the RER.

The third variable is the share of fiscal spending in gross domestic product (GDP). A larger participation of government spending will appreciate the RER through a composition effect (which is usually assumed to be relatively nontradables intensive) or through an aggregate demand effect if there is not perfect capital mobility. The role of government consumption is highlighted by Froot and Rogoff (1995), who postulate that increases in government consumption tend to increase the relative price of nontradables, since government consumption is concentrated in nontradables. De Gregorio, Giovannini, and Wolf (1994) and Chinn (1997) also find that increases in government consumption are associated with real appreciation. The usual proxy for this variable is government consumption to output, $(G/\text{GDP})_t$.

The stock variable we consider is the economy's net foreign asset position as a percentage of GDP, which we denote NFA/GDP. This stock variable should influence the RER because owning more assets results in greater revenues earned (a surplus in factor payments), which in turn can finance a larger sustainable commercial deficit in steady state. This larger commercial deficit is only consistent with a more appreciated RER. Despite the fact that the net foreign asset position is our only stock variable, its impact stems from its flow effect on the current account.

This approach has been applied to various countries, including Brazil (Paiva, 2006), Chile (Calderón, 2004), China (Wang, 2004), and South Africa (Frankel, 2007). Bayoumi, Faruqee, and Lee (2005) estimate RER equations for a sample of 22 developed economies, using panel cointegration techniques. Aguirre and Calderón (2005) use the same approach to estimate RER equations for a larger sample of developed and developing countries, while Soto and Elbadawi (2007) estimate equations only for developing economies. In general, these studies find that the fundamental variables in equation (1) or a subset thereof explain the behavior of the RER in the long run.

One criticism of the papers cited above is related to the type of variables used. Given the lack of consistent data, the proxy for the relative productivity of the tradables and nontradables sectors (TNT) is constructed based on overall per capita relative output or on GDP per worker. This measure does not necessary capture the Balassa-Samuelson effect: GDP per capita is likely to be correlated to either tradables or nontradables productivity, but not the ratio between them. To overcome this problem, Lee, Milesi-Ferretti, and Ricci (2008) estimate RER equations for 45 countries, considering a more precise measure of relative productivity based on a detailed sectoral breakdown. They find that the estimated impact of productivity differentials between traded and nontraded goods, while statistically significant, is small. They conclude that there is positive relation between the CPI-based real exchange rate and commodity terms of trade. Increases in net foreign assets and government consumption tend to be associated with appreciating RERs.

A second criticism is related to the role of government expenditure in RER dynamics. In general, the literature focuses only on the role of government consumption. Government investment and transfers have been neglected, even though they represent a large share of total fiscal expenditures. In particular, as shown in table 1, government transfers account for nearly 20 percent of GDP, on average, among OECD countries, while investment is 2 percent of GDP. In Finland, France, Germany, Greece, and Italy, those components represent a larger fraction of GDP than government consumption. Galstyan and Lane (2009) lay out a two-sector small open-economy model that incorporates both government consumption and government investment as potential influences on the RER. They conclude that in some countries, government investment tends to be associated with an increase in the relative productivity of the tradables sector, whereas for others the opposite is true. The direct impact of government investment on the RER is not statistically different from zero.

Galstyan and Lane (2009) do not assess the impact of transfers on the RER. In particular, they assume that transfers only redistribute resources across private sector entities without changing the relative demand of tradable and nontradable goods. As a consequence, they conjecture that the impact of transfers on the RER is zero.

In addition to the traditional fiscal spending variable (G/GDP), we asses the relevance of public investment (I/GDP), and transfers (TR/GDP). Those are important components of government expenditures, yet their impact on the RER is usually neglected. According to Galstyan and Lane (2009), government consumption and government investment have different effects on the evolution of relative price levels. While an increase in government consumption is typically associated with an increase in the relative demand for nontradables, thereby leading to real appreciation, a long-run increase in public investment has an ambiguous impact on the RER. An increase in public investment that delivers a productivity gain in the tradables sector may generate real appreciation through the Balassa-Samuelson mechanism. However, if public investment disproportionately raises productivity in the nontradables sector,

Table 1. Relative Contribution of Fiscal Expenses Components: Average, 1980–2008

Country	*G/GDP*	*I/GDP*	*TR/GDP*
Australia	0.225	0.015	0.091
Austria	0.249	0.027	0.216
Bahrain, Kingdom of	0.203	0.070	0.041
Belgium	0.254	0.013	0.183
Brazil	0.166	0.022	0.074
Canada	0.243	0.011	0.122
Chile	0.116	0.025	0.127
Colombia	0.137	0.071	0.090
Denmark	0.309	0.001	0.191
Dominican Republic	0.066	0.072	0.087
Finland	0.279	0.013	0.186
France	0.283	0.015	0.190
Germany	0.229	0.016	0.188
Greece	0.179	0.021	0.147
Iceland	0.242	0.049	0.085
Iran, I.R. of	0.149	0.098	0.030
Ireland	0.208	0.025	0.128
Israel	0.286	0.027	0.224
Italy	0.215	0.022	0.176
Japan	0.176	0.037	0.099
Malaysia	0.133	0.124	0.153
Mexico	0.101	0.048	0.113
Netherlands	0.286	0.016	0.169
New Zealand	0.251	0.019	0.127
Norway	0.261	0.017	0.173
Pakistan	0.114	0.046	0.133
Paraguay	0.090	0.059	0.062
Peru	0.098	0.046	0.064
Portugal	0.211	0.021	0.132
Singapore	0.105	0.079	0.108
South Africa	0.186	0.038	0.083
Spain	0.196	0.036	0.134
Sweden	0.337	0.018	0.204
Thailand	0.113	0.077	0.058
Tunisia	0.158	0.040	0.132
United Kingdom	0.240	0.019	0.142
United States	0.198	0.011	0.116
Uruguay	0.125	0.052	0.139
Venezuela, Bol. Rep.	0.110	0.108	0.111

Source: Authors' calculations.

it may actually lead to real depreciation. If productivity increases symmetrically in both sectors, there is no long-run impact on the relative price of nontradables and the real exchange rate.

Unlike Galstyan and Lane (2009), we not only introduce government transfers and investment, but also incorporate the ToT variable and the stock variable (NFA/GDP). We also incorporate measures of relative productivity based on sectoral productivities in both the tradable and nontradable sectors, as in Lee, Milesi-Ferretti, and Ricci (2008).

2. Data and Econometric Methodology

We construct a set of variables for the 65 countries listed in table 2. The frequency is annual, from 1980 to 2009. The real effective exchange rate (REER) is based on the consumer price index (CPI) and new competitiveness weights constructed from international trade data for 1999–2001 (Bayoumi, Faruqee, and Lee, 2005). The nominal exchange rate and CPI were obtained from the IMF's *International Financial Statistics* (IFS) and the World Bank.

The productivity of tradables and nontradables relative to trading partners is constructed using several sources. For output in each sector, we consider data on GDP (in constant 1990 U.S. dollars for each country) provided by the United Nations Statistics Division. The tradables sector includes agriculture, hunting, fishing, mining, and industry. The nontradables sector includes construction; wholesale and retail trade; restaurants and hotels; transport, storage, and communications; and other services. Labor in each sector is constructed based on information from the International Labor Organization (ILO) and the World Bank. Following Lee, Milesi-Ferretti, and Ricci (2008), we filled in a few missing observations using the sectoral shares for adjacent years and aggregate data. Series for trading partners were constructed by applying the competitiveness weights to productivity series (Bayoumi, Faruqee, and Lee, 2005).

The ratio of net foreign assets to GDP, at the end of the previous period, is from Lane and Milesi-Ferretti (2007) and updated by the IMF. We also consider the impact of gross assets and gross liabilities separately, as in Pistelli, Selaive, and Valdés (2007). Data on NFA and GDP are in current U.S. dollars. Data on GDP are from the IMF and the World Bank.

The ratio of government consumption to GDP is defined as the ratio of government purchases of goods and services plus government wages to GDP. The ratio of government transfers to GDP, denoted

Table 2. Country List

Industrialized economies		*Developing economies*			
IMF code	*Country*	*IMF code*	*Country*	*IMF code*	*Country*
193	Australia	612	Algeria	548	Malaysia
122	Austria	311	Antigua and Barbuda	273	Mexico
124	Belgium	419	Bahrein	278	Nicaragua
156	Canada	339	Belize	564	Pakistan
128	Denmark	223	Brazil	288	Paraguay
172	Finland	228	Chile	293	Peru
132	France	924	China	566	Philippines
134	Germany	233	Colombia	456	Saudi Arabia
174	Greece	238	Costa Rica	724	Sierra Leone
176	Iceland	423	Cyprus	576	Singapore
178	Ireland	662	Cote d'Ivoire	199	South Africa
136	Italy	321	Dominica	361	St. Kitts and Nevis
158	Japan	248	Ecuador	364	St. Vincent and Grens.
138	Netherlands	646	Gabon	578	Thailand
196	New Zealand	648	Gambia, The	369	Trinidad and Tobago
142	Norway	652	Ghana	744	Tunisia
182	Portugal	328	Grenada	298	Uruguay
184	Spain	336	Guyana	299	Venezuela, Bol. Rep.
144	Sweden	532	Hong Kong	754	Zambia
186	Switzerland	536	Indonesia		
112	United Kingdom	436	Israel		
111	United States	666	Lesotho		

Source: Authors' calculations.

TR/GDP, includes transfers to households (subsidies), social security transfers, government grants, public employee pensions, and transfers to nonprofit institutions serving the household sector. The ratio of government investment to GDP, or I/GDP, refers to the purchase of structures and equipment by the government sector. The data sources are the OECD, the IMF's World Economic Outlook (WEO), local authorities, and central banks. We were able to construct consistent data for 21 OECD countries and 18 emerging economies.

The terms-of-trade variable, ToT, is the ratio between the price of exports and the price of imports. It is constructed from the UN COMTRADE database.

Given the limited length of the sample (29 years), estimating separate RER equations for each country would result in very imprecise estimates. This shortcoming can be overcome by pooling the data.

To estimate equation (1), we implement a panel version of a dynamic ordinary least squares (DOLS) procedure, following Aguirre and Calderón (2005) and Lee, Milesi-Ferretti, and Ricci (2008).This methodology corrects the reverse causality due to the eventual correlation between the disturbances to the RER in equation (1) and the fundamentals. This problem is addressed by including leads and lags of the first differences of the fundamental variables, as suggested by Phillips and Loretan (1991), Saikkonen (1991), and Stock and Watson (1993). In particular, if $\mathbf{X}_t$ is the vector containing the fundamental variables, the long run responses of the real exchange rate to its determinants, β , is estimated through the following expression:

$$\log \mathrm{RER}_{i,t} = f_i + \beta \mathbf{X}_{i,t} + \sum_{k=-p_1}^{p_2} \gamma_k \Delta \mathbf{X}_{i,t-k} + \varepsilon_{i,t}, \tag{2}$$

where f_i is a country fixed effect. The p_1 leads and p_2 lags are chosen according to the Schwarz information criterion. In this particular case, we incorporate one lead and one lag.[1]

Before proceeding to the estimation, we tested for the existence of a unit root in the series by implementing the Levin, Lin, and Chu (2002) and Im, Pesaran, and Shin (2003) tests. We implement the tests for the whole set of countries, as well as for the groups of

1. The results are robust to inclusion of additional leads and lags. As noted by Choi, Hu, and Ogaki (2008), the lead and length selection issue has not been settled in the DOLS literature, so we need to check the robustness to alternative values of p_1 and p_2.

Table 3. Unit Root Test[a]

	Levin, Lin, and Chu test			*Im, Pesaran, and Shin test*		
Variable	*All countries*	*Industrialized*	*Developing*	*All countries*	*Industrialized*	*Developing*
LogRER	0.000	0.000	0.000	0.000	0.000	0.000
LogToT	0.000	0.002	0.016	0.015	0.227	0.014
LogTNT	0.001	0.012	0.008	0.165	0.619	0.072
NFA/GDP	0.995	1.000	0.656	1.000	1.000	0.615
FA/GDP	1.000	1.000	0.998	1.000	1.000	1.000
FL/GDP	1.000	1.000	0.025	1.000	1.000	0.033
G/GDP	0.001	0.142	0.000	0.008	0.242	0.007
TR/GDP	0.137	0.207	0.145	0.034	0.112	0.085
I/GDP	0.000	0.000	0.000	0.000	0.000	0.000

Source: Authors' calculations.

a. The null hypothesis is the presence of a unit root. Both tests include a constant and one lag. The tests for government transfers and investment are based on a smaller set of countries, due to data availability.

developed and emerging economies. As show in table (3), for some series it is not possible to reject the existence of a unit root. In particular, the net foreign asset series, the relative productivity variable, terms of trade and government expenditure are nonstationary according to the Im, Pesaran, and Shin test. In the face of this evidence, we used the Kao (1999) test to check whether there is a long-run (stationary) relationship among the variables. Based on the test results, we could not reject the null hypothesis of no cointegration, not only for the full set of countries, but also for the developed and developing subsamples. We also found a long-run relationship for a small set of variables that only includes G/GDP as the relevant fiscal variable, as well as for a larger set that incorporates the components of the net foreign asset position and the government transfers and investment series.

Table 4. Kao Cointegration Test[a]

Variable		*ADF statistic (p value)*		
Government expenditure measure	*Foreign assets measure*	*All countries*	*Industrialized*	*Developing*
G/GDP	NFA/GDP	0.000	0.000	0.000
G/GDP	FA/GDP FL/GDP	0.000	0.000	0.000
G/GDP TR/GDP *I*/GDP	NFA/GDP	0.000	0.000	0.000
G/GDP TR/GDP *I*/GDP	FA/GDP FL/GDP	0.000	0.000	0.000
(*G* + TR)/GDP *I*/GDP	NFA/GDP	0.000	0.000	0.000
(*G* + *I*)/GDP TR/GDP	NFA/GDP	0.000	0.000	0.000
(*G* + *I* + TR)/GDP	NFA/GDP	0.000	0.000	0.000

Source: Authors' calculations.

a. The null hypothesis is no cointegration. All the tests include the real exchange rate (logRER), the terms of trade (logToT), and relative productivity (logTNT), in addition to the indicated measures of government expenditures and foreign assets. The first two rows are based on the full sample; the rest of the table uses a smaller set of countries due to data availability.

Overall, there appears to be a long-run relation between the REER and the set of fundamentals. We can therefore estimate equation (1) using DOLS.

3. Results

We proceed in two steps. First, we estimate an RER equation without including public investment and transfers. Given that we have data on the RER and the rest of the fundamentals for all 65 countries listed in table 2, our first set of estimations include those countries. This is a larger set of countries than considered by Lee, Milesi-Ferretti, and Ricci (2008), and it also includes more observations. Given our larger data set, we can split the sample into developed and emerging economies, an analysis that has not previously been performed. Second, we estimate the model again after introducing two additional components of government's global expenses: government transfers and government investment. For this exercise, we were able to construct the series for a subset of 39 countries, including 21 developed and 18 emerging economies.

3.1 Long-Run Dynamics: Full Sample of Countries

Table 5 presents the estimation of equation (1) using DOLS, for the complete set of 65 countries (see columns 1 and 2. The estimation includes a country fixed effect and a time fixed effect.[2] The impact of fundamentals have the expected sign and are statistically significant.

An increase of 1 percent in government consumption to GDP tends to appreciate the RER by 4.6 percent. This estimate is somewhat higher than the results found by Lee, Milesi-Ferretti, and Ricci (2008) and De Gregorio, Giovannini, and Wolf (1994), who use an advanced economy sample. To assess the extent to which this difference can be explained by the type of countries considered, we split the sample into developed and emerging economies. For advanced economies, the response to government spending declines substantially (columns 3 and 4): an increase of 1 percent in government consumption tends to appreciate the RER by nearly 1 percent. In the case of emerging economies, the same increase tends to appreciate the RER by 4.4 percent (columns 5 and 6). Hence, the impact of an increase in

2. The results does not change significantly if the time fixed effect is removed.

Table 5. Baseline Regressions[a]

Variable	*All countries* (1)	(2)	*Industrialized* (3)	(4)	*Developing* (5)	(6)
G/GDP	4.426***	4.421***	0.924***	1.012***	4.319***	4.345***
	(0.385)	(0.387)	(0.216)	(0.220)	(0.512)	(0.516)
LogToT	0.564***	0.564***	0.547***	0.569***	0.434***	0.434***
	(0.086)	(0.086)	(0.047)	(0.047)	(0.115)	(0.115)
LogTNT	0.115**	0.114**	0.170***	0.154***	0.079	0.078
	(0.051)	(0.051)	(0.027)	(0.027)	(0.067)	(0.068)
NFA/GDP	0.195***		0.007		0.189***	
	(0.034)		(0.018)		(0.046)	
FA/GDP		0.195***		0.007		0.186***
		(0.035)		(0.018)		(0.046)
FL/GDP		–0.194***		0.004		–0.197***
		(0.035)		(0.018)		(0.048)
Summary statistic						
No. observations	1,746	1,746	620	620	1,126	1,126
R^2	0.256	0.256	0.414	0.426	0.280	0.281
IFS code no.	65	65	23	23	42	42

Source: Authors' calculations.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 10 percent level.
a. The regressions include country and time fixed effects. Standard errors are in parentheses.

government expenditure differs substantially between the developed and emerging economies.

In terms of other fundamentals, a 10 percent increase in the terms of trade generates an equilibrium appreciation of 5.6 percent. This appreciation is slightly lower for emerging countries, at 4.3 percent. A 10 percent increase in the relative productivity of the tradables and nontradables sectors, tends to appreciate the equilibrium RER by 1.1 percent. The magnitude is in line with previous studies and suggests that the Balassa-Samuelson effect can explain, in part, the dynamics of the RER. In this case, however, the effect is not statistically different from zero for the set of emerging economies considered.

The equilibrium RER depreciates 2 percent in response to a 10 percent deterioration of the NFA-GDP ratio, although the effect is zero for developed economies. Hence, the net foreign asset position only has a significant effect in the case of emerging economies. Foreign assets and liabilities produce effects of a similar magnitude, although with the opposite signs (columns 2 and 6). As noted by Pistelli, Selaive, and Valdés (2007), if all components of net foreign assets had the same rate of return, they would have the same effect on the equilibrium real exchange rate, for they would produce the same income flow.

3.2 The Real Exchange Rate and the Composition of Government Expenditure

As mentioned before, we were able to construct the government transfer and investment series for a smaller, yet still relatively large, set of countries. When all the countries are considered, we found a negative and statistically significant effect of government consumption on the RER (see table 6, column 3). The response is substantially lower than in the previous exercise, however, and closer to the value found by Lee, Milesi-Ferretti, and Ricci (2008).

Government investment has a negative impact on the long-run RER. In particular, an increase of 1 percent in government investment generates an RER depreciation of 1.7 percent. This contrasts with Galstyan and Lane (2009), who did not find any significant impact from government investment in developed countries. When we take into account the differences between industrialized and emerging economies, our results are similar to those obtained by Galstyan and Lane (2009).

Government transfers do not have a significant effect on the long-run RER (table 6, column 3). This result suggests that an increase

Table 6. Regressions with Government Transfers and Investment: All Countries

Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
G/GDP	2.242***	2.172***	2.286***		2.224***	2.163***	2.253***	
	(0.295)	(0.304)	(0.308)		(0.299)	(0.308)	(0.313)	
TR/GDP		0.243	0.371	0.649**		0.224	0.445	0.704**
		(0.264)	(0.271)	(0.270)		(0.272)	(0.279)	(0.277)
I/GDP			−1.702***	−1.413***			−1.745***	−1.473***
			(0.532)	(0.530)			(0.535)	(0.532)
LogToT	0.496***	0.486***	0.473***	0.504***	0.496***	0.486***	0.474***	0.506***
	(0.051)	(0.053)	(0.053)	(0.055)	(0.051)	(0.053)	(0.053)	(0.055)
LogTNT	0.201***	0.200***	0.203***	0.160***	0.204***	0.202***	0.194***	0.155***
	(0.038)	(0.038)	(0.038)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
NFA/GDP	0.075***	0.079***	0.072**	0.052*				
	(0.029)	(0.029)	(0.029)	(0.030)				
FA/GDP					0.075***	0.078***	0.071**	0.049
					(0.029)	(0.029)	(0.030)	(0.030)
FL/GDP					−0.078***	−0.080***	−0.063**	−0.043
					(0.030)	(0.030)	(0.030)	(0.030)
Summary statistic								
No. observations	1,034	1,033	1,025	1,025	1,034	1,033	1,025	1,025
R^2	0.267	0.268	0.277	0.222	0.267	0.268	0.278	0.226
No. countries	39	39	39	39	39	39	39	39

Source: Authors' calculations.
** Statistically significant at the 5 percent level. *** Statistically significant at the 10 percent level.
a. The regressions include country and time fixed effects. Standard errors are in parentheses.

in transfers does not affect the relative demand between tradables and nontradables in industrialized economies.

The rest of the fundamentals have the expected sign, and the estimated effects are statistically significant. Our results on the impact of government transfers and investment are robust to the sequential inclusion of the relevant variables (table 6, columns 1 through 4). The results are also robust to considering external assets and liabilities separately, instead of the NFA/GDP (table 6, columns 5 through 8).

3.2.1 Industrialized economies

As before, we estimate the model for different groups of countries. In the case of industrialized economies, the impact of government consumption on the RER is close to 1.0 (table 7, column 3). This value is well below the impact found for the whole set of countries, which may be an indication that the government is relatively smaller in this group of countries or that government consumption is less concentrated in domestically produced goods.

The response of the RER to government transfers is not different from zero. This tends to confirm Galstyan and Lane (2009) conjecture that transfers only redistribute resources across private sector entities, without changing the relative demand of tradable and nontradable goods.

The response of the RER to public investment is positive, but not statistically different from zero (table 7, column 3). This result is in line with Galstyan and Lane (2009), who find that government investment does not have a significant impact on the RER for a set of OECD countries. This, in turn, indicates that an increase in public investment has a symmetric impact on productivity in both the tradables and nontradables sectors.

The impact of the terms of trade and real-time productivity is similar to the result for the whole set of countries (see table 5). However, in sharp contrast with the previous results, the NFA variable and its components (assets and liabilities) do not have a significant impact on the RER.

3.2.2 Emerging economies

The results from the estimated model for emerging economies show some important differences vis-à-vis the industrial countries (see table 8, column 3). First, the impact of government consumption

Table 7. Regressions with Government Transfers and Investment: Industrialized Countries

Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
G/GDP	0.988***	0.949***	1.062***		1.091***	0.984***	1.062***	
	(0.222)	(0.234)	(0.236)		(0.225)	(0.237)	(0.239)	
TR/GDP		−0.264	−0.090	−0.081		−0.049	0.120	0.101
		(0.232)	(0.236)	(0.230)		(0.247)	(0.252)	(0.247)
I/GDP			0.433	0.326			0.270	0.180
			(0.467)	(0.474)			(0.472)	(0.482)
LogToT	0.568***	0.555***	0.538***	0.536***	0.595***	0.579***	0.561***	0.556***
	(0.050)	(0.050)	(0.049)	(0.051)	(0.050)	(0.050)	(0.049)	(0.051)
LogTNT	0.203***	0.203***	0.216***	0.169***	0.181***	0.185***	0.204***	0.157***
	(0.0357)	(0.0354)	(0.0356)	(0.0362)	(0.0364)	(0.0362)	(0.0363)	(0.0371)
NFA/GDP	0.007	0.005	0.010	−0.002				
	(0.019)	(0.019)	(0.019)	(0.019)				
FA/GDP					0.011	0.010	0.014	0.003
					(0.0186)	(0.0187)	(0.0187)	(0.0189)
FL/GDP					0.004	0.003	−0.004	0.008
					(0.019)	(0.019)	(0.019)	(0.019)
Summary statistic								
No. observations	563	563	561	561	563	563	561	561
R^2	0.414	0.430	0.448	0.397	0.428	0.440	0.458	0.406
No. countries	21	21	21	21	21	21	21	21

Source: Authors' calculations.
*** Statistically significant at the 10 percent level.
a. The regressions include country and time fixed effects. Standard errors are in parentheses.

Table 8. Regressions with Government Transfers and Investment: Developing Countries

Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
G/GDP	2.682***	2.400***	2.974***		2.660***	2.405***	2.938***	
	(0.535)	(0.548)	(0.547)		(0.536)	(0.549)	(0.550)	
TR/GDP		0.987**	1.667***	2.021***		0.905**	1.678***	2.056***
		(0.452)	(0.469)	(0.475)		(0.450)	(0.468)	(0.472)
I/GDP			−4.514***	−3.868***			−4.856***	−4.477***
			(0.928)	(0.917)			(0.937)	(0.932)
LogToT	0.292***	0.222**	0.164*	0.192**	0.287***	0.221**	0.152*	0.181*
	(0.087)	(0.092)	(0.091)	(0.094)	(0.086)	(0.091)	(0.091)	(0.093)
LogTNT	0.131**	0.122*	0.138**	0.058	0.145**	0.136**	0.145**	0.070
	(0.064)	(0.064)	(0.062)	(0.062)	(0.064)	(0.064)	(0.062)	(0.062)
NFA/GDP	0.165***	0.200***	0.0827	0.126*				
	(0.061)	(0.063)	(0.065)	(0.066)				
FA/GDP					0.204***	0.237***	0.120*	0.153**
					(0.062)	(0.064)	(0.067)	(0.068)
FL/GDP					−0.242***	−0.275***	−0.164**	−0.203***
					(0.066)	(0.070)	(0.071)	(0.072)
Summary statistic								
No. observations	471	470	464	464	471	470	464	464
R^2	0.334	0.345	0.389	0.338	0.350	0.360	0.402	0.355
No. countries	18	18	18	18	18	18	18	18

Source: Authors' calculations.
* Statistically significant at the 1 percent level. ** Statistically significant at the 5 percent level. *** Statistically significant at the 10 percent level.
a. The regressions include country and time fixed effects. Standard errors are in parentheses.

is larger for emerging countries, where a 1 percent increase in the ratio of government consumption to GDP tends to appreciate the RER by 3.0 percent. This suggests that government consumption is more biased toward domestically produced goods in emerging economies than in industrialized countries.

Second, government transfers tend to appreciate the RER. This effect is smaller than the impact of government consumption, but it is still significant. A natural interpretation of this result is that transfers in emerging economies not only redistribute resources across private sector entities, but also change the relative demand of tradable and nontradable goods. In particular, if resources flow from high-income households to low-income households and if the latter group is financially constrained, then overall consumption will increase, inducing an RER appreciation.

Third, government investment has an important effect on the RER. A 1 percent increase in the ratio of public investment to GDP tends to depreciate the RER by 4 percent in the long run. In terms of the Galstyan and Lane (2009) model, this result suggests that investment increases productivity in the nontradables sector more than in the tradables sector, thus reducing its relative price.

Fourth, the impact of the NFA variable is not statistically different from zero. The results change, however, when the two components of the net foreign asset position are considered independently. The ratio of external assets to GDP tends to appreciate the RER, although its impact is, in absolute value, below the effect of liabilities (see table 8, column 7). This suggests that the two components should be considered separately.

Finally, the terms of trade and relative productivity have a significant effect on the RER. The magnitude of the effect is similar to the results for industrialized economies we found in previous specifications.

4. Conclusions

Two important components of government expenditure are usually overlooked in studies of the RER: namely, public investment and government transfers. Using panel cointegration techniques, we have assessed the relevance of these variables in the determination of the RER for a large sample of countries. Following Lee, Milesi-Ferretti, and Ricci (2008), we incorporated measures of relative productivity based on sectoral mean productivity in both the tradables and nontradables sectors, the impact of the terms of trade, and the effect of the economy's net foreign asset position.

Our main results suggest that the effect of fiscal variables on the RER differs markedly across countries. First, an increase in government consumption has a larger impact in emerging economies than industrialized ones. This indicates that government consumption is more biased toward domestically produced goods in emerging economies. Second, government transfers tend to appreciate the RER in emerging economies. One explanation is that an increase in government transfers changes the relative demand of tradable and nontradable goods: as resources flow from high-income households to low-income households, the relative price of nontraded goods rises, which appreciates the RER. In the case of developed countries, however, transfers do not have a significant impact on the RER. Third, government investment tends to depreciate the RER in emerging economies. In this case, an increase in government investment increases productivity in the nontradables sector, inducing a relative decline in the price of nontraded goods. Again, this effect is not significant in the case of industrialized countries. This result, which is in line with Galstyan and Lane (2009), suggests that an increase in public investment has a symmetric impact on productivity in both the tradables and nontradables sector in this group of countries.

With regard to the countries' net external assets position, we find that the impact of this variable on the RER differs markedly among developed and developing countries. In developing countries, there is a long-run impact on the RER, whereas the impact is not different from zero in developed economies.

Finally, the terms of trade and the relative productivity of the tradables and nontradables sectors tend to appreciate the RER in both groups of countries, with a quantitatively similar effect across countries.

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Riding the Roller Coaster: Fiscal Policies of Nonrenewable Resource Exporters in Latin America and the Caribbean

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In the last decade, the prices of nonrenewable resources, which constitute a critical source of fiscal revenue in many Latin American and Caribbean countries, recorded sharp swings correlated with economic growth developments in the world and in the region. Similar episodes in the past led to boom and bust cycles, but there is a perception that lessons were learned this time around. This paper analyzes the fiscal policies of nonrenewable-resource-exporting countries (NRECs) in Latin America and the Caribbean during the economic and resource price cycle of the last decade. The analysis focuses on two periods: the boom years (2003–08) and the more recent period, characterized by the global financial crisis and the receding of resource prices. It examines the role of fiscal policy vis-à-vis fluctuations in economic activity; the evolution of short-term fiscal vulnerability to resource price shocks and long-term fiscal sustainability; and the role of fiscal rules and resource funds in

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determining these aspects of fiscal policy. The countries covered in the study are Bolivia, Chile, Ecuador, Mexico, Peru, Trinidad and Tobago, and Venezuela.

The paper starts by presenting background information on recent trends in nonrenewable resource prices and the relevance of nonrenewable resource revenues in the NRECs covered in the study (section 1). It then proceeds to address four sets of questions. First, what were the countries' fiscal policy responses to the recent economic and resource price cycle? To address this question, section 2 explores whether fiscal policies were expansionary or contractionary—and procyclical or countercyclical—in the boom and the downturn in Latin American and Caribbean NRECs. Several cross-country studies analyze the evolution of the fiscal stance in Latin American and Caribbean countries.[1] Alberola and Montero (2006) assess the fiscal stance in a sample of nine countries in 1981–2004 and link it to the economic cycle; they find that fiscal policy was procyclical in that period. Izquierdo and Talvi (2008) focus on the seven largest Latin American countries in 2003–07 and conclude that fiscal policy was expansionary. In contrast, Vladkova-Hollar and Zettelmeyer (2008), using a different methodology, find that fiscal policy was contractionary in most Latin American and Caribbean countries during the same period. Di Bella (2009) explores the fiscal responses of Latin American and Caribbean countries to the 2009 downturn, concluding that countries with more prudent fiscal policies during the upswing were able to implement more expansionary fiscal policies during the downturn. Daude, Melguizo, and Neut (2010) find that although fiscal policies in Latin American and Caribbean countries were procyclical in the last two decades, sustainability improved.

In this paper, our analysis of the cyclical stance of fiscal policies explicitly takes into account the special characteristics of revenues arising from nonrenewable resources. We propose an approach for assessing the fiscal stance based on the nonresource primary balance that is simpler and more reliable than other approaches used in the literature. To complement our analysis, we present comparisons with the fiscal policies of middle-income NRECs in other regions.

The second question, addressed in section 3, is how fiscal vulnerabilities to resource price shocks evolved during the recent cycle. Resource price shocks are a fact of life for Latin American

1. Gavin and Perotti (1997) and Talvi and Végh (2000) are the classic earlier studies.

and Caribbean NRECs. In the past, because of financing and sustainability problems, sharp declines in these prices often led to the need to implement contractionary fiscal policies during downturns, with sudden and painful adjustments. Have the fiscal positions of Latin American and Caribbean NRECs become more resilient to potential resource price shocks? Are there relationships between the fiscal policies implemented during the boom and current fiscal vulnerabilities to resource price shocks? To answer these questions, the paper assesses the fiscal vulnerability of NRECs in the region to changes in resource prices to derive the sensitivity of net financing requirements to these prices. This sensitivity depends primarily on the size of the financial buffers that countries accumulated during the boom years.

Third, in section 4, we consider whether the fiscal positions of Latin American and Caribbean NRECs became more sustainable during the recent cycle. Specifically, the paper examines the long-term fiscal sustainability of NRECs in the region, its evolution over the recent economic and resource price cycle, and the potential link to the degree of procyclicality during the boom. Our approach extends conventional debt sustainability analysis to explicitly incorporate the exhaustibility of the resources in the ground. This requires making explicit assumptions regarding intertemporal welfare.

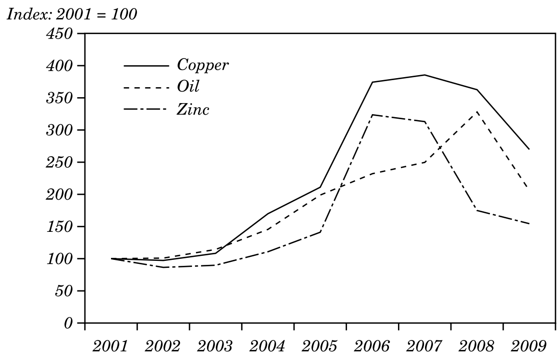
Finally, section 5 explores the role of fiscal rules and resource funds in the various dimensions of fiscal policy during the recent cycle. Most NRECs in the region have established such rules or funds (or both) to help address the significant challenges that volatile, uncertain, and exhaustible resource revenues pose to fiscal management. In many cases, rules and funds have also been motivated by political economy considerations: they are seen as potentially useful instruments for containing spending pressures or enhancing the government's credibility to manage resource revenues. The design of fiscal rules and funds varies widely among NRECs in the region. We therefore outline their main characteristics and how they were implemented during the recent boom and slump.[2] We consider possible links between the presence of rules or funds and the fiscal policy response to the cycle, and we offer some suggestions for the design of these mechanisms in NRECs based on conceptual considerations and lessons from country experiences.

2. Appendix A provides a detailed description of the workings of the fiscal rules and funds implemented in the sample countries.

1. Background

The prices of nonrenewable resources recorded sharp swings in the last decade. This was particularly the case for oil, gas, copper, and zinc, critical resources for some Latin American countries. The peak annual average prices in real terms in 2006–08 were more than three times their 2001 values (see figure 1).[3] Prices receded strongly thereafter, but they are still twice as high, on average, as at the beginning of the decade. Analytically, this pattern represents a price cycle, with a boom period until 2008 and a downturn in 2009.

Figure 1. Nonrenewable Resource Prices in Real Terms



Source: IMF, *World Economic Outlook* database.

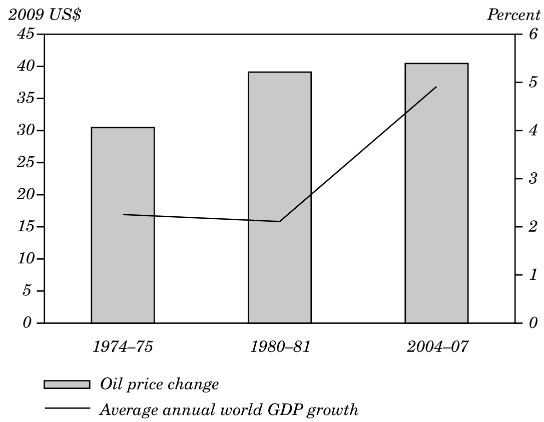
The large increase in oil prices in real terms recorded in 2003–08 took place together with a very strong expansion in global economic activity (see figure 2). This contrasts sharply with the sizable weakening in world GDP growth when oil prices spiked in the 1970s and early 1980s.

Nonrenewable resources are a critical source of fiscal revenue for some Latin American and Caribbean countries (see table 1). This paper focuses on a sample of nonrenewable-resource-exporting countries (NRECs) where fiscal revenue from nonrenewable resources (based on readily available information) accounted for at least

3. The price of oil used in this paper is the International Monetary Fund's *World Economic Outlook* (WEO) basket of oil prices, which is a simple average of the prices for Brent, Dubai, and West Texas Intermediate grades.

20 percent of total fiscal revenue over 2005–09: namely, Bolivia, Chile, Ecuador, Mexico, Peru, Trinidad and Tobago, and Venezuela.[4] These countries can be split into two groups: oil-exporting countries or OECs (Bolivia, Ecuador, Mexico, Trinidad and Tobago, and Venezuela)[5] and mineral-exporting countries or MECs (Chile and Peru). Dependence on nonrenewable resource revenues is greater in Latin American and Caribbean OECs (40 percent in 2005–09) than MECs (20 percent). This is partly due to a larger government take from oil than from minerals, as shown by a comparison of the ratios to GDP of fiscal resource revenue and resource sector size.[6]

Figure 2. Oil Price Changes in Real Terms and Global Economic Growth[a]



Source: IMF, *World Economic Outlook* database.
a. Average annual world GDP growth is measured on the right-hand axis.

4. The coverage of the fiscal accounts refers to the nonfinancial public sector (that is, including national resource companies) for Bolivia, Ecuador, Mexico, and Venezuela; the general government for Chile; and the central government for Peru (based on the national definition that includes regional governments, which are the beneficiaries of the *canon minero*) and Trinidad and Tobago. Part of the operating expenditure of Venezuela's national oil company (PDVSA) has been imputed as nonresource spending to capture the company's extensive quasi-fiscal spending.

5. Throughout this paper, we use the term oil as a substitute for the more encompassing terms hydrocarbon or petroleum; gas is the more important resource in Bolivia and Trinidad and Tobago.

6. Some OECs record oil revenue net of implicit or explicit domestic fuel subsidies. Resource revenue dependency ratios would be higher if gross oil revenue figures were used (together with higher nonoil spending in the form of fuel subsidies).

Table 1. Resource Sector Size and Revenue, 2005–09[a]

		Fiscal resource revenues	
Country	*Size of resource size*	*Percent of total revenues*	*Percent of GDP*
Bolivia	12	28	10
Chile	19	23	6
Ecuador	16	25	7
Mexico	8	36	8
Peru	11	20	3
Trinidad and Tobago	44	57	18
Venezuela	27	53	19
OECs	21	40	12
MECs	15	22	5

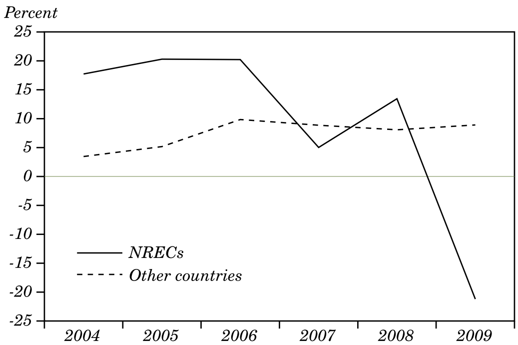
Source: IMF data and national sources.
a. Simple averages. Size of resource sector in percent of GDP.

The specific characteristics of fiscal resource revenues bring about difficult challenges for fiscal policy design and implementation in NRECs. First, the high volatility and uncertainty of nonrenewable resource revenues complicate fiscal management, budgetary planning, and the efficient use of public resources. During the recent resource price cycle (2003–09), the volatility of total fiscal revenue in real terms in Latin American and Caribbean NRECs was much higher than in a comparator group (see figure 3); the standard deviation of percentage changes of total revenue in real terms was 16 percent in the former compared to 4.5 percent in the latter.[7] Second, the exhaustibility of the resources raises complex issues of intergenerational equity, in terms of how much to consume and save, and long-term fiscal sustainability. Finally, with resource revenue largely arising from abroad, the fiscal spending of these resources domestically may generate inflationary pressures and lead to reduced competitiveness of nonresource export and import-competing sectors (so-called Dutch disease).

7. In some countries, the increases in resource revenues during the recent boom were also due to changes in fiscal regimes aimed at increasing government take (for example, Chile and Venezuela) and nationalizations (for example, Bolivia, Ecuador, and Venezuela).

In addition to the underlying characteristics of resource revenues, political economy and institutional factors (such as earmarking and revenue-sharing provisions in Ecuador and Bolivia, respectively) can add to the challenges noted above. They can exacerbate spending pressures, particularly when revenue is rising as in the 2003–08 boom.

Figure 3: Growth Rates of Fiscal Revenue in Latin America and the Caribbean in Real Terms[a]



Source: IMF data and national sources.
a. The sample of NRECs includes Bolivia, Chile, Ecuador, Mexico, Peru, Trinidad and Tobago, and Venezuela. The comparator group comprises Argentina, Brazil, Colombia, Costa Rica, Dominican Republic, Guatemala, Nicaragua, Panama, Paraguay, and Uruguay.

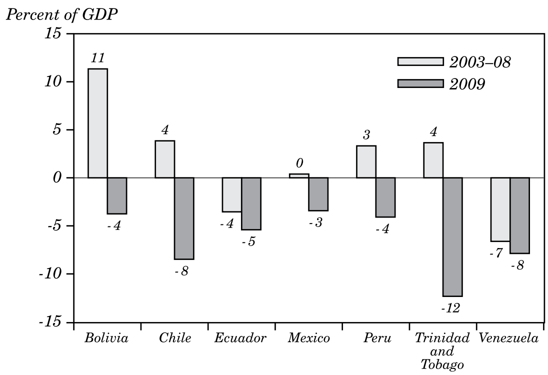
2. 2. The Procyclicality of Fiscal Policy

This section assesses the extent to which fiscal policy been expansionary (contractionary) in good times and contractionary (expansionary) in bad times, in order to determine whether fiscal policy has helped exacerbate (dampen) business cycle fluctuations in NRECs. Our analysis starts by examining the evolution of one of the most widely used fiscal policy indicators, the primary-balance-to-GDP ratio, together with real GDP growth dynamics. We then discuss some important limitations of this approach and the ways in which the literature has attempted to address some of its shortcomings. Finally, we propose an alternative approach to assess the fiscal stance in the short run that is simpler and more reliable than other approaches used in the literature.

The average growth rates of real GDP in Latin American and Caribbean NRECs accelerated in 2003–08, but fell dramatically in 2009. All countries except Mexico experienced markedly higher growth rates in 2003–08 than in the previous six years.[8] In all countries, there was a pronounced slowdown in 2009, and some countries recorded significant output declines.

Looking simply at the evolution of the primary-balance-to-GDP ratio would suggest that in the majority of Latin American and Caribbean NRECs, fiscal policy was contractionary during 2003–08 and was uniformly expansionary in 2009 (see figure 4). The primary balance ratios improved in most countries during the boom and deteriorated in all countries in 2009.

Figure 4. Change in Primary Balances



Source: IMF data and national sources.

The combination of a seemingly contractionary fiscal policy with relatively high growth rates and a seemingly expansionary fiscal policy with low growth rates might suggest predominantly countercyclical fiscal policy responses to the economic cycle. However, this type of assessment based on primary balance ratios would be misleading for three reasons. First, the primary balance is not a good indicator of the impact of fiscal policy on

8. Mexico was an exception because of the strong recovery that followed the tequila crisis in the mid 1990s.

domestic demand in NRECs because it does not take into account the specific nature of resource revenues, which largely originate from abroad and therefore do not affect the purchasing power of domestic economic agents. Thus, changes in the primary balance arising from fluctuations in these revenues should be expected to have limited effects on domestic demand. Second, the analysis does not control for the influence of the nonresource economic cycle on nonresource government revenues. Third, resource prices can have major effects on the observed ratios of fiscal variables to GDP because the resource and nonresource GDP deflators can deviate markedly, making nominal GDP quite volatile. Changes in resource prices can therefore drive large changes in conventional fiscal policy indicators, which make their interpretation difficult.[9]

Alberola and Montero (2006), Izquierdo and Talvi (2008), and Vladkova-Hollar and Zettelmeyer (2008) attempted to address the first and second of these issues by distinguishing between resource and nonresource revenues and then separately estimating the structural (or permanent) level for each. They define structural fiscal balances as the sum of structural resource and nonresource revenues net of government expenditures, and they characterize the fiscal stance by analyzing the changes in the estimated structural fiscal balances.[10] A key drawback of this approach is that the structural level of resource revenues is subject to major estimation uncertainty resulting from the highly volatile and unpredictable evolution of resource prices and the nature of the stochastic process that drives them.[11] In fact, Izquierdo and Talvi (2008) and Vladkova-Hollar and Zettelmeyer (2008) arrived at opposite conclusions on the fiscal stance in 2003–07 mainly because of differences in their assumptions about the persistence of resource price changes.

For these reasons, to assess the fiscal stance in NRECs, it is preferable to abstract from government resource revenue, eschew

9. For instance, a lower nonresource deficit in nominal terms might come hand in hand with a higher ratio of the nonresource deficit to GDP if, as a result of a decline in international resource prices, nominal GDP falls proportionally more than the nonresource deficit. Barnett and Ossowski (2003) provide examples.

10. Earlier studies, such as Gavin and Perotti (1997) and Talvi and Végh (2000), do not attempt to estimate structural fiscal balances.

11. In a major study of crude oil prices, Hamilton (2008) finds that the statistical evidence is consistent with the view that the price of oil in real terms seems to follow a random walk without drift. He notes that to predict the price of oil one quarter, one year, or one decade ahead, it would not be at all naïve to use the current price as a forecast—though he emphasizes the enormous uncertainty surrounding such forecasts.

structural resource revenue estimates, and refrain from using total GDP as the scaling factor. The nonresource primary balance (NRPB) measured in percent of nonresource GDP (NRGDP) fulfils these requirements (Barnett and Ossowski, 2003; Medas and Zakharova, 2009).[12]

The evolution of the NRPB as a ratio to NRGDP tells a completely different story from that obtained from the primary balance (see figure 5). It suggests that fiscal policy in most Latin American and Caribbean NRECs was expansionary in 2003–08 and was more mixed in 2009. This finding, however, is subject to the important caveat that the measured NRPB does not include domestic fuel subsidies (which are implicit in several countries) due to the difficulty of obtaining reliable, time-consistent, and methodologically uniform estimates for a number of countries (see appendix B). Appendix C sets out the main factors underlying the evolution of NRPBs in the sample countries.

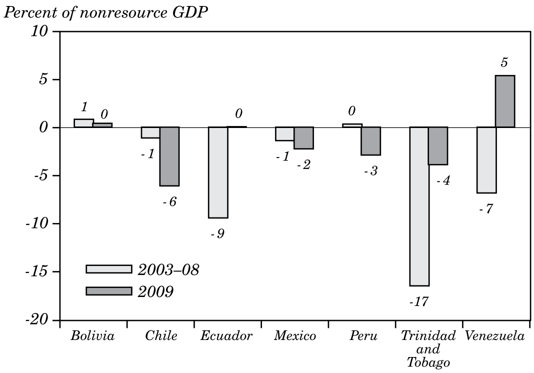
To study the relationship between the fiscal stance and the economic cycle more precisely, we need to measure the economic cycle more carefully and adjust the NRPB for the influence of the cycle. We measure the nonresource economic cycle by quantifying the nonresource output gap (NROG), applying the standard Hodrick-Prescott filter to the annual time series of NRGDP in real terms.[13] The NROG is defined as actual NRGDP minus trend NRGDP (measured in percent of trend NRGDP).

To define fiscal policy as either expansionary or contractionary, we break down the NRPB into the sum of the cyclically adjusted NRPB and the cyclical NRPB. Fiscal policy is then defined as contractionary when the change in the cyclically adjusted NRPB (CANRPB) is

12. This approach is therefore closer to Di Bella (2009), who also relies on the change in the NRPB to assess the fiscal stance in the short run, but scaled it in percent of total GDP instead of NRGDP. As discussed above, this can lead to spurious estimated effects, as changes in the ratio could be mainly driven by changes in the denominator resulting from changes in resource prices.

13. We use the standard smoothing parameter for annual time series ($\lambda = 100$). The sample period for which the output gap is computed starts in 1980. To address the endpoint problem of the HP filter, we used NRGDP annual time series projections up to 2015, based on the IMF's latest WEO. An alternative method would be to use the production function approach (Giorno and others, 1995), but estimates of the cycle based on this method require the availability of reliable data on the use of labor and capital stocks for the nonresource sector. With regard to the decomposition of a series into a trend and a cyclical component, possible methodologies include the Beveridge-Nelson approach, the unobservable component approach, the Baxter-King filter, and the Hodrick-Prescott filter. Each of these methods entails some advantages and drawbacks. We chose the Hodrick-Prescott filter because it is simple and transparent, and it continues to be the most commonly used filter in empirical studies and policy analysis.

Figure 5. Change in Nonresource Primary Balances



Source: IMF data and national sources.

positive (ΔCANRPB > 0), and it is expansionary when the change is negative (ΔCANRPB < 0).

Following the standard methodology to compute cyclically-adjusted balances (see Fedelino, Ivanova, and Horton, 2009, pp. 4–5), we estimate the CANRPB for each country during 2003–09 using the following formula:

$$\text{CANRPB} = r[1 - (\varepsilon^r - 1)\text{NROG}] - g[1 - (\varepsilon^g - 1)\text{NROG}],$$

where CANRPB is the cyclically-adjusted NRPB measured in percent of potential NRGDP, r is the ratio of nonresource revenues to NRGDP, ε^r is the elasticity of nonresource revenues with respect to the NROG, g is the ratio of expenditures to NRGDP, and ε^g is the elasticity of expenditures with respect to the NROG.[14] We call an expansionary fiscal policy a fiscal impulse (that is, ΔCANRPB < 0).

To assess whether fiscal policy is countercyclical or procyclical, we have to examine the link between changes in the NROG and the change in CANRPB. If the change in the NROG is negative

14. We assume that $\varepsilon^r = 1$ and $\varepsilon^g = 0$ for all countries and that no major tax policy changes took place. Most studies in developing countries assume that $\varepsilon^g = 0$, mainly because of the absence of extended unemployment insurance schemes. We assume that $\varepsilon^r = 1$ following Vladkova-Hollar and Zettelmeyer (2008), who estimate nonresource income elasticities controlling for changes in tax structure and find that they are close to unity in most cases.

(positive), then expansionary (contractionary) fiscal policy entails a countercyclical fiscal stance. Expansionary (contractionary) fiscal policy in the face of a positive (negative) change in the NROG implies a procyclical fiscal policy.[15]

Using this methodology, we find that fiscal policy in Latin American and Caribbean NRECs was predominantly procyclical during 2003–08.[16] Figure 6 shows the change in the NROG and the fiscal impulses for each country during the period.[17] The change in the NROG was positive in all countries and was particularly high in Venezuela. The fiscal impulses were positive in all countries except Bolivia. They were very substantial in Ecuador, Trinidad and Tobago, and Venezuela. The combination of positive changes in NROGs with positive fiscal impulses implies a procyclical fiscal policy response. The degree of procyclicality (measured by the ratio of fiscal impulse to changes in the NROG) was relatively more pronounced in the case of Ecuador and Trinidad and Tobago. The degree of procyclicality can also be measured in figure 6 as the slope of the ray from the origin to the point corresponding to each country. The slope of the ray is highest for Trinidad and Tobago and Ecuador.

The degree of procyclicality of fiscal policy in our sample of Latin American and Caribbean NRECs during the boom was lower, on average, than in a comparator sample of 13 middle-income NRECs outside the region.[18] The median fiscal impulse normalized by the change in the NROG was 0.5 in Latin American and Caribbean

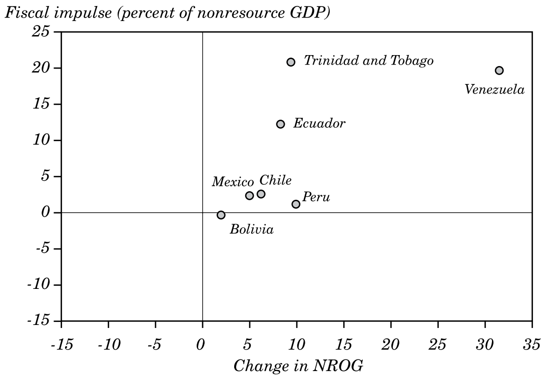
15. We follow Fedelino, Ivanova, and Horton (2009) in linking the change in CANRPB (that is, the fiscal impulse) to changes in the NROG to assess the cyclicality of the fiscal response. In contrast, Alberola and Montero (2006) study the link between fiscal impulses and the level of the output gap. We find the former approach more appealing, in part because the estimation of the direction of changes in output gaps is arguably more reliable than the estimation of the specific level of the output gap.

16. In this paper, we follow the literature on the cyclical behavior of fiscal policy, which implicitly assumes that output shocks drive fiscal policy. Some authors (such as Rigobon, 2005) claim that fiscal policy shocks drive output and not the other way around, suggesting that the conventional wisdom of procyclical fiscal policy in developing countries might not be well founded. These reverse causality considerations might be particularly relevant in some NRECs where nonresource economic activity is dominated by government spending. However, Ilzetzki and Végh (2008) rely on a battery of econometric tests to show that causality goes in both directions. They also show that the evidence of procyclical fiscal policy in developing countries is robust to endogeneity considerations.

17. We computed the cumulative change in the NROG and the cumulative fiscal impulse in 2003–08.

18. The sample of countries comprises Algeria, Angola, Azerbaijan, Cameroon, Congo, Gabon, Indonesia, Iran, Kazakhstan, Libya, Russia, Sudan, and Timor Leste.

Figure 6. Fiscal Impulses and Nonresource Output Gaps, 2003–08



Source: IMF data and national sources.

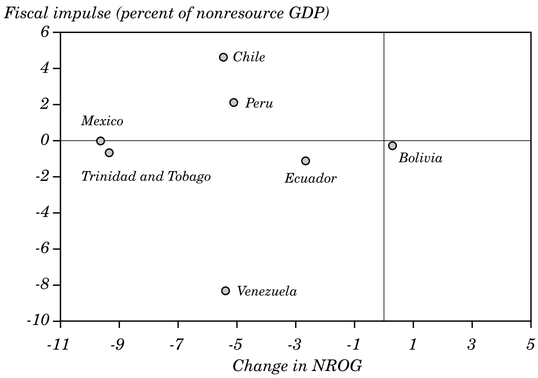
NRECs, compared with 1.1 in the comparator group. This is explained, in part, by the fact that the average size of the resource sector and of resource revenues relative to GDP in the comparator group is substantially higher than in Latin American and Caribbean NRECs.[19] Thus, in the comparator countries, the same proportional fiscal use of additional resource revenues would result in a higher fiscal impulse relative to NRGDP because of the smaller size of the latter relative to windfall resource revenues.

In the 2009 downturn, the change in the NROG was negative in all countries except Bolivia and was particularly large in Mexico and Trinidad and Tobago (see figure 7). The fiscal impulses were positive only in Chile and Peru, indicating the implementation of a countercyclical fiscal policy response in those countries. Fiscal policy was relatively neutral in Mexico and Trinidad and Tobago, procyclical in Ecuador, and highly procyclical in Venezuela.

In the downturn, and in marked contrast to the boom, the degree of procyclicality in Latin American and Caribbean NRECs was higher than in the comparator group of NRECs. The median fiscal impulse normalized by the change in the output gap was 0.1, versus –1.2 in the

19. The average size of the resource sector in Latin American and Caribbean NRECs is 16 percent of GDP, versus 43 percent in the comparator group. The average resource-revenue-to-GDP ratio is 8 percent of GDP in Latin American and Caribbean NRECs and 19 percent in the comparator group.

Figure 7. Fiscal Impulses and Nonresource Output Gaps, 2009



Source: IMF data and national sources.

other countries. Thus, the average fiscal response in the comparator countries was more countercyclical in the downturn. Government net financial positions are an important factor that may help explain the different fiscal responses. In Latin American and Caribbean NRECs, most governments were net financial debtors in 2008, while most governments in the comparator countries were net financial creditors. This suggests that Latin American and Caribbean NRECs had relatively less room for maneuver to implement expansionary fiscal policies than the comparator countries.

The evidence suggests that the procyclical fiscal policy bias was more prominent in the boom.[20] Table 2 shows the degree of fiscal policy procyclicality in 2003–08 and 2009. The average degree of procyclicality (measured by the ratio between the fiscal impulse and the change in the NROG) was 0.75 during the boom and –0.04 in 2009. The evidence also suggests that the countries that had more conservative fiscal policies during the boom tended to implement more expansionary fiscal policies during the slowdown in 2009.[21] During the boom, fiscal policy was close to neutral in Peru and mildly procyclical in Chile; in both

20. This asymmetry of fiscal policy has been documented for a large sample of developing and advanced countries by Balassone and Kumar (2007). Thus, political economic factors that result in strong spending pressures in good times might have played a more important role than financing constraints in explaining the cyclical behavior of fiscal policy.

21. Di Bella (2009) arrived at a similar conclusion in a larger sample of Latin American countries.

Table 2. Fiscal Impulses and Nonresource Output Gaps[a]

	2003–08			2009		
Country	*FI*	$\Delta NROG$	$FI / \Delta NROG$	*FI*	$\Delta NROG$	$FI / \Delta NROG$
Bolivia	−0.26	1.98	−0.13	−0.32	0.28	−1.12
Chile	2.63	6.18	0.43	4.62	−5.47	−0.84
Ecuador	12.34	8.26	1.49	−1.15	−2.66	0.43
Mexico	2.45	4.97	0.49	−0.05	−9.62	0.01
Peru	1.25	9.90	0.13	2.11	−5.09	−0.41
Trinidad and Tobago	20.94	9.34	2.24	−0.68	−9.34	0.07
Venezuela	19.77	31.48	0.63	−8.35	−5.34	1.56

Source: IMF data and national sources.
a. FI: Fiscal impulse, in percent of NRGDP; DNROG: Change in NROG, in percent.

countries it was strongly countercyclical during the crisis. In Mexico, fiscal policy was mildly procyclical during the boom and relatively neutral during the crisis. Bolivia was a special case combining a mild countercyclical fiscal policy response both during the boom and in 2009. In contrast, fiscal policy was procyclical in Ecuador, Trinidad and Tobago, and Venezuela during the upswing and the downswing (except in Trinidad and Tobago, where it was neutral in 2009).

As discussed in later sections, there are links between the degree of procyclicality during the boom and the current degree and dynamics of fiscal vulnerability and long-term fiscal sustainability. Broadly speaking, the countries that had the most procyclical fiscal responses to the boom are currently the most exposed to resource price shocks and questionable sustainability. In contrast, the countries that pursued the least procyclical policies during the upswing currently enjoy relatively comfortable fiscal vulnerability and sustainability positions. In addition, there is no obvious link between the cyclical stance of fiscal policy and the presence of fiscal rules and resource funds across countries during the cycle.

3. Short-Term Fiscal Vulnerability to Resource Price Shocks

Resource price shocks are a fact of life for NRECs. The prices in real terms of copper, oil, and zinc experienced annual average (absolute) changes of around 20–25 percent in 1970–2009. In turn, sharp declines in those prices have often led to sudden and painful fiscal adjustments and financing problems, as shown by many OECs in the mid-1980s and mid-1990s. In addition, access to external credit markets has historically tended to be procyclical.[22] A number of current projections suggest an upward path in resource prices over the medium term, but the recent swings in resource prices (such as the collapse in oil prices from a peak of almost US$150 per barrel in mid-2008 to US$35 per barrel in early 2009) provide a sobering reminder of potential price volatility. In addition, the still-significant downside risks to the global recovery cannot be ignored. It is thus important to examine the resilience of fiscal positions of Latin American and Caribbean NRECs to potential resource price shocks to determine whether countries reduced their fiscal vulnerability to those shocks.

22. Gavin and Perotti (1997); Kaminsky, Reinhart, and Végh (2005).

The analysis in the preceding section provided some hints regarding the ability of the sample countries to respond to resource price shocks, as some countries had to undertake contractionary fiscal policies in 2009. This section carries out a more systematic and forward-looking analysis by contrasting potential net and gross financing requirements resulting from resource price shocks with the financial asset stocks that governments accumulated in previous years.[23] The results of this analysis are not clear a priori, as fiscal vulnerability could have increased in the last decade due to greater dependence on resource revenues in the region, larger nonresource deficits, and sizable overall fiscal deficits in the downturn.[24] On the other hand, some countries accumulated sizable financial assets (and reduced debt) that could be tapped to smooth any needed adjustment to lower resource prices. Policy and institutional reforms may also have increased countries' resilience to negative shocks.

A simple way to assess the fiscal impact of a resource price shock is to assume local linearity between resource prices and fiscal revenue and, by extension, the overall fiscal balance and the gross financing requirement (that is, the fiscal deficit plus amortizations due). To illustrate, we compute the impact of a hypothetical 15 percent fall in prices relative to the projected 2010 levels (in line with the median absolute change in prices over the last 40 years or the difference between the third and second quartile of the distribution of negative changes) and apply a proportional adjustment to the projected resource revenues and resource GDP for 2010, while keeping nonresource revenue and spending unchanged (that is, the same nonresource balance in nominal terms).[25]

This approach helps isolate the specific impact of changes in resource prices, but it has some drawbacks: specifically, it does not account for different effective rates of taxation across prices,

23. This exercise may have become more relevant in the wake of the recent global financial crisis and the tightening of financing conditions, as it assumes that the estimated fiscal deficits and gross financing requirements must be financed out of the government's financial assets and, by association, out of public sector external assets. This assumption, however, might be considered extreme for some countries with relatively developed domestic financial markets.

24. Dependence on resource revenues in the sample countries increased, on average, from 20 percent of total fiscal revenue in 2003 to 26 percent in 2009.

25. The 2010 projections are from the International Monetary Fund (IMF, 2010). We use projected 2010 fiscal figures in this exercise and in the next section to avoid making analytical assessments of fiscal vulnerability and long-term fiscal sustainability based on the unsettled conditions prevailing in 2009.

and it abstracts from possible responses to lower resource prices (such as currency depreciation, increases in nonresource revenue, or reductions in government spending) or automatic declines in fuel subsidies and in intergovernmental transfers arising from revenue-sharing provisions.[26] Despite these shortcomings, this simple approach is useful to assess the fiscal impact of a resource price shock and the capacity of governments to manage it.

Based on this methodology, the overall fiscal balance would fall more significantly in OECs than in MECs (see table 3). The fiscal impact of a 15 percent decline in mineral prices would be around 0.5 percent of GDP in Chile and Peru, while a similar decline in oil prices would have a fiscal impact of 3.5 percent of GDP in Venezuela. These results reflect the larger share of oil revenue in fiscal revenues and total GDP in OECs relative to mining revenue in MECs. More importantly, the average overall deficit in OECs would be close to the peak recorded in 2009, and gross financing requirements would average 11 percent of GDP in those countries. These values contrast greatly with those for Chile and Peru, where gross financing requirements would increase only to 3–4 percent of GDP.

Table 3 also shows the ratio of the overall fiscal deficits after the shock (and gross financing requirements) to gross government or nonfinancial public sector domestic financial assets (that is, deposits with the banking system) and government foreign assets.[27] On this measure, Ecuador is highly exposed to resource price shocks, with net financing needs after the assumed shock representing 55 percent of available government financial assets. This situation is exacerbated by the government's lack of access to international capital markets following its 2008 debt default. To a lesser extent, Mexico, Trinidad and Tobago, and Venezuela would also be exposed to a resource price shock.[28]

26. Admittedly, an automatic reduction in shared resource revenue would just transfer the fiscal adjustment to other levels of government (as occurred in Bolivia and Venezuela). The extent to which this is effective depends on the government's ability to resist pressures for offsetting transfers and the ability of other beneficiary public entities to adjust to lower transfers.

27. In some countries, government deposits are the main counterpart of international reserves on the central bank's balance sheet. In Chile and Trinidad and Tobago, savings in resource funds are separate from the stock of international reserves held by the central bank.

28. An extension, which is particularly relevant for the countries with fixed exchange rates regimes, is to measure the implied coverage of public external assets (that is, central banks' net international reserves plus resource funds) in terms of months of imports of goods and services. In Ecuador, this external vulnerability indicator would fall to below two months of imports.

Table 3. Fiscal Impact of a 15 Percent Fall in Resource Prices

Country	*Change in overall balance (% of GDP)*	*Implied overall balance (% of GDP)*	*Implied gross financing requirement (% of GDP)*	*Implied overall deficit (% of gov. financial assets)*
Bolivia	−1.64	−1.93	7.02	10.16
Chile	−0.74	−2.37	4.21	15.09
Ecuador	−1.16	−5.24	7.07	54.71
Mexico	−1.11	−4.61	12.71	39.36
Peru	−0.44	−0.79	3.43	8.85
Trinidad and Tobago	−2.38	−6.58	12.91	36.70
Venezuela	−3.61	−7.75	14.01	50.79

Source: IMF staff estimates, based on projected 2010 IMF WEO figures.

To explore how the short-term fiscal vulnerability to negative resource price shocks evolved during the last cycle, we undertake a similar sensitivity analysis on the fiscal figures for 2003, applying a 15 percent fall to resource prices prevailing that year. We find that fiscal exposure to resource price shocks has increased in Ecuador and Venezuela, in that much larger fiscal deficits have not been offset by increases in government financial assets. Fiscal exposure to shocks fell substantially in Bolivia and Peru due to improvements in their overall fiscal balances and higher financial assets, and it remains broadly unchanged in the other NRECs in Latin America and the Caribbean (see table 4).

The evidence shows links between procyclical fiscal policies during the boom and fiscal vulnerability. Broadly speaking, the fiscal positions of countries that implemented procyclical fiscal policies during the upswing are currently the most exposed to resource price shocks and have also seen the biggest increase in their exposure to shocks.

Finally, fiscal vulnerability exercises should be combined with assessments of the overall policy framework and its ability to help deal with negative shocks to resource prices and volumes. In this regard, reforms in the last two decades have made many of the countries in the sample more resilient to those shocks.[29] The introduction of inflation targeting frameworks in Chile, Peru, and Mexico has strengthened the central bank's mandate for maintaining low and stable inflation rates while increasing the flexibility of exchange rates to adapt to changes in external conditions. Countries of the sample have reformed their fiscal institutions, with varied degrees of success, including strengthening revenue administration, improving public financial management, reducing budget rigidities, increasing fiscal transparency, and introducing fiscal responsibility legislation, fiscal rules, and resource funds (see section 5 and appendix A for an analysis of fiscal rules and resource funds). Finally, the composition of public debt has changed dramatically in Latin American and Caribbean NRECs, with the largest share now being denominated in local currency and having a longer average maturity. This said, Ecuador's policy framework, for example, is less flexible to tackle potential financing shortfalls (in contrast to Mexico) due to the absence of monetary and exchange rate policies under its fully dollarized regime.

29. See IMF, *Regional Economic Outlooks*, various issues, and Fernández-Arias and Montiel (2009) for a more thorough discussion.

Table 4. Evolution of Fiscal Vulnerability Indicators

	Implied overall deficit (% of gov. financial assets)		*Implied NIR + resource funds coverage (months of imports)*	
Country	*2003*	*2010*	*2003*	*2010*
Bolivia	105.9	10.2	7.2	19.0
Chile	9.2	15.1	8.0	8.0
Ecuador	–2.5	54.7	1.4	1.6
Mexico	45.9	39.4	3.3	3.8
Peru	27.8	8.9	3.8	12.8
Trinidad and Tobago	–3.1	36.7	6.4	16.3
Venezuela	39.5	50.8	15.5	10.1

Source: IMF Staff estimates, based on projected 2010 IMF WEO figures.

4. Long-Term Fiscal Sustainability

Some observers argue that the sustainability of fiscal policies in the region has improved in the recent past. To assess this position, we examine the evolution of long-term fiscal sustainability in Latin American and Caribbean NRECs in the recent cycle and explore whether those developments are linked to the degree of procyclicality of fiscal policy during the boom.

Analyses of fiscal sustainability often focus on a comparison between the observed cyclically adjusted primary balance and a debt-stabilizing primary balance. This approach is combined with a "reasonable" objective for the debt-to-GDP ratio.[30] In NRECs, however, the analysis needs to explicitly take into account two critical issues: the exhaustibility of resource revenues and the accumulation of sizable financial asset stocks by some of those countries during the boom. The first issue is particularly relevant for the countries with a limited production horizon for existing resource reserves, like Mexico and Trinidad and Tobago.[31] On the other hand, a focus on gross debt is misleading for countries such as Chile and Trinidad and Tobago, which were able to turn part of their mineral or hydrocarbon wealth into financial assets during the boom.

With these key considerations in mind, we compare the cyclically adjusted nonresource primary balance (CANRPB) (that is, removing the impact of cyclical factors from the assessment of the actual fiscal policy stance) with a long-term or benchmark NRPB.

The computation of the latter requires two steps. First, we calculate government net wealth, defined as the sum of the present value of projected future resource revenues (evaluated at the prices prevailing in the respective year of analysis—for example, 2010 prices for the 2010 sustainability benchmark) plus net government financial assets. Estimating the present value of future resource revenue requires assumptions about future resource prices, resource reserves in the ground, production profiles, production costs, the government take, real interest rates and returns on financial assets, and the path of the real exchange rate (that is, the domestic purchasing power of resource revenue).

30. See, for example, Fernández-Arias and Montiel (2009) for a recent application to Latin American countries. Reinhart, Rogoff, and Savastano (2003) provide a discussion of debt tolerance in Latin America.

31. The ratio of proven reserves to production at the end of 2009 was less than 15 years for Mexico and Trinidad and Tobago, less than 40 years for Chile, Ecuador, and Peru, and more than 50 years for Bolivia and Venezuela.

Second, we derive a consumption (or spending) path from government net wealth (that is, the NRPB). This requires making intertemporal welfare choices regarding how much resource revenue to consume now versus how much to save for consumption by future generations. For this purpose, the literature typically relies on alternative variants of the permanent income hypothesis (PIH) and consumption smoothing over time.[32] The application of the PIH approach usually involves the calculation of perpetuities, either constant in real terms or growing in line with the population or GDP growth rate.[33]

These two steps are subject to uncertainty and face difficult issues regarding intertemporal welfare choices. The estimation of wealth from future resource revenue is complicated by uncertainty about many of the parameters mentioned above. This is especially the case for future resource prices, but there are other sources of uncertainty for the countries in the sample. For instance, Peru has a large mining potential (yet to be properly measured), but some of its proven reserves might not be exploited at all because of social concerns (for example, Río Blanco). [34] Moreover, the intertemporal welfare choice regarding consumption and savings paths can be controversial, particularly in light of ever-expanding social needs. The implications of using a PIH-based approach or any other alternative are not trivial and lead to different consumption and savings paths and, therefore, different intergenerational distribution of the resource wealth.

Despite these caveats, fiscal sustainability exercises can be useful benchmarks for fiscal policy analysis and formulation in a longer-term perspective, provided they are properly designed and take into account the specific circumstances of each country. The benchmarks should be reassessed from time to time as new information becomes available.

32. Similar judgments about intertemporal welfare choices are made in the debt sustainability analysis (DSA) for other countries, but they are usually not explicit. For example, the stabilization of the public debt in percent of GDP has major implications for the intertemporal allocation of taxes and public spending. See Barnett and Ossowski (2003) for a formal derivation, Maliszewski (2009) and Van der Ploeg and Venables (2008) for comparative assessments, and Carcillo, Leigh, and Villafuerte (2007) for a specific application.

33. See, for example, Carcillo, Leigh, and Villafuerte (2007), Baunsgaard (2003), and Clausen (2008).

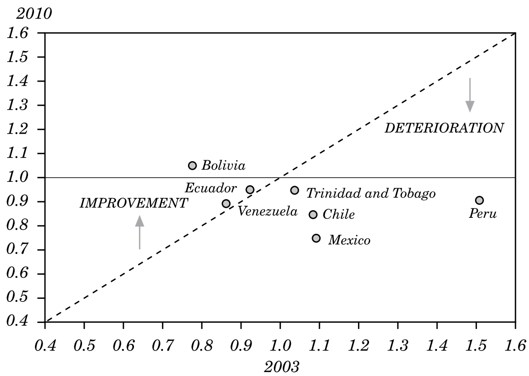
34. Reserves, production profiles, and government takes can also change substantially over time with price changes, as documented by the literature on the so-called expropriation cycles (see, for example, Hogan and Sturzenegger, 2010).

This paper computes a long-term fiscal benchmark based on a PIH formulation, but with an important difference relative to the traditional perpetuity-based approaches described above. These approaches are relatively stringent, as they require the stock of government wealth to increase over time through savings, including out of the return on financial investments. They would also not be realistic on policy grounds for countries with short resource production horizons and limited net financial assets, as spreading the consumption of oil-related wealth too far into the future would require large savings by current (probably poorer) generations. In this paper, we estimate an annuity (at constant prices) on the basis of the total government wealth over the remaining production period (the reserves-to-production ratio in number of years) plus 15 years.[35] This is an ad hoc formulation, but it is less stringent than other approaches and more realistic for some countries in the sample. The long-term annuity out of total government wealth is compared with the cyclically adjusted NRPB as the relevant measure of its current consumption. Appendix D offers details about the methodology and assumptions used, as well as an illustrative simulation for a representative NREC.

The comparative sustainability analysis over time and across countries in the sample can be facilitated by presenting the results in terms of the ratio of the implied long-term primary nonresource expenditure relative to the actual primary nonresource expenditure (this implicitly assumes an unchanged nonresource revenue ratio to NRGDP in the future). A fiscal sustainability ratio lower than one means that the country would have to adjust to reach the sustainable benchmark (for instance, if the ratio is 0.8, by an equivalent of 20 percent of the current level of expenditures), while a value greater than one would imply a sustainable fiscal position. The main results of this analysis are as follows (see figure 8). First, if the IMF WEO-projected 2010 fiscal stance (the cyclically adjusted NRPB) were to be maintained unchanged into the future, it would not be sustainable in the long run for Ecuador and Trinidad and Tobago, and sustainability questions would emerge for Mexico and Venezuela. Potential adjustments would range from 25 percent of primary nonoil

35. This sustainability analysis has a static dimension in that it focuses on the fiscal position in one specific year at a time based on the information then available. A sustainability gap can be closed in subsequent years in various ways, including through higher nonresource revenue, reductions in spending, or changes in the fiscal regime of the resource sector. These factors can only be captured explicitly in a dynamic setting.

Figure 8. Fiscal Sustainability Ratios, 2003 and 2010



Source: IMF Staff estimates.

expenditure in Trinidad and Tobago to 10 percent in Mexico.[36] By contrast, the fiscal position in Bolivia, Chile, and Peru would be more or less in line with the sustainability benchmark.[37]

Second, when we compare the sustainability position in 2010 relative to 2003 (before the boom in resource prices), Ecuador, Trinidad and Tobago, and Venezuela show substantial deteriorations, mainly because of a large expansion in their nonresource primary deficits relative to the increases in government net wealth. (Countries above the 45 degree line in figure 8 improved their fiscal sustainability position between 2003 and 2010, whereas countries below the line recorded a deterioration.) These results are somewhat surprising given that the oil price more than doubled in real terms between 2003 and 2010, and proven reserves increased substantially in Ecuador and Venezuela. However, these factors were more than offset by the increased nonoil deficits, the reduced domestic

36. As indicated earlier, although domestic fuel subsidies are sizable in several countries, we did not include them in the NRPB because it is difficult to obtain reliable estimates over time in several countries and the fiscal accounting treatment of the subsidies varies across countries.

37. Under the perpetuity approach, all countries were running unsustainable fiscal policies in 2010. The analysis assumes that domestic fuel subsidies will be eliminated at some point in the future. Otherwise, the fiscal adjustment needed would be larger—in some cases, substantially so. For instance, in Ecuador these subsidies are estimated to have amounted to more than 8 percent of NRGDP in 2008.

purchasing power of higher oil revenue due to real appreciations of the currency (particularly in Venezuela), and the reduced size of the oil wealth relative to a growing nonoil sector. In contrast, the long-term sustainability positions barely changed in Chile, Mexico, and Peru, and they improved in Bolivia.

Finally, the countries whose fiscal responses to the boom were most procyclical currently show the weakest long-term fiscal sustainability positions and saw the greatest deterioration in their fiscal sustainability during the cycle.

Long-term unsustainable positions do not necessarily imply the need for immediate adjustment, although the issue may be more pressing for countries with short remaining production horizons. Fiscal sustainability assessments have to be updated from time to time, given that the estimation of long-term sustainability benchmarks is subject to considerable uncertainty. In addition, governments could reap sufficient fiscal dividends (through higher nonresource revenue) from higher government spending to keep their 2010 levels (in percent of NRGDP, for example). However, the latter will depend on the quality of government spending, its impact on economywide productivity levels, and the government's ability to reap fiscal dividends from the additional activity—as well as the quality of overall policies, institutions, and decisionmaking.

5. Fiscal Rules and Resource Funds

Most NRECs in the region have introduced numerical fiscal rules or fiscal guidelines and/or nonrenewable resource funds (NRFs) in the expectation that these institutional features may help address the challenges that uncertain, volatile, and exhaustible resource revenues pose to fiscal management.[38] In many cases, fiscal rules and funds have also been motivated by political economy considerations: they have been seen as potentially useful instruments to contain spending pressures or enhance the government's credibility.

This section looks at the role played by these mechanisms during the recent cycle. Fiscal rules and funds vary widely among NRECs in the region. We explore their main characteristics and implementation during the boom and the slump and look for links

38. Fiscal rules are defined here as standing commitments to specified numerical targets for some key budget aggregates. Unlike fiscal rules, fiscal guidelines are not legally binding. This is the case in Chile, but for simplicity we refer to Chile's "fiscal rule."

between the presence of rules or funds and the fiscal responses to the cycle. The section also offers some suggestions for the design of these mechanisms in NRECs based on conceptual considerations and lessons from country experiences.

Six of the seven countries covered in this study have, or have had at some point during the last decade, one or both of these mechanisms: fiscal rules and NRFs in Chile, Ecuador, Mexico, Peru, and Venezuela; and NRFs alone in Trinidad and Tobago. Bolivia is the only country in the group not to have put in place such mechanisms. The design and implementation experience of rules and funds in the NRECs in the region are discussed in detail in Appendix A. Here we provide a brief outline.

Chile introduced a fiscal rule in 2001, targeting the structural central government balance (which comes close to targeting the cyclically adjusted nonresource balance given the adjustment made for the price of copper). The rule underwent successive technical refinements over time and was relaxed twice. The country also had a price-contingent copper stabilization fund that was later replaced by two NRFs: a fund with flexible rules where overall fiscal surpluses are deposited and from which resources can be drawn if desired; and a fund with a prespecified range for annual deposits as a ratio to GDP.[39]

Ecuador originally established three fiscal rules in 2002, targeting the nonresource balance, the real growth rate of expenditures, and the public debt. The rules were later modified (some expenditures were excluded from the coverage of the spending rule) and subsequently replaced by a nonoil golden rule in 2008. There has also been a series of NRFs with various operational rules—including rigid deposit rules and trigger rules contingent on actual oil prices relative to budgeted prices. The last of these NRFs was abolished a few years ago.

In Mexico, the fiscal rule put in place in 2006 targets the overall budget balance, while the NRFs are based on trigger rules contingent on actual oil prices relative to budgeted prices. Both mechanisms underwent modifications: some expenditures were excluded from the coverage of the rule, and subsequently the rule

39. Most nonrenewable resource stabilization funds around the world have rigid price- or revenue-contingent deposit and withdrawal rules, whereby deposits and withdrawals depend on the realization of an outcome (resource price or revenue) relative to a specified trigger. In contrast, most savings funds have rigid noncontingent deposit rules that typically require the annual deposit of a fixed share of revenues into the fund. Finally, some financing funds have flexible operational mechanisms more closely aligned with overall balances.

was temporarily relaxed; the caps on the accumulated resources in some of the funds were suspended.

Peru's fiscal rules (1999) target the overall balance and the real growth rate of expenditure. The rules have been modified several times, with the relaxation of the fiscal balance targets and expenditure growth ceilings and the removal of some expenditures from the coverage of the spending rule.

Trinidad and Tobago has instituted NRFs with trigger rules contingent on actual oil revenues relative to budgeted revenues. A fiscal stabilization fund with rigid deposit rules and contingent withdrawal rules is also in place.

Finally, Venezuela introduced multiyear fiscal rules in 2000, targeting the current balance, the real growth rate of expenditure, and the public debt, but the rules have not been implemented. The country also has an NRF with oil price trigger rules that have frequently been modified, as circumstances and policy objectives changed.

On the whole, and mirroring developments with fiscal rules and funds in NRECs elsewhere in the world, the experience of Latin American and Caribbean NRECs with these mechanisms has been mixed.[40] There seems to have been no obvious link between the presence of fiscal rules and NRFs and the cyclicality of fiscal policy across Latin American and Caribbean NRECs during the recent cycle. In Chile and Peru (which have fiscal rules and NRFs), fiscal policies were at most moderately procyclical during the boom and countercyclical during the slump. Bolivia, which has no such mechanisms, conducted fiscal policies broadly similar to those of Chile and Peru. In Mexico (with fiscal rule and NRFs), fiscal policy became more procyclical following the establishment of the rule and the funds in the latter part of the boom, and policy was neutral in the downswing. Ecuador (fiscal rules and NRFs), Venezuela (fiscal rules and NRFs), and Trinidad and Tobago (NRFs) conducted the most procyclical fiscal policies during the boom, and their policies were also procyclical or neutral during the slump.

In other words, fiscal rules and NRFs were associated with a broad range of fiscal responses to the recent economic and resource price cycles, including highly procyclical responses. This is partly the

40. See Ossowski and others (2008) for a general review of the international experience with fiscal rules and NRFs in NRECs and an econometric analysis of their effectiveness. Bacon and Tordo (2006) provide a detailed operational review of many oil funds. Arezki and Ismail (2010) econometrically evaluate some aspects of the effectiveness of fiscal rules in OECs, and Shabsigh and Ilahi (2007) examine oil funds.

result of the many modifications that rules and funds underwent in several countries as circumstances and policy objectives changed (see below and appendix A).[41] This said, these mechanisms may have had some disciplining and credibility-enhancing effects in some countries. For instance, in Peru the expenditure rule seems to have helped anchor the fiscal policy formulation process and moderate procyclicality while undergoing several modifications. These effects are difficult to test empirically, however, particularly when the rules and funds have been in place for just a few years in a context of dramatic changes in the external environment and other factors.

Many factors could potentially explain the variety of outcomes with rules and funds. They range from design issues to institutional and political economy aspects, such as political support and commitment to the rule or fund, consensus, fiscal transparency, sound public financial management, and adequate monitoring and control. Although a detailed examination of these issues is beyond the scope of this paper, the next subsections highlight some critical lessons arising from the working of fiscal rules and funds in Latin American and Caribbean NRECs.

5.1 Fiscal Rules

As in other regions, it has been difficult to design and implement fiscal rules in Latin American and Caribbean NRECs that can withstand the volatility and uncertainty of nonrenewable resource revenues and the rapidly changing economic environments facing these countries—particularly in countries that are more heavily dependent on resource revenues, namely, the OECs in the sample.

During the boom and in a situation of abundant liquidity generated by resource revenues, a number of rules targeting the nonresource balance and the growth rate of expenditures were tested by mounting expenditure pressures. These pressures may have been based, in part, on growing perceptions that the resource price increases were permanent. As a result, the rules were changed over time (sometimes several times, as in Ecuador and Peru), were

41. An analysis of the link between the presence of fiscal rules and NRFs in OECs around the world and the degree of fiscal policy procyclicality during the recent oil price cycle based on Villafuerte and López-Murphy (2010) does not show statistically significant differences in the fiscal policy responses of countries with such mechanisms and countries without them.

not followed (Ecuador), or were not implemented (Venezuela). The Chilean structural balance rule, while undergoing technical modifications over time, was met throughout the period. There was strong political support for the rule, but the latter was nonetheless eased in the last year of the boom. Rules targeting the overall balance were more easily met, particularly as the increase in resource prices accelerated during the later years of the boom (Peru). They also implied or allowed procyclical fiscal policies, however (Mexico). In Peru, the expenditure rule seems to have provided a more binding constraint during the upswing.

As resource prices fell precipitously and recession took hold in a number of Latin American and Caribbean NRECs, rules targeting the overall balance came under pressure and were modified or suspended, invoking exceptional clauses (Mexico and Peru). In Peru the spending rule was also eased to undertake a countercyclical fiscal response. In Chile, the structural balance rule was relaxed further to accommodate an easing of fiscal policy, and methodological changes of various types were introduced.

The compliance difficulties and frequent changes to fiscal rules in most Latin American and Caribbean NRECs during the recent economic cycle highlight the complex design, implementation, and political economy issues associated with the volatility and unpredictability of nonrenewable resource revenues. In particular, the rules must balance difficult tradeoffs between rigidity, flexibility, and credibility. Rigid rules can be easily overcome by events, undermining their credibility. Excessive flexibility can increase uncertainty about the direction of fiscal policy.

The experience of Latin American and Caribbean NRECs with fiscal rules suggests a number of lessons for successful strategies that are consistent with those emanating from NRECs in other regions (Ter-Minassian, 2010). First, targeting the overall balance in NRECs on its own is procyclical (for example, Mexico) and can result in major swings in expenditure, which is made hostage to the vagaries of resource prices. Targeting nonresource balances (adjusted for the nonresource cycle if technically and institutionally feasible) or alternative structural balances as in Chile can help smooth spending, decouple it from resource revenues in the short run, and reduce procyclicality, provided other preconditions listed below are met, as illustrated by the different experiences of Chile and Ecuador. This type of targeting should be supplemented by some feedback loop from the debt or the overall deficit if the initial fiscal or financial position is precarious. In all cases, theappropriate level of the targeted nonresource balance has to take into account long-term fiscal sustainability and fiscal vulnerability to resource shocks.

Second, some flexibility in the design of fiscal rules and specified escape clauses, are advisable in NRECs that face large uncertainties about relevant macroeconomic factors (such as resource prices) and are heavily exposed to unpredictable exogenous shocks. This would help reduce the likelihood of ad hoc modifications to the rules or their suspension (for example, Chile, Mexico, and Peru). With regard to flexibility, the targets could be specified for a period of a few years, with periodic revisions based on medium- and long-term reassessments; or revision clauses could be introduced specifying the conditions under which the targets may be revised. Rolling targets could also be used, although this may weaken discipline and carry credibility costs if used inappropriately. In all cases, transparent, clear, and specific escape clauses for unpredictable and major shocks should be put in place.

Other key technical elements and preconditions for a successful strategy include added emphasis on a medium-term perspective, a minimum set of public financial management requirements, and fiscal transparency. Moreover, consensus and political commitment to the rules are vital for their success. Rules that are not buttressed by broad social and political agreement over their objectives are unlikely to be effectively implemented and in cases of major political volatility can easily end up being ignored (as occurred in Ecuador and Venezuela).

5.2 Nonrenewable Resource Funds

Almost all the funds put in place by NRECs in the region have (or have had) rigid (contingent or non-contingent) accumulation and withdrawal rules, with the notable exception of the recent Economic and Social Stabilization Fund in Chile. The implementation of funds with rigid rules was premised largely on the expectation that the removal of high resource revenues relative to some benchmark or of a fixed share of revenues from the budget would help moderate and stabilize public spending, reduce the room for discretion in fiscal policy, and foster savings. In practice, setting fixed-trigger resource prices or revenues in contingent NRFs has proved difficult, owing to the characteristics of the stochastic process generating these prices. The large resource price volatility, uncertainty, and shock persistence generate significant challenges to setting estimated long-term average prices that are supposed to remain unchanged over time. As a result, funds with such trigger rules do not have a stable history. In Venezuela, the rules were modified frequently orfund operations were temporarily suspended, while Chile initially modified the trigger rules of the copper stabilization fund before replacing it altogether with tow funds based on different rules. In Peru, the stabilization fund's deposit and withdrawal rules have not always been observed.

Funds in which deposits and withdrawals are contingent on realized resource prices or revenues relative to the prices or revenues set in the budget have proved more resilient, as in the cases of Mexico and Trinidad and Tobago, but in certain circumstances this mechanism can complicate asset and liability management and, if the budgeted resource revenue or price is not set by formula, can provide incentives for the strategic setting of resource prices or revenues in the budget. The fund in Ecuador, for which deposits were based on a fixed share of certain oil revenues, was abolished after a few years of operation.

The experience with NRFs in the region also shows that tensions can easily surface between rigid-rule NRFs and overall fiscal policy and asset management. For example, in Venezuela, the overall stance of fiscal policy implied that the required deposits into the NRF could sometimes only be made by issuing debt at high interest rates; this led to temporary suspensions of the operations of the fund. In Ecuador, the combination of rigid deposit rules into the NRF, extensive revenue earmarking, and cash fragmentation led to the implementation of schemes to bypass the restrictions placed by the NRF, including the domestic placement of debt subsequently "bought back" by the NRF.

In most NRECs in the region that have or have had NRFs with rigid operational rules, these operate in conjunction with fiscal rules (with the exception of Trinidad and Tobago). When overall fiscal policy is constrained by fiscal rules, the rationale for funds with separate rigid operational rules is unclear. This setup may lead to conflicting objectives, thereby complicating asset and liability management, as shown by Ecuador. Rather, the existence of a fiscal rule would argue for establishing a financing fund with flexible accumulation and withdrawal rules and clear asset management objectives, which would ensure its effective integration with the budget.

As noted above, it has been argued that NRFs with rigid operational rules contribute to the moderation of spending because they remove certain resources from the budget during upswings. It is useful to disentangle the technical and political economy aspects of the issue. At a purely technical level, this would be the case if there are strong liquidity constraints and if the NRF rules are binding and observed. However, if the government is running large surpluses, removing some resources from the budget would not necessarily moderate spending. In the absence of surpluses, since resources are fungible, the government can borrow or run down other financial assets to increase spending and make the required deposits in the NRF—or it can ignore the NRF rules.

This still leaves possible political economy arguments for rigid NRF rules: even if there are no liquidity constraints, rules that mandate deposits into a fund can influence the political process in the direction of moderating spending. The evidence suggests, however, that the political economy advantages of removing resources from the budget are often unclear, that when pressures are mounting the funds' rules can be changed, bypassed, or ignored, and that the results seem to be very country-specific. On the other hand, rigid NRF rules can have significant fiscal costs in terms of suboptimal asset and liability management, as illustrated by the examples cited above.

The evidence of a number of Latin American and Caribbean NRECs therefore suggests that the focus should be on overall fiscal policy; that NRFs with rigid operational rules (such as those in Ecuador, Mexico, and Venezuela) would best be avoided; and that if there is a preference for having an NRF, consideration should be given to financing funds with flexible rules that are well integrated with budget systems and fiscal policy frameworks (for example, the Economic and Social Stabilization Fund in Chile).

Some countries have made efforts in the last few years to better integrate their NRFs with budget systems and fiscal policy frameworks. Chile replaced its rigid-rule contingent fund with a flexible-rule stabilization and savings fund in which overall fiscal surpluses are deposited and from which deficits can be financed. The usefulness of such a fund was shown in 2009, when the deficit was largely financed by drawings from the fund. Mexico temporarily suspended the statutory caps on the resources held in some of its NRFs, which had been a source of procyclicality and inefficiency (because resources accumulated in excess of the caps were earmarked for extrabudgetary expenditures, and these expenditures did not compete for resources with spending included in the budget).

6. Conclusions

This paper examined several dimensions of fiscal policy in NRECs in Latin America and the Caribbean during the last decade, including their fiscal stance from a short-run stabilization perspective; their short-term fiscal vulnerability to sudden falls in resource prices; and the long-term sustainability of their fiscal policy stance. The paper then looked at the role played by fiscal rules and resource funds and their relative performance with regard to these various dimensions of fiscal policy.

Fiscal policy was found to be predominantly procyclical in Latin American and Caribbean NRECs during the boom, as most countries, particularly Ecuador and Trinidad and Tobago, relaxed their fiscal policies during the upswing. In the 2009 downturn, the differences in the fiscal policy stance were more marked across these countries, with a countercyclical policy in Bolivia, Chile, and Peru, a neutral one in Mexico and Trinidad and Tobago, and a procyclical stance in Ecuador and Venezuela. The evidence also suggests that procyclicality was, on average, more prominent during the boom years. The heterogeneous responses to the slump can be partly linked to the fiscal policy stance during the boom: countries displaying more conservative fiscal policies in 2003–08 implemented more expansionary fiscal policies, on average, during the 2009 crisis.

The paper found links between the degree of procyclicality during the boom and the current degree and dynamics of fiscal vulnerability and long-term fiscal sustainability. Broadly speaking, the countries that had the most procyclical responses to the boom are currently the most fiscally vulnerable to resource price shocks and display questionable fiscal sustainability. In contrast, the countries that pursued the least procyclical fiscal policies during the upswing currently enjoy relatively comfortable fiscal vulnerability and sustainability positions.

In terms of short-term fiscal vulnerability to resource price shocks, the analysis suggests that Ecuador and, to a lesser extent, Mexico, Trinidad and Tobago, and Venezuela would be affected more strongly by such shocks. When examining the evolution of fiscal vulnerability during the recent cycle, Bolivia and Peru reduced their vulnerability substantially, while the fiscal exposure to resource price shocks of Ecuador and Venezuela increased. The analysis also indicates that the current fiscal positions of Ecuador, Mexico, Trinidad and Tobago, and Venezuela would pose challenges to long-term fiscal sustainability if maintained into the future.

Based on empirical analysis in this paper, we can classify Latin American and Caribbean NRECs into groups according to the fiscal policies implemented during the last decade. Fiscal policies in Bolivia, Chile, and Peru played a more stabilizing role during the cycle while becoming more sustainable in the short- and long-terms. In contrast, fiscal policies in Ecuador, Trinidad and Tobago, and Venezuela were mostly procyclical (and sometimes highly so), contributing to a deterioration in their short- and long-term sustainability positions. Mexico ran mildly procyclical policies during the boom and faces long-term sustainability challenges, but it was able to keep its fiscal vulnerability and long-term sustainability positions broadly unchanged over time.

Most NRECs in the region have put in place fiscal rules or NRFs in response to the difficult challenges brought about by fiscal dependence on volatile, uncertain, and exhaustible resources. The experience of Latin American and Caribbean NRECs with fiscal rules and NRFs has been mixed, mirroring developments in NRECs elsewhere in the world. The evidence suggests no obvious link between the presence of fiscal rules and NRFs and the cyclicality of fiscal policy across Latin American and Caribbean NRECs during the recent cycle. Indeed, rules and NRFs were associated with a broad range of fiscal responses, including highly procyclical responses. This partly reflects frequent modifications to the rules in a number of countries as circumstances and policy objectives changed. In other countries, fiscal rules and NRFs seem to have had some disciplining and credibility-enhancing effects.

The design and implementation of fiscal rules and NRFs in NRECs is very challenging owing to the volatility and uncertainty of nonrenewable resource revenues, the rapidly changing economic conditions, and the need for supportive political and institutional environments. The lessons extracted from the region suggest some key elements for successful strategies. With regard to fiscal rules, recommendations include targeting nonresource balances (either balances adjusted for the nonresource cycle or alternative structural balances as in Chile, if feasible); some flexibility in the design of fiscal rules, including clear mechanisms for the modification of targets based on medium- and long-term reassessments if appropriate; an enhanced medium-term perspective for fiscal policy; transparent, clear, and specific escape clauses; a minimum set of public financial management requirements; fiscal transparency; and strong political support for the rules. For NRFs, rigid operational rules should preferably be avoided, and funds should be well integrated with budget systems and fiscal policy frameworks.

Appendix A
Fiscal Rules and Resource Funds in Selected Nonrenewable-Resource-Exporting Countries

This appendix expands on our description of the history of fiscal rules and resource funds in six of the seven Latin American and Caribbean NRECs in our sample: namely, Chile, Ecuador, Mexico, Peru, Trinidad and Tobago, and Venezuela. Bolivia is excluded as it does not employ either fiscal rules or resource funds.

Chile: Structural balance rule and resource funds

Since 2001, Chile's fiscal policy has been built on the concept of a central government structural balance. This framework has been intended to signal fiscal policy intentions, while limiting procyclical policies and allowing full operation of automatic stabilizers from the revenue side. Under the structural balance rule, government expenditures are budgeted ex ante in line with estimated structural revenues, that is, revenues that would be achieved if the economy were operating at full potential and the prices of copper and molybdenum were at their long-term levels. The expenditure envelope is, in turn, split into an inertial component (that is, legal and contractual obligations, multiyear commitments, and operating expenses) and a fraction for the creation of new spending programs or the expansion of existing ones. The authorities have also aimed at meeting the structural balance targets ex post by undertaking any necessary intra-annual revenue and expenditure adjustments during budgetary execution.

Compliance with structural balance targets in Chile is not legally binding. However, successive governments have reiterated their commitment with set targets and mostly complied with them. The 2006 Fiscal Responsibility Law (FRL) institutionalized key aspects of the structural balance rule framework, without forcing the government to commit to a specific target or specifying procedures for its calculation. It also complemented the fiscal framework with the introduction of two funds: namely, the Economic and Social Stabilization Fund and the Pension Reserve Fund.

In clear contrast to other countries in the region, most fiscal powers in Chile are vested in the president and the executive branch (IMF, 2003). This means that the structural balance rule mainly acts as a self-imposed and self-assessed constraint on the executive. In this context, changes to this fiscal framework have been introduced through policy papers issued by the Budget Office (DIPRES), including the migration of accounting standards to the 2001 IMF Government Financial Statistics Manual, an expansion of its institutional coverage to the consolidated central government (that is, including extrabudgetary transactions from the *Ley Reservada del Cobre*), and changes in the numerical targets.

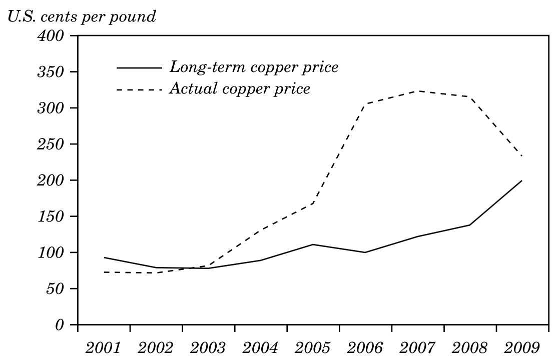
The structural balance target has changed over time. It was originally set at a surplus of 1 percent of GDP based on three grounds: the structural operating deficit and negative net worth of the Central Bank of Chile; the existence of contingent liabilities related primarily to state-guaranteed minimum pensions and old-age benefits; and external vulnerabilities arising from currency mismatches in the public sector balance sheet. This target was more or less in line with the fiscal outcomes recorded during most of the 1990s. In 2008, the target was reduced to a 0.5 percent of GDP surplus because of an improvement in underlying macrofiscal conditions, the reduction in fiscal risks, and the accumulation of financial savings. In 2009, the target was reduced further to accommodate a countercyclical fiscal policy package in the context of the global financial crisis and the sharp reduction in economic activity. Furthermore, the 2009 target was defined to exclude the impact of temporary tax reduction measures (amounting to about 1.5 percent of GDP).

The implementation of the structural balance rule has been supported by two independent panels of experts to determine potential output and the long-term price of copper. Each year, the Finance Ministry assembles two independent panels of 11–15 individuals who are widely regarded as experts in their fields. The Finance Ministry asks the copper price panel to provide a ten-year forecast of copper prices, and the reference price is then set as the arithmetic average of the forecasts (excluding two most extreme estimates). From the potential output panel, the ministry requests five- to six-year growth forecasts for the labor force, real investment, and total factor productivity. The procedure used to date is to compute average forecasts and use HP-filtered series to estimate trend GDP and the output gap from an aggregate Cobb-Douglas production function. More recently, GDP elasticities disaggregated for five types of taxes have been used to derive the structural nonmining revenue.

The structural balance rule framework in Chile has been a critical cornerstone for Chile's strong fiscal performance during the recent economic cycle. In particular, the use of long-term copper prices limited the impact of highly volatile copper prices during the boom years (prices quadrupled between 2003 and 2008) and in 2009 (a 25 percent fall in prices; see figure A1). In fact, the long-term copper price was more or less equivalent to average copper prices for rolling ten-year periods (with a correlation of 0.92 between 2003 and 2009). Primary expenditure in real terms grew by an average of 7.5 percent in 2004–08, highly correlated with the increase in copper prices but still relatively limited. By contrast, primary expenditure in real terms grew by 18 percent in the recessionary year of 2009 thanks to a drawdown of part of the large financial assets previously accrued in the Economic and Social Stabilization Fund.

The success of the rule can be explained in part by the existence of a strong institutional framework, which includes a concentration of fiscal powers in the executive, and an effective inflation-targeting framework. At the same time, issues surrounding the implementation of the rule in 2009–10, such as the ad hoc exclusion of temporary tax reductions from the target, have revealed some challenges in its functioning. The framework might have become unduly complex over time (with reduced transparency) and rigid. In May 2010, the authorities established an advisory committee to review the workings of the framework, suggest ways to improve and simplify its methodologies, and increase its transparency and accountability. A first report by the committee, which was aimed at providing temporary recommendations to guide the formulation of the 2011

Figure A1. Copper Prices



Source: IMF *World Economic Outlook* database and Chilean authorities.

budget, suggested changes in the use of inputs from the potential output independent panel, the exclusion of temporary tax reductions from the calculation of the structural target, the elimination of the cyclical correction on the return on accrued financial assets, and the reversion of some accounting practices that were understating the headline and structural deficits. The final report of the committee is expected to provide broader advice on the fiscal rule that would be put implemented in 2012.

Ecuador: Fiscal rules and oil funds

Dependence on oil revenues, lack of political consensus, and institutional weaknesses have complicated fiscal policy in Ecuador. The country has suffered from recurrent problems in reaching sustainable agreements regarding fiscal policy. This is reflected in the introduction of frequent legal reforms, some short-lived, in the fiscal framework. An important factor behind this instability is lack of trust among various groups involved in the fiscal policy process, which is also reflected in extensive revenue earmarking and budget rigidities. The high degree of budget rigidity, in turn, has generated frequent liquidity problems and contributed to the procyclicality of fiscal policy.

In 2000, shortly after dollarization, an oil stabilization fund (FEP) was created. The fund was to receive 45 percent of all oil revenue in excess of oil revenue projected in the budget. The remainder was earmarked to regional projects and some investments. In subsequent years, the FEP accumulated limited resources, and it did not seem to have any noticeable impact on the conduct of fiscal policy.

An important attempt to strengthen the fiscal framework and provide greater clarity in the conduct of fiscal policy was made in 2002. That year, a Fiscal Responsibility and Transparency Law (FRTL) was adopted. The law included numerical fiscal rules for the central government, procedural budgetary rules, and the creation of a new oil fund (FEIREP). There were three fiscal rules: a limit on the annual growth of primary expenditure in real terms (3.5 percent); a requirement to reduce the nonoil fiscal deficit by at least 0.2 percentage points of GDP a year down to zero; and a requirement to steadily reduce the public debt ratio until it reached at most 40 percent of GDP. The new oil fund was to receive all the oil revenue arising from the operation of the new heavy crude pipeline (OCP). Its resources were earmarked to debt reduction in excess of regularly scheduled amortization (70 percent); stabilization of the budget and payment of expenditures arising from natural disasters and economic emergencies (20 percent); and health and education spending (which was included in the 3.5 percent spending rule; 10 percent).

As oil revenues increased, governments had growing difficulties withstanding pressures for more public spending and resisting questionable policy initiatives from powerful interest groups and local governments. The implementation of some of the fiscal rules thus deteriorated over time as financing constraints lifted, revenues increased, and spending pressures mounted. Furthermore, the 3.5 percent cap on the growth of primary spending in real terms in the presence of extensive revenue earmarking was bound to reduce even further the already limited fiscal flexibility of the central government. The latter steadily deteriorated over time as revenue-sharing transfers and other revenue earmarking increasingly squeezed out discretionary spending. To avoid this effect, it would have been essential to reduce earmarking significantly, but attempts to pass fiscal reforms through congress, including reductions in earmarking, proved unsuccessful.

The situation was not helped by the existence of certain ambiguities in the FRTL. Notably, the legislation did not specify whether the basis for comparison for the spending and deficit rules was to be the approved budget or the executed budget of the previous fiscal year. This generated incentives to use the most convenient definition depending on the circumstances—and still, the nonoil deficit reduction rule was frequently not observed. Invoking economic emergencies also became common, to allow the use of FEIREP resources to increase spending. In addition, the central government resorted to placing debt domestically that was later bought back through FEIREP (as a creative asset-liability management approach). In the event, FEIREP only managed to accumulate limited balances.

The fiscal policy framework was changed and weakened in 2005. Congress approved a reform to the FRTL, sponsored by a new government, that removed capital spending from the spending rule, eliminated the FEIREP oil fund, brought all oil revenues into the budget, and increased the earmarking of oil revenues, thus exacerbating budget rigidities. Further changes were introduced in 2008, when the Constitutional Assembly abolished all existing oil funds and fiscal rules, which were replaced by a new rule. The rule stipulates that current spending can only be financed by nonoil revenue (a sort of nonoil golden rule). Arguably, these changes were simply the final result of a gradual and sustained weakening of political support to the fiscal rule and oil funds. The new nonoil golden rule seems to have provided incentives for creative accounting and reclassification of spending. In 2008, recorded capital spending more than doubled.

To summarize, the success of fiscal rules and oil funds in Ecuador was very limited. Rules and the operating mechanisms of funds were repeatedly changed or simply ignored. The fiscal rules did not withstand strong spending pressures during the boom. The oil funds became largely additional earmarking mechanisms that increased budget rigidities and complicated fiscal management.

Mexico: Fiscal rule and oil funds

Mexico implemented an oil stabilization fund in 2000. A part of government revenues in excess of budgeted amounts was to be transferred to the fund. At first, fund resources could only be used if oil export revenues fell below the reference oil price in the budget by more than US$1.50 a barrel. In 2002, however, the rules were changed to allow for full compensation of shortfalls. During that year the fund's accumulated resources were fully drawn.

Major changes in the fiscal framework were introduced in 2006 with the adoption of the Federal Budget and Fiscal Responsibility Law. The law established a fiscal balance target, mechanisms for budgeting under oil price uncertainty, a system of oil funds, and a medium-term expenditure framework.

A balanced budget rule applies to the budgetary federal public sector, which consists of the federal government, the social security systems, and some public enterprises including PEMEX, the national oil company. Under the rule, budgets must target a zero balance on a cash basis. In exceptional circumstances a weaker budget may be proposed, but this requires explicit justification and plans for returning to a zero balance. The law requires the government to present the annual budget in the context of a medium-term framework, with projections covering the subsequent five years.

Federal oil revenues for each annual budget are projected using a reference oil price. The price is set by a formula, with a weight of 0.75 being given to oil futures prices and a weight of 0.25 to the average oil price of the last ten years. Any excess revenue that results from oil prices being higher than the reference price may first be used to compensate for certain specified budget overruns.

The remainder is split between three first-tier oil funds (90 percent) and state-level investments (10 percent). The first-tier oil funds are a stabilization fund and funds to finance PEMEX investment and investment by federal entities. If actual oil revenues turn out to be lower than budgeted due to lower oil prices or exchange rate effects, the oil stabilization funds may make transfers to cover the shortfalls. Until 2010, once the first-tier funds reached their statutory ceilings (totaling about 1.5 percent of GDP), any subsequent excesses were to be allocated to a second tier of funds that finance investment by subnational governments (50 percent), PEMEX investment (25 percent), and a fund to finance future costs of pension reform (25 percent). Resources held in the first-tier funds at end-2009 were equivalent to 1 percent of GDP.

Important developments concerning the fiscal framework took place in 2009–10, when the Mexican economy was hit by a substantial external shock, reflecting the strong real and financial linkages with the united States. First, beginning in 2009, investment by PEMEX was excluded from the calculation of the budget balance under the fiscal rule; this created room for a discretionary increase in spending. Second, the exceptional circumstances clause in the fiscal rule that allows a temporary widening of the deficit was invoked in the 2010 budget, with the deep recession and associated drop in revenues cited as the basis for the exception; a deficit of 0.5 percent of GDP in the balance targeted by the rule was budgeted. Third, the statutory caps on the resources held in the first-tier oil funds—a key source of procyclicality—were suspended for 2010, allowing additional room for saving windfall revenues.

Arguably, the balanced budget rule has helped build credibility and contain fiscal deficits in recent years. In particular, it may have had disciplining effects on the legislature, where in the past there had been a tendency to increase spending allocations compared to the proposed budgets. This said, a higher level of savings of windfall oil revenues in the years prior to the crisis would have facilitated stronger fiscal support to domestic demand during the global financial crisis. Moreover, the fiscal rule proved too constraining in 2009–10 in that compliance with the rule would have entailed a large withdrawal of fiscal stimulus. In the event, the fiscal rule was eased through the mechanisms discussed above.

A fiscal rule that targets the overall budget balance, combined with the presence of significant oil revenues, is procyclical, and so it has been in Mexico. Following the introduction of the rule, the growth rate of spending increased and the NRPB deteriorated, at a time when savings in the oil funds were capped. It was necessary to intoduce changes to the rule in 2009 and suspend the rule in 2010 to avoid having to implement an unwarranted procyclical tightening in the midst of a deep recession.

Peru: Fiscal rule and stabilization fund

In the late 1990s, and on the back of a sharp deterioration of the public finances in 1998–99, a growing consensus emerged in Peru toward a formal strengthening of the fiscal framework, including through the adoption of numerical fiscal rules. One of the main motivations for this development was the desire to put the public debt on a firmly downward path. The Fiscal Responsibility and Transparency Law (FRTL) was thus adopted in 1999, as a device to promote fiscal discipline and enhance fiscal transparency. The FRTL was partially modified with the introduction of the Fiscal Management Responsibility Law in 2003, and further changes were introduced in 2007. The legislation included procedural and fiscal transparency provisions, the requirement to prepare a multiyear macroeconomic and fiscal framework with rolling three-year fiscal projections, and numerical fiscal rules. The original FRTL fiscal rules targeted the deficit of the nonfinancial public sector, the growth rate of general government expenditure (that is, including local governments) in real terms, and debt ceilings for the local governments.

The deficit ceilings for 2000–02 featured a declining path for the deficit, from 2 percent of GDP in 2000 to 1 percent of GDP in 2002 and thereafter. Following repeated breaches, the target was loosened in 2003, when a new sliding scale for the deficit was put in place, from 2 percent of GDP in 2003 to 1 percent of GDP in 2005 and thereafter. The limit to the annual growth of expenditure in real terms was loosened in 2003 from 2 percent to 3 percent. The coverage of expenditure under the rule was narrowed in 2007 to consumption of the central government (wages and salaries, goods and services, and pensions), thereby excluding the investment spending and expenditure of local governments from the spending rule. The limit on the growth rate of current spending was also loosened to 4 percent. The Ministry of Health was exempted from the current expenditure limits in 2008.

Compliance with the deficit limits proved problematic in the early years (2000–02). It improved significantly in later years as mineral and other revenues boomed, and the limits were met with growing margins until 2008. Compliance with the general government expenditure limits proved challenging in the context of the revenue boom despite the loosening of the limit in 2003. This, combined with the lack of effective control of subnational spending, led to the narrowing of coverage in 2007 and the increase in the permitted rate of expenditure growth. Nevertheless, the expenditure rule seems to have provided more of a binding constraint than the deficit rule, despite undergoing several modifications.

The global financial crisis put pressure on the fiscal rules. The government's policy response included a significant countercyclical fiscal stimulus, which was facilitated by the savings accumulated during the boom (Rial, 2010). To accommodate this policy response, recourse was made to an exceptional escape clause in the FRTL that allowed for a temporary relaxation of the ceilings with congressional approval. A relaxation of the FRTL was approved in May 2009 to allow for a deficit of 2 percent of GDP in 2009–10 (returning to the 1 percent limit in 2011) and a relaxation of the expenditure rule.

The FRTL also created a fiscal stabilization fund (FEF). Resources of the FEF include any fiscal surpluses generated by the Treasury, 10 percent of privatization proceeds, and 10 percent of concessional revenues. The FEF is subject to a cap of 4 percent of GDP, with any excess allocated to debt reduction. FEF resources may only be used when the revenue shortfall (in percent of GDP) is more than 0.3 percent the average ratio of last the years or under the escape clauses of the FRL. However, no more than 40 percent of total funds can be used in a given year. Some fiscal savings have been accumulated at the FEF, but it has not been used regularly for stabilization. The rules proved too stringent for it to be used as a stabilization fund, mainly because two quarters of declining GDP are needed to use funds that are capped—while the funds should preferably be used preemptively. As a result, either funds were not allocated to the FEF according to the accumulation rules, or those deposited were barely used, making the FEF a de facto savings fund.

Trinidad and Tobago: Oil fund

In 2000, Trinidad and Tobago's government established an oil fund, the Interim Revenue Stabilization Fund (IRSF), with the aims of promoting fiscal discipline during oil booms, cushioning the effects of unexpected drops in oil prices, and promoting public saving. The fund was not formally approved by parliament, and after an initial transfer, it remained inactive for a few years before receiving further transfers. Under the IRSF's rules, deposits into (withdrawals from) the fund were to be made when quarterly oil revenues exceeded (fell short of) the quarterly revenues projected in the budget by at least 10 percent. Budget revenues were based on a discretionary reference price. Deposits were to be at least two-thirds of the difference between projected and actual revenues.

In May 2007, the IRSF was replaced by the Heritage and Stabilization Fund (HSF). The new fund's initial capital comprised the resources accumulated in the IRSF, which were transferred to the HSF. The HSF has stabilization and savings objectives. The stabilization objective is to cushion the impact on spending of petroleum revenue downturns. With regard to saving, the fund aims at accumulating assets over time to generate an alternative income stream to support public spending after petroleum revenue declines and oil and gas resources are depleted.

Under the HSF's rules, at least 60 percent of oil and gas revenues in excess of budgeted amounts are to be deposited in the HSF, provided the excess is more than 10 percent of budgeted revenues. Withdrawals from the HSF are permitted in cases where actual oil and gas revenues fall at least 10 percent below budgeted revenues. The withdrawal can be up to 60 percent of the shortfall, but cannot exceed 25 percent of the resources in the HSF. Budgeted revenue is estimated on the basis of a reference oil price derived from an eleven-year moving average of prices (the five years prior to the current fiscal year and projected prices for the current year and the next five years).

Despite the operation of the IRSF and the HSF, fiscal policy in Trinidad and Tobago was highly procyclical during the boom, with expenditures being increased massively over the period.

Venezuela: Fiscal rules and oil funds

Venezuela has a long history with oil funds. The Venezuelan Investment Fund (FIV) was created in the mid 1970s, following the first oil price boom. The objective of the fund was to help save a significant share of the oil windfall. Part of the fund's resources was soon diverted to financing domestic investments and taking equity in public enterprises that subsequently turned out to be loss makers.

Thus, while Venezuela's oil exports surged from US$3 billion in 1972 to US$20 billion in 1981, the FIV saved only US$2.5 billion at the central bank in the period. In the 1990s, some of the fund's remaining resources were used to support loss-making state companies in the electricity sector—in effect, energy subsidies were provided off budget through the use of the FIV's resources.

A new framework to help manage oil resources was put in place between 1998 and 2000. First, an organic budget law was approved in 2000. The law was intended to strengthen fiscal policy and reduce expenditure volatility—a chronic problem in Venezuela. It focused on improving the budget process, including the use of a multiyear framework, and introduced multiyear numerical fiscal rules for the current balance, expenditure growth, and the public debt. Implementation of the law, however, was postponed. Second, an oil stabilization fund, the Macroeconomic Investment and Stabilization Fund (FIEM), was created. The objectives of the fund were to help insulate the budget and the economy from fluctuations in oil prices. As initially designed in late 1998, contributions to the fund were specified as the oil revenues above a reference value corresponding to a five-year moving average. Resources could only be drawn from the fund in a given year if oil revenues were below the reference value or resources in the fund exceeded 80 percent of the moving average of oil export revenues, in which case resources could be used to amortize public debt.

The rules of the FIEM were substantially modified in 1999. The reference values triggering accumulation or withdrawal of resources were fixed at US$9 a barrel. Fifty percent of any oil revenues that accrued at a price above this value were to be deposited by the central government, the regional governments, and PDVSA (the state oil company) in the FIEM. Discretionary withdrawals from the fund with government authorization and legislative approval were allowed. The FIEM was modified again in 2001, and the government and PDVSA were exempted from the requirement to make deposits for a while. Many further changes were introduced in subsequent years in the context of the annual budgets.

Over the years, the integration of the oil fund with overall fiscal policy has proved problematic. At times, high-cost borrowing took place to meet the FIEM's rules. Specifically, when the central government was in deficit, the required deposits could only be made by taking on public debt, such that the buildup of gross assets in the fund was financed by expensive borrowing. FIEM's rules were frequently changed, ignored, or temporarily suspended, and the FIEM did not accumulate any significant resources in 2005–08 when oil prices surged.

More broadly, the organic budget law and the FIEM were put in place with the objective of improving fiscal performance and smoothing expenditure, but they did not achieve this purpose—they did not prevent the implementation of highly procyclical fiscal policies during the oil boom and the subsequent slump. In fact, Clemente, Faris, and Puente (2002), using a general equilibrium model, find that the FIEM seems to have increased macroeconomic volatility.

Appendix B
Subsidies on Fuel Products and the Fiscal Stance

The NRPB indicator used in this paper is subject to an important caveat. In several oil-exporting countries (OECs) in the sample, fuel products are sold domestically at controlled prices that are often below international prices. Some of these subsidies are explicit (for example, the subsidies on imported products in Bolivia and the negative excise in Mexico). In most of the OECs in the sample, however, some or all of the subsidies on fuel products sold domestically are implicit. Often, they are effectively netted against the national oil company's oil revenue, as, for instance, in Ecuador and Venezuela.

In a number of cases, there is a lack of consistent, reliable time series of fuel subsidies. Some countries have repeatedly changed the subsidization mechanisms, as well as their institutional and fiscal accounting methods. The fiscal accounting treatment of various fuel subsidies also differs across countries.

To ensure comparability of treatment among the OECs in the sample, the NRPB does not include subsidies on fuel products sold domestically, whether implicit or explicit. Whenever domestic fuel prices failed to keep pace with international or import prices during the boom, subsidies increased over time, and the fiscal impulse during the upswing would be underestimated by the measured NRPB. For example, in Mexico an excise acts as a tax or a subsidy depending on whether controlled domestic prices of fuels are higher or lower than international prices; the swing between the revenue collected from the excise in 2003 and the subsidy provided in 2008 amounted to about 3 percentage points of GDP.

Appendix C
The Evolution of Nonresource Primary Balances

The nonresource fiscal stance in Latin American and Caribbean NRECs over the last decade can largely be explained by the trends in primary expenditure, but with significant differences across country groups. In the OECs, the simple average of the ratios of primary spending to NRGDP expanded strongly by about 12 percentage points of NRGDP between 2003 and 2008, leading to an average 8 percentage point increase in the nonresource primary deficit (see figure C1). Average spending contracted in 2009 as the crisis set in, and the NRPB improved somewhat. In contrast, MECs displayed a more moderate expansion of primary spending until 2008 (with a relatively stable NRPB), but increased primary spending (and the nonresource deficit) strongly in 2009 in response to the global economic crisis (see figure C2).

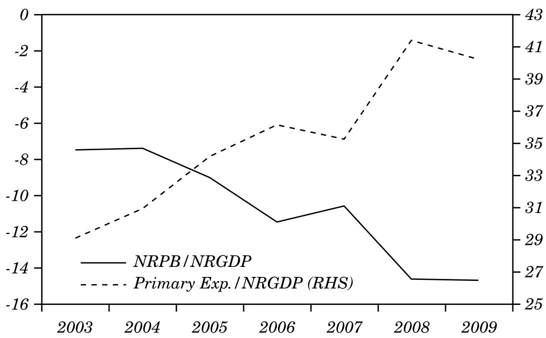
These differing trends can be seen from another angle by looking at the annual growth rates of expenditure in real terms (see figure C3). On average, primary expenditure in real terms expanded much more rapidly in OECs than in MECs during the boom: 16 percent a year in the former versus 8 percent a year in the latter. These numbers compare with an average increase of 7 percent in a group of ten comparator Latin American and Caribbean countries.[42] Within the OEC sample, Venezuela (2004–06) and Ecuador (2007–08) recorded the highest annual expenditure jumps in that period (with maximum growth rates ranging from 25 to 45 percent). Bolivia and Mexico consistently recorded the more moderate expenditure expansions in their peer groups. In 2009, by contrast, all OECs (with the exception of Mexico) reduced primary expenditure in real terms (quite sharply in the case of Venezuela), while Chile and Peru significantly stepped it up in response to the global economic crisis. In the comparator group of Latin American and Caribbean countries, primary expenditure increased in real terms in 2009 at a similar annual rate as during 2003–08.

The rates of increase of capital expenditure in real terms were generally larger than those of current spending across the sample until 2008: an average of 27 percent a year in OECs and 12 percent

42. The countries in the comparator group are Argentina, Brazil, Colombia, Costa Rica, Dominican Republic, Guatemala, Nicaragua, Panama, Paraguay, and Uruguay.

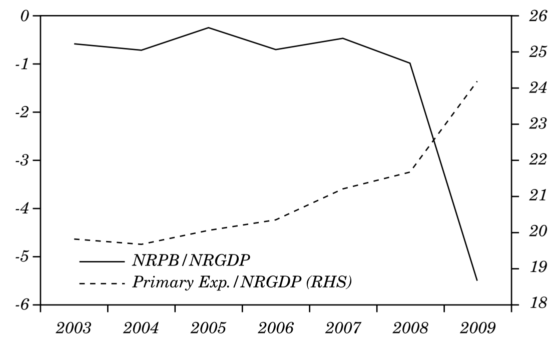
a year in MECs (see figure C4). Trinidad and Tobago (2004–05) and Ecuador (2007–08) recorded the highest annual expansions in capital spending. The contraction in capital expenditure was quite sharp and generalized in OECs in 2009, while MECs recorded a staggering 40 percent increase in real terms resulting in large part from fiscal stimulus packages.

Figure C1. Some Fiscal Indicators during the Recent Cycle: Oil-Exporting Countries



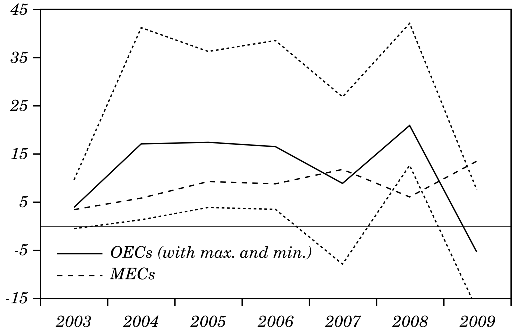
Source: IMF Staff estimates.

Figure C2. Some Fiscal Indicators during the Recent Cycle: Mineral-Exporting Countries



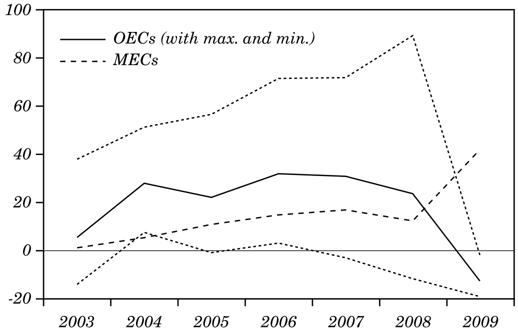
Source: IMF Staff estimates.

Figure C3. Evolution of Primary Expenditure during the Recent Cycle



Source: IMF Staff estimates.

Figure C4. Evolution of Capital Expenditure during the Recent Cycle



Source: IMF Staff estimates.

Appendix D
Calculation of a Long-Term Fiscal Benchmark: An Example

The calculations of long-term fiscal benchmarks used for the fiscal sustainability analysis in this paper involved the following steps:

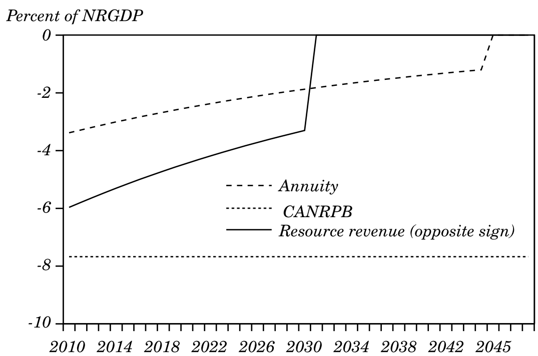
—First, resource wealth (that is, the present value of future fiscal resource revenue flows) was calculated on the basis of (annual) proven reserves estimates from BP (hydrocarbons) and the U.S. Geological Survey (minerals), constant real resource prices at the level observed in each particular year for which the analysis was carried out, four-year average government take from resource production, and an interest rate of 3 percent in real terms (the historical average of long-dated U.S. treasury bonds);

—Second, total government wealth was computed as the sum of the resource wealth and net government financial assets;

—Finally, the long-term annuity out of the total government wealth was compared with the cyclically adjusted NRPB (that is, nonresource revenue minus nonresource primary expenditure) as the relevant measure of the consumption out of the government wealth.

Figure D1 shows a simulation of the long-term sustainability analysis undertaken in this paper, as applied to a representative NREC. In the figure, resource revenues are declining in percent of NRGDP until they are exhausted after 20 years. The annuity curve

Figure D1. Long-Term Fiscal Sustainability Simulation



Source: Authors' calculation.

shows the sustainable level of consumption out of the government wealth over 35 (20 plus 15) years. The latter is compared with the horizontal line, which shows the continuation into the future of the cyclically adjusted NRPB as of 2010. The gap between the last two lines suggests that the 2010 fiscal policy stance would be unsustainable from a long-term perspective.

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Fiscal Multipliers and Policy Coordination

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It is important to recognize that the role of an independent central bank is different in inflationary and deflationary environments. In the face of inflation, which is often associated with excessive monetization of government debt, the virtue of an independent central bank is its ability to say "no" to the government. With protracted deflation, however, excessive monetary creation is unlikely to be the problem, and a more cooperative stance on the part of the central bank may be called for.

—Ben Bernanke, (2003)

This paper is about an economy in a liquidity trap, that is, an environment with a zero nominal interest rate, deflationary pressures, and subpar growth. The paper shows two fiscal policy multipliers in a relatively standard New Keynesian liquidity trap economy with taxation costs. It computes real government spending multiplier and the deficit spending multiplier. In line with recent literature, it shows that the real government spending multiplier can be quite big. The deficit spending multiplier, however, can be either big or zero, depending on the institutional arrangement. That is the main point of the paper.

It is perhaps a bit misleading to talk about a deficit spending multiplier, but I do this to sharpen the distinction between this mechanism relative to real government spending. The deficit spending multiplier in this paper refers to the effect that increasing nominal debt has on output. In a Ricardian environment, where the choice between

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debt and taxes is irrelevant, this multiplier is zero. Things change, however, if there are costs of taxation. In this case, a high nominal debt can trigger expectations of higher future inflation because the discretionary government optimally trades off between costly taxation and some inflation. Expectation of some future inflation is exactly what is needed in an economy with a zero short-term nominal interest rate and deflationary pressures, because with the interest rate stuck at zero, higher inflation expectations reduce the real rate of interest and thus stimulate demand. Hence, higher debt leads to higher inflation expectations, lowering the real interest rate, which in turn leads to an output expansion. One interesting aspect of this is that while standard budget deficits lead to higher debt, that is not the only way nominal debt can be increased. Any policy action that increases debt, such as printing money (or bonds) and buying privately held assets like foreign exchange or stocks, also does the trick, as does dropping money (or bonds) from helicopters. The deficit spending multiplier is therefore a catchphrase for things that increase government debt and thus affect the inflation incentive of the government.

The main focus in this paper is on optimal policy when the government cannot commit to future policy (that is, optimal policy under discretion), which puts relatively strong restrictions on what sort of taxes the government can levy. The problem of the liquidity trap can largely be eliminated in most general equilibrium models if the government can commit to higher future money supply or, equivalently, a higher future price level.[1] The optimal monetary policy commitment in Eggertsson and Woodford (2003), for example, makes the problem of the zero bound pretty trivial. One way to understand how bad things can happen in these models at a zero interest rate, therefore, is to say that this commitment cannot be achieved due to credibility problems (see Eggertsson, 2006b). If the monetary authorities increase the money supply today, the problem boils down to this: how can they commit to not reducing the money supply back to its original level in the future? This puts a certain perspective on monetary and fiscal cooperation. Monetary-fuelled fiscal expansion is a way of credibly committing the government to a higher future money supply.

1. See, for example, Krugman (1998); Eggertsson and Woodford (2003); Eggertsson (2006b); Auerbach and Obstfeld (2006). The problem can similarly be eliminated if the government has access to a sufficiently rich number of fiscal instruments; see Eggertsson and Woodford (2003).

While the mechanism through which deficits and debt can increase inflation is relatively obvious, its existence relies on a key assumption. Not only does it require some cost of taxation, but it will also only work to the extent that monetary authorities react to the inflation incentives this nominal debt creates. If the monetary authority does not react to this inflation incentive, then the deficit multiplier spending is also zero. In some respects, modern independent central banks have been developed precisely to eliminate inflationary incentives. Hence, under modern institutional arrangements, it is not all that clear that this multiplier is all that big, if it exists at all. That is one motivation for monetary and fiscal policy coordination, and one goal of this paper is to try to clarify what coordiation means both in theory and practice.

In this paper, an independent central bank is defined as a bank that has an objective other than optimizing social welfare and whose policy choices are not influenced by the government budget constraint or borrowing limits. Coordinated monetary and fiscal policy, on the other hand, is when policymakers jointly set monetary and fiscal policy to maximize social welfare and are both responsible for satisfying the government's budget constraint and debt limit. Under coordination, deficit spending increases output and the price level when the interest rate is zero because it credibly increases expectations about the future money supply, since this has fiscal benefits.[2] Without coordination, this link is broken because the central bank does not internalize the fiscal consequences of its actions. Therefore, deficit spending and other actions that affect the government balance sheet (such as foreign exchange interventions and purchases of real assets) have no effect on nominal output and the price level if the central bank is goal independent.

This perspective on coordinated monetary and fiscal policy provides an interesting interpretation of several proposals that are common in the literature, which often implicitly (or explicitly) assume some form of coordination. Caballero (2010), for example, recommends a "helicopter drop" of money from the Federal Reserve to the Treasury.[3] This paper's framework clarifies that such an action only has an effect if the Federal Reserve cares about the fiscal consequences of its action or, more precisely, that its own budget

2. See Calvo (1978); Barro and Gordon (1983); Lucas and Stokey (1983); Eggertsson (2006b, 2008); Auerbach and Obstfeld (2005).

3. Bernanke (2003) and Auerbach and Obstfeld (2005) make similar proposals.

constraint or that of the Treasury plays a role in the Federal Reserve's policymaking. In the absence of fiscal considerations, there is nothing to prevent the Fed from undoing the helicopter drop as soon as the economy improves (that is, when the nominal interest rate rises), rendering the policy irrelevant.

While the main point of the paper is positive, the normative implications are a topic in itself. The results indicate that some cooperation between the treasury and the central bank can be helpful to combat a deflationary shock, as argued by Ben Bernanke, then Governor of the Federal Reserve, in Japan in 2003, as cited above. Such cooperation may not be necessary, however, to the extent that the central bank can make credible commitments about future policy. One way to think about coordination, then, is as an escalation plan that is implemented if monetary policy reflation lacks credibility.

The importance of fiscal policy emphasized here relates to the recent literature on the fiscal theory of the price level.[4] The key difference between my model and these contributions is that I model the government as a maximizing agent subject to certain constraints while the fiscal theory characterizes policy by exogenous policy rules. This alternative modeling strategy allows me to clarify the role of central bank independence and a richer interpretation of the role of coordination.

1. A Tale of Two Countries

The way in which I specify the institutional setup, that is, the interaction between the Treasury and the central bank, is guided by a certain objective, because the paper also has a complementary goal. That goal, which is somewhat lofty, is to use the theory sketched out to think about the very different results observed during the Great Depression in the United States and the Great Recession in Japan in response to relatively similar policy actions. This part of the paper is quite speculative, and it is based on the simple theoretical structure proposed and some broad patterns in the data. The thought experiments are quite helpful, however, for casting some light on these episodes, and the largely speculative component of the exercise is justified given how high the stakes are for understanding these events.

4. See, for example, Sargent and Wallace (1981); Sims (1994); Woodford (1996); Benhabib, Schmitt-Grohé, and Uribe (2002).

The episodes I have in mind are the United States during the Great Depression of 1929–41 and Japan during the Great Recession of 1992–2006.[5] Both countries implemented unusually large policy actions as measured by interest rate cuts, increases in the money supply, expansion in fiscal variables, and exchange market interventions. Nevertheless, the outcomes were very different: while demand responded strongly during the Great Depression in the United States during the recovery phase (1933–37 and 1938–41), it responded little—if at all—during the Great Recession in Japan. I suggest that the different outcomes are explained by the greater independence of the Bank of Japan relative to the Federal Reserve during the respective crises. Illustrating how economic outcomes, as a function of policy actions, depend on the institutional framework underpins a novel interpretation of the Great Depression relative to the Great Recession. More generally, one takeaway from this paper is that the consequences of certain policy actions cannot be understood independently from the institutional framework. The modeling exercise provides one way of thinking about this, but the narrative accounts in the paper do, as well.

While the Great Depression in the United States and the Great Recession in Japan were very different along several dimensions, there are some important similarities. Both events started with a big decline in the stock market. In the aftermath of these large shocks, both central banks cut the interest rate down to zero, albeit somewhat gradually, to counteract an economic slowdown. Table 1 shows that by 1996, the overnight interest rate had declined to close to zero in Japan. While there is no comparable data for the United States during the Great Depression, the closest proxy is the interest paid on three-month Treasury bills. Table 2 shows that according to this measure, the short-term interest rate had also declined close to zero in the United States by the end of 1932. Another similarity is that both countries experienced deflation and contraction in their nominal gross domestic product (GDP). During the entire Great Recession in Japan, nominal GDP stagnated and there was mild deflation, while the Unted States experienced sharp and violent declines in prices and nominal GDP during the first and second phases of the Great Depression in 1929–33 and 1937–38.

5. I am coining the period 1992–2006 as the Great Recession in Japan, since in 2006 the Bank of Japan raised interest rates based on the expectation that the growth observed at the time and modest inflation would signal the end of the long contractionary phase. In 2008, however, the world economy entered financial crisis, and Japan once again found itself in a similar situation as during 1992–2006.

Table 1. Fiscal Multipliers for coordinated policy
United States during the Great Depression

	$i = 0$	$i > 0$
Real Spending Multiplier	2.20	0.33
Deficit Spending Multiplier	4.20	0.50

Source: Author's computations

Table 2. Fiscal Multipliers for uncoordinated policy
Japan during the Great Recession

	$i = 0$	$i > 0$
Real Spending Multiplier	1.20	0.33
Deficit Spending Multiplier	0.00	0.00

Source: Author's computations

Another striking similarity is the response of the Japanese and American policymakers. In both countries, after the nominal interest rate reached zero, the central banks expanded the monetary base much beyond what was required to keep the interest rate at zero. The Federal Reserve almost doubled the nominal monetary base in 1933–37 (the initial phase of the recovery). Similarly, the Bank of Japan more than doubled the base beetween 1996, when the interest rate first approached zero, and 2006. The Bank of Japan was especially aggressive in the period of quantitative easing that started in May 2001 and ended in the spring of 2006, when it expanded the base by 70 percent in nominal terms. A similar picture emerges on the fiscal front. In the United States, the government spent 70 percent more dollars in 1937 than in 1933. The expansion of government expenditures was of the magnitude of 6 percent of GDP in 1933. The growth rate of government spending in Japan was smaller. The Japanese government spent 20 percent more yen in 2005 than in 1992. However, if the increase is measured as a fraction of 1992 GDP, it is about the same as in the United States, at 6 percent (table 1).[6]

6. The government in Japan was much bigger in 1992 in relative terms than the United States. government in 1933. Although deficits and government expenditures have increased in Japan, government consumption of final goods and services has, by various measures, not been increased substantially since 1996 (Broda and Weinstein, 2005). Similar points, however, have been made about the government expansion in the United States during the Great Depression (Brown, 1956), so this fact hardly explains the difference in outcomes.

Neither country financed these spending increases with tax hikes. Instead, both governments ran large deficits. The annual deficits were 4–9 percent of GDP in the United States from 1933–37, and they were of a similar magnitude throughout the Great Recession in Japan. In fact, net government debt was 94.7 percent of GDP in Japan as of 2006, up from 14.3 percent in 1992 before the onset of the Great Recession. Finally, both countries intervened in the foreign exchange markets. The Japanese Ministry of Finance bought foreign exchange on several occasions. In 2003, for example, the interventions corresponded to about 5.7 percent of GDP and 37.0 percent of the monetary base (Lipscomb and Tille, 2005). One can to some extent interpret United States purchases of gold as corresponding to foreign exchange interventions. The scope of these interventions were of a similar order, for example, in 1933–34 (Eggertsson, 2008).[7]

Despite the similarities in policy actions, the outcomes were radically different. One sensible measure of outcomes is nominal GDP. A real-business-cycle theorist expects a nominal demand stimulus to mainly increase the price level, whereas a Keynesian or a monetarist would expect some combination of real output and price increases. All theories, however, suggest that nominal GDP will increase. Consider the reaction of nominal GDP in the United States after President Franklin D. Roosevelt started expansionary policies in earnest. In 1933–37, nominal GDP expanded by 52 percent, of which about 80 percent is explained by growth in real GDP and 20 percent by inflation (table 2). In contrast, nominal GDP contracted or stagnated throughout the Great Recession in Japan due to ongoing mild deflation and modest or no real growth (table 1). The nominal GDP in 2005 was only 5 percent higher than it was in 1992 and 2 percent lower than in 1997. What is the reason for these radically different outcomes?

The reigning hypothesis for United States growth in 1933–37 attributes it to the monetary expansion. Leading proponents include Friedman and Schwartz (1963) and Bordo, Erceg, and Evans (2000). All authors point toward the increase of the monetary base (or usually M1). However, if a 70 percent increase in the nominal stock of money increased nominal GDP by 52 percent in the United

7. The United States went off the gold standard in 1933. The dollar value of gold was again fixed in 1934 only to be changed in the 1970's but it is generally argued that the United States was off the gold standard for all practical purposes from 1933 onward.

States, why did the larger increase in Japan not lead to a robust recovery in nominal GDP? The leading alternative hypothesis relates to fiscal expansion. Here again, if increasing government spending by 6 percent of GDP and running deficits of 4–9 percent increased nominal GDP by 52 percent in the United States, why did the larger and more sustained increase in Japan not lead to a robust recovery in nominal GDP?

The hypothesis for the United States recovery submitted in this paper relies on an earlier work (Eggertsson, 2008), which argues that the recovery was driven by a shift in expectations. This shift was triggered by President Roosevelt's policy choices. In particular, Roosevelt announced an explicit target to raise prices. A large body of recent literature on the liquidity trap shows that when the short-term interest rate is zero, as it was in 1933 when Roosevelt came into office, it is crucial to raise expectations about the future money supply in order to stimulate demand.[8] The problem is how to generate these expectations. Eggertsson (2008) argues that beyond making an explicit verbal commitment to inflate, Roosevelt achieved this objective with fiscal expansion and other actions that affected the government's balance sheet (such as foreign exchange interventions), thereby making the commitment to inflate credible. Printing money in the future became crucial to finance fiscal actions and prevent future balance sheet losses. This paper adds to the story in Eggertsson (2008) by emphasizing that for this channel to work, monetary and fiscal policy need to be coordinated. I use this insight to contrast the economy's response to policy in the Great Recession with its response in the Great Depression.

Why did the public's expectations about the future money supply not increase as dramatically in Japan in the Great Recession as they did during 1933–37 in the United States, even though the fiscal and monetary policy actions taken by the Japanese government were just as dramatic? The most obvious difference is that in addition to his various expansionary actions, Roosevelt announced an explicit objective to inflate the price level to pre-Depression level (Eggertsson, 2008). In Japan, by contrast, policymakers undertook various expansionary actions, but they never made an explicit commitment to future inflation. This explanation is unsettling,

8. See, for example, Krugman (1998); Auerbach and Obstfeld (2005); Eggertsson (2006b, 2008); Eggertsson and Woodford (2003); Svensson (2001, 2003); and Jeanne and Svensson (2007); Adam and Billi (2006, 2007); Jung, Teranishi, and Watanabe (2006).

however. Is the lesson that policy actions are irrelevant, and all that matters is what policymakers say? And why did Roosevelt's words have such tremendous power in 1933? President Hoover repeatedly announced in 1929–33 that a recovery in prices and output was just around the corner (even if he did not specify pre-Depression levels for prices), and Japanese policymakers made similar predictions at various points in the crisis. Why did these words not carry the same weight?

In this paper, I explain the strong reaction of nominal demand in the United States versus the weak response in Japan with differences in the monetary and fiscal institutions in the two countries. In particular, I assume that the Bank of Japan is independent, while in the United States monetary and fiscal policy were coordinated. I document how this coordination was achieved through legislation in the United States Congress in section 7. This explanation does not rely on policymakers' words. In fact, I assume words have no power in this paper.[9] While extreme and arguably unrealistic, the assumption that words carry no weight is useful for isolating the importance of different institutions and for identifying why some actions had a big effect in the United States in the 1930s and little or no effect in Japan in the 1990s, even if we abstract from differences in announced policy commitments. This approach also highlights what types of action are likely to help make various communication strategies credible and which institutional reforms may facilitate this objective. This is why I consider an equilibrium in which the government is purely discretionary so that it cannot commit to any future actions (as in Kydland and Prescott, 1977; Barro and Gordon, 1983) apart from repaying any debt issued (as in Lucas and Stokey, 1983).

While coordination of monetary and fiscal policy can explain the recovery in the United States in 1933–37—and the lack thereof during the prolonged recession in Japan—there are some alternative explanations. One alternative is that the United States recovery was

9. This is surely an extreme assumption that does not hold exactly. There is some evidence, for example, that Bank of Japan's announcements (for example, in the fall of 2003) were helpful in stimulating demand. At that time, and on a few other occasions, the bank announced that the short-term interest rates would be zero until the changes in the consumer price index (CPI) moved back into positive territory, which helped lower real rates and stimulate spending. Similar announcements by the Federal Reserve in 2003 most likely also stimulated demand (but the Federal funds rate was then at 1 percent, and there were concerns over deflation).

due to the resolution of the banking crisis in the spring of 1933, an explanation emphasized by many authors. Given the difficulties in the Japanese banking system, one could speculate that what was missing in Japan was not coordination of monetary and fiscal policy, but a cleanup of the banking system. While solving the banking crisis was certainly a contributing factor in the recovery in 1933–37, this hypothesis does not explain the second contractionary phase of the Great Depression in 1937–38 and the recovery starting in 1938, as there were no banking crises in thesecond phase. As I argue in section 7, however, the recession in 1937 can be interpreted through the lens of the same theory we apply here, namely, that the Federal Reserve was reasserting its independence (mostly by raising reserve requirements) and the private sector expected it to renege on the administration commitment to reinflate prices to pre-Depression levels. Hence, Roosevelt's commitment to permanently increase the money supply was no longer credible in 1937. Similarly, as I argue in section 7, the recovery in 1938 can be interpreted as a renewed commitment to inflating the price level by a coordination of monetary and fiscal policy.[10]

2. The Model

Here I outline a simplified version of a relatively standard New Keynesian model, assuming reduced-form money demand and special functional forms.[11] I assume there is a representative household that maximizes expected utility over an infinite horizon:

$$E_t\left[\sum_{T=t}^{\infty}\beta^{T-t}b_T\left(\log C_T+\chi\log G_T-\psi\frac{h_T^{1+\omega}}{1+\omega}\right)\right], \qquad (1)$$

where b_t is an intertemporal shock; C_t is a Dixit-Stiglitz aggregate of consumption of each of a continuum of differentiated goods,

10. An alternative hypothesis is that abolishing the gold standard explains the recovery in 1933, in exclusion of the channel proposed. As I argue in Eggertsson (2008), going off gold was a necessary condition for the recovery, but it was not a sufficient condition. Some countries that abolished the gold standard (such as Great Britain) did not experience fast growth during the Great Depression. Furthermore, the price of gold was fixed from 1934 to the 1970's, so focusing on the government-mandated price of gold in dollar terms cannot explain the recession in 1937–38 and the recovery in 1938.

11. See Eggertsson (2006b) for a more detailed version with a money-in-utility function and general functional forms.

$$C_t \equiv \left[\int_0^1 c_t(i)^{\frac{\theta}{\theta-1}}\right]^{\frac{\theta}{\theta-1}},$$

with elasticity of substitution equal to $\theta > 1$; G_t is a Dixit-Stiglitz aggregate of government consumption defined in a similar way; P_t is the Dixit-Stiglitz price index,

$$P_t \equiv \left[\int_0^1 p_t(i)^{1-\theta}\right]^{\frac{1}{1-\theta}};$$

and h_t is hours worked. E_t denotes mathematical expectation conditional on information available in period t. For simplicity, I assume as cashless economy where only one-period riskless government bonds are traded. The household thus faces the following budget constraint:

$$C_t + B_t = (1 + i_{t-1})B_{t-1} + Z_t + n_t h_t - T_t,$$

where Z_t is the profit earned by a representative firm, T_t taxes, B_t one-period riskless bonds, i_t the one-period nominal riskfree interest rate, and n_t wages. The household maximizes its utility subject to the budget constraint by choosing its asset holdings, labor, and consumption. There is a continuum of firms on the unit interval that maximize expected discounted profits. Firms produce using a production function that is linear in labor, and I abstract from capital dynamics. As in Rotemberg (1982), I assume that firms face a resource cost of price changes, $(\delta/2)[(p_t(i))/(p_{t-1}(i)) - 1]$. For algebraic simplicity, I follow Rotemberg and Woodford (1997) by assuming a subsidy of $(1 + s) = \theta / (1 - \theta)$ for each unit produced, so that production is at its efficient level in the steady state and there is no inflation bias (see Eggertsson, 2006b, for the general case).

The first-order conditions of the household and firm maximization problems can be summarized by two Euler equations. The household consumption decisions satisfy the Euler equation often referred to as the IS equation:

$$C_t^{-1} = (1 + i_t) f_t^e, \tag{2}$$

where $f_t^e = E_t C_{t+1}^{-1} \prod_{t+1}^{-1} \beta((b_{t+1})/b_t))$ is an expectation variable and $\prod_t \equiv p_t/(p_{t-1})$. This equation says that consumption demand depends on expected future consumption, the nominal interest rate, expected inflation, and the intertemporal shocks. The firm optimal pricing decisions, on the one hand, and the household optimal labor supply decisions, on the other, also satisfy a Euler equation, often referred to as the AS equation:

$$\Pi_t(\Pi_t - 1) = \frac{\theta}{\delta}(\psi C_t Y_t^{\omega} - 1)Y_t + \beta C_t S_t^e \tag{3}$$

where $S_t^e = E_t \prod_{t+1}(\prod_{t+1} - 1)C_{t+1}^{-1}\beta[(b_{t+1})/b_t)]$ is an expectations variable. This equation is a standard New Keynesian Phillips curve that says that inflation depends on the marginal cost of production and expected inflation deflated by the stochastic discount factor.

There is an output cost of taxation (for example, due to tax collection costs as in Barro, 1979) captured by the function $(\gamma/2)\, T_t^2$. For every dollar collected in taxes, $(\gamma/2)\, T_t^2$ units of output are wasted without contributing anything to utility. Total government real spending, F_t, is then given by

$$F_t = G_t + \frac{\gamma}{2} T_t^2.$$

In the remainder of the paper, all expressions are written in terms of F_t instead of G_t, using the equation above. Abstracting from seigniorage revenues, the government budget constraint can be written as[12]

$$w_t = (1 + i_t)[w_{t-1}\prod_t^{-1} + F_t - T_t] \tag{4}$$

where I have defined the variable $w_t \equiv [(B_t(1 + i_t)) + M_t]/P_t$ as the real value of the end-of-period government debt inclusive of interest payments. To ensure solvency, I assume that the government needs to satisfy a debt limit:

12. For simplicity, I drop the term $[i_t / (1 + i_t)]\, M_t / P_t$ in the budget constraint. See Eggertsson (2006b) for the extension.

$$w_t \leq \bar{w} \tag{5}$$

which excludes Ponzi schemes. Market clearing implies that

$$Y_t = C_t + F_t + (\delta/2)(\Pi_t - 1)^2. \tag{6}$$

Space considerations preclude entering into the details of the means by which the central bank controls the nominal interest rate. However, as long as the government is committed to supplying a nominal claim (that is, money) with zero return, there is a zero bound on the short-term nominal interest rate:

$$i_t \geq 0 \tag{7}$$

An equilibrium is a collection of stochastic processes for $\{T_t, F_t, i_t, C_t, Y_t, \pi_t, w_t\}$ that satisfy equations (2) through (7) for a given path for the exogenous shock $\{b_t\}$.

An equilibrium can be defined without any reference to the money supply. A money demand equation can be appended to the model, for example, by having money supply enter additively separately in utility (Eggertsson, 2006b). This will have no effect on the equilibrium, provided I abstract from seigniorage revenues in the government budget constraint, which in any event is relatively small in most industrialized countries. The money demand equation only has a role in determining money demand given the interest rate and consumption. It is useful, however, to keep track of a money supply since much of the earlier literature is cast in terms of money. I assume (as do Krugman, 1998, and King and Wolman, 2004) that a certain fraction of production needs to be held in money balances, so the following inequality has to be satisfied:

$$(M_t/P_t) \geq vY_t. \tag{8}$$

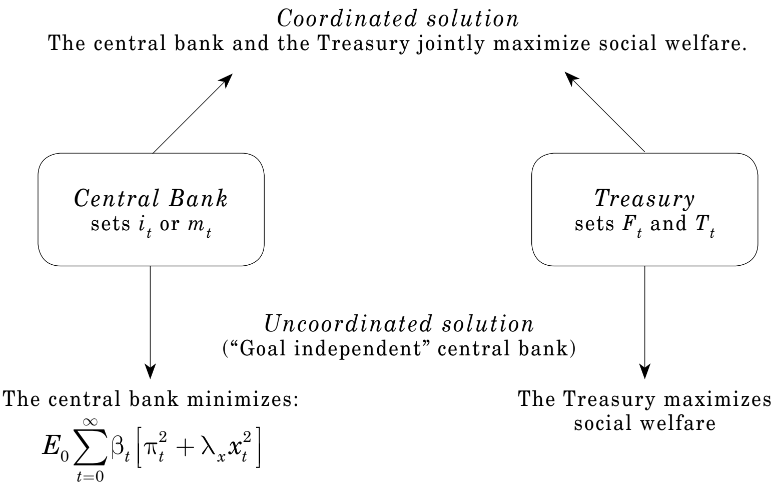
I abstract from any effect money balances have on utility or welfare. At a zero interest rate, this inequality can be slack because the households can be indifferent to holding money versus bonds.

3. Institutions

I assume that monetary and fiscal policy were coordinated in the United States in 1933–37 and 1938–41 during the first and second recovery phases of the Great Depression and that they were uncoordinated in Japan in 1992–2006 during the Great Recession. Figure 1 illustrates what coordination means in this paper. There are two government agencies: the central bank and the Treasury. The central bank sets the interest rate, i_i (or alternatively the money supply, M_i). The Treasury decides spending, F_i, and taxes, T_i. Policy is coordinated when the Treasury and the central bank join forces to maximize social welfare; policy is uncoordinated when each agency pursues its own objectives. The example I consider for uncoordinated policy is when the Treasury maximizes social welfare, but the central bank pursues a narrower objective. I refer to this institutional arrangement as a case in which the central bank is independent. I assume that the independent central bank minimizes the quadratic deviation of inflation and output from a target (a relatively standard objective in the literature), but other specifications for the bank's preferences do not change the central results. An important additional assumption I make is that the independent central bank is not responsible for satisfying the Treasury's budget constraint or borrowing limit. If this assumption is not made, the treasury can force the central bank's hand by accumulating debt up to the limit and then cutting taxes further (in which case the central bank would have to inflate in order to make the budget constraint and borrowing limit hold). The key difference between the coordinated and uncoordinated solutions is that in the uncoordinated case, the independent central bank does not take into account the fiscal consequences of its actions. This institutional arrangement is somewhat special, and my definition of coordination does not encompass all the different cases that various authors have in mind when discussing the coordiation of monetary and fiscal policy (although it corresponds quite closely to some of the previous literature).[13] This is not a major weakness in my view. What is important for my purposes is that the two

13. Observe that this definition, that is, the goal independent central bank, is consistent with Rogoff's (1985) conservative central banker and is identical to Dixit and Lambertini's (2003) institutional framework.

Figure 1. Coordinated versus Uncoordinated Policy Actions of the Central Bank and the Treasury



Source: Author's elaboration.

cases (coordinated versus uncoordinated policy) capture a basic difference between the monetary and fiscal policy arrangements in Great Depression and the Great Recession. This may be even more clear in section 7, where I explicitly discuss how this particular institutional arrangement can be used to interpret these two events in light of the narrative record. Hence, the paper primarliy outlines a positive analysis, whereas a normative analysis may require a more detailed and flexible institutional description.

4. Discretionary Equilibrium under Coordinated Policy

4.1 Definition

This section defines optimal policy under discretion when monetary and fiscal policy are coordinated. Under discretion, the government cannot commit to future policy. Optimal policy under discretion is sometimes referred to as a Markov perfect equilibrium. The timing of events in the game is as follows. At the beginning of each period t, w_{t-1} is a predetermined state variable, and the shock b_t is realized and observed by the private sector and the government. The monetary and fiscal authorities choose policy for period t given the current state (b_t, w_{t-1}), and the private sector forms expectations f_t^e and S_t^e. I assume that the private sector may condition its expectation at time t on the policy actions of the government. In other words, it observes the policy actions of the government in that period so that expectations are determined jointly with the other endogenous variables. The only endogenous state variable in the model at time $t+1$ is w_t. This implies that the expectation variables f_t^e and S_t^e are a function of w_t and b_t:

$$f_t^e = \bar{f}^e(w_t, b_t), \tag{9}$$

and

$$S_t^e = \bar{S}^e(w_t, b_t), \tag{10}$$

so that the IS and AS equations can be written as

$$C_t^{-1} = (1 + i_t)\bar{f}^e(w_t, b_t), \tag{11}$$

and

$$\Pi_t(\Pi_t - 1)^2 = (\theta/\delta)[(\psi C_t Y_t^{\omega} - 1)Y_t + C_t \bar{S}^e(w_t, b_t)]. \tag{12}$$

Under discretion, the government maximizes the value function $J(w_{t-1}, b_t)$ by its choice of the policy instruments, taking the expectation functions $\bar{f}^e(w_t, b_t)$, $\bar{S}^e(w_t, b_t)$ as given because it cannot commit to future policy. It thus solves

$$J(w_{t-1}, b_t) = \max_{F_t, T_t, i_t} \left\{ \begin{array}{l} [\log C_t + \chi \log(F_t - \frac{\gamma}{2} T_t^2) - \psi \frac{h_t^{\omega}}{1+\omega}]b_t \\ + \beta E_t J(w_t, b_{t+1}) \end{array} \right\} \tag{13}$$

subject to equations (4), (5), (6), (7), (11), and (12). The first-order conditions for the maximization problem are derived by writing the right-hand side as a Lagrangian problem and setting the partial derivatives with respect to each of the variables (Π_t, C_t, Y_t, w_t, i_t, F_t, T_t) to zero. Because the government is a large strategic player and moves simultaneously with the private sector, it can choose a value for all these variables as long as they satisfy the private sector optimality conditions and the resource constraint.[14] The model has a well-defined steady state with zero inflation and debt. The model is approximated around this steady state so that the solution is only accurate to the first order. The next section characterizes this approximate solution.

4.2 Results

Below I show the linear approximation of the equilibrium. To express this solution, I first need to define two concepts: the natural level of output and the natural rate of interest. The natural level of output is the output that would be produced if prices were flexible, that is, $\delta = 0$ in equation (3). Using this equation in conjunction with (6) yields

$$\hat{Y}_t^n = \frac{\sigma^{-1}}{\sigma^{-1} + \omega}\hat{F}_t \tag{14}$$

where $\sigma \equiv (C/Y)$, $\hat{F}_t = \log F_t/\overline{Y}$, and the natural level is expressed in log deviation from steady-state output. Output under flexible prices does not depend on the shock b_t, but increases with $\hat{F}_t$ for familiar reasons from the real business cycle (RBC) literature: a higher level of government consumption increases the marginal utility of consumption and thereby increases the labor supply.

The natural rate of interest is the real interest rate when prices are flexible, that is,:

$$\begin{aligned} r_t^n &= \overline{r} + \hat{b}_t - E_t\hat{b}_{t+1} + \frac{\sigma^{-1}\omega}{\sigma^{-1} + \omega}(\hat{F}_t - E_t\hat{F}_{t+1}) \\ &= r_t^e + \frac{\sigma^{-1}\omega}{\sigma^{-1} + \omega}(\hat{F}_t - E_t\hat{F}_{t+1}) \end{aligned} \tag{15}$$

14. Some recent examples in the literature assume that the government moves before the private sector within each period (see, for example, King and Wolman, 2004; Albanesi, Chari, and Christiano, 2003). In those cases, there can be multiple point-in-time equilibria. I do not prove the global uniqueness of equilibria, only local uniqueness. Proving global uniqueness is hard except in simpler models. The timing assumption here is the same as in the linear-quadratic literature on discretion, such as Clarida, Galí, and Gertler (1999) and Woodford (2003).

where $\bar{r} \equiv \log\beta^{-1}$, $\hat{b}_t \equiv \log b_t/\bar{b}$. The natural interest rate depends both on the intertemporal shock and fiscal spending. I summarize the exogenous component of the natural rate by r_t^e.

A linear approximation of the private sector first-order conditions can be written in terms of deviations from these variables. The consumption Euler equation (2) is

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t \pi_{t+1} - r_t^n), \tag{16}$$

where $\pi_t = \log\Pi_t$ is inflation and x_t is the output gap $x_t \equiv \hat{Y}_t - \hat{Y}_t^n$ where $\hat{Y}_t \equiv \log Y_t - \log \bar{Y}$. The term i_i now refers to $\log(1 + i_i)$ in the notation of the previous section so that the zero bound in the form (7) can still be expressed. This equation can be forwarded to yield

$$x_t = E_t x_T - E_t \sum_{s=t}^{T-1} \sigma(i_s - \pi_{s+1} - r_s^n)$$

which illustrates that the output gap depends not only on the current nominal interest rate and expected inflation, but on the entire expected path of future interest rates and inflation. Equation (3) can be approximated as

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1}, \tag{17}$$

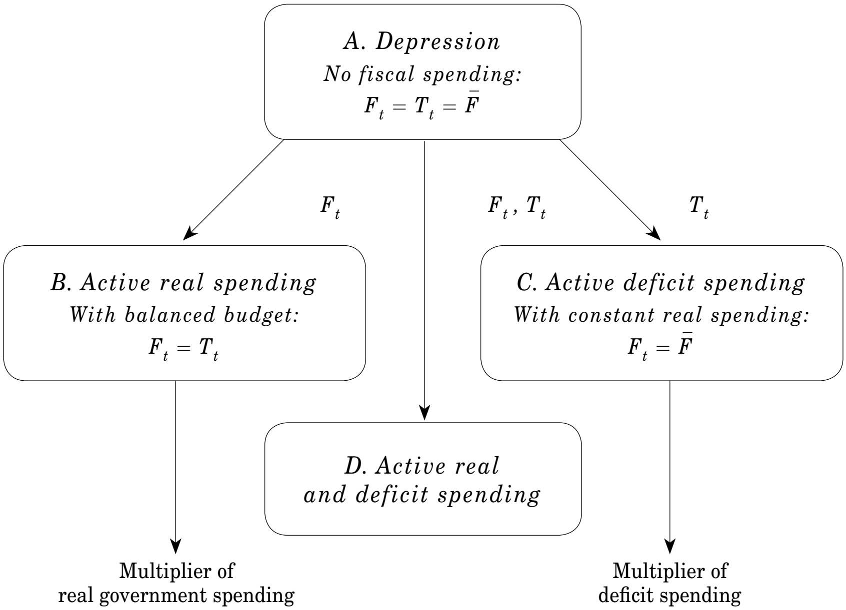
where $\kappa_t \equiv (\theta/\delta)(\sigma^{-1} + \omega)$. If this equation is forwarded, it says that inflation depends on the expected path of future output gaps.

Finally, the budget constraint of the government is approximated by

$$w_t - \bar{w} i_t = \beta^{-1} w_{t-1} - \beta^{-1} \bar{w} \pi_t + \beta^{-1} \hat{F}_t - \beta^{-1} \hat{T}_t, \tag{18}$$

where $\hat{T}_t = \log T_t/\bar{Y}$ and where I have linearized around a given level for outstanding debt $\bar{w}$. The budget constraint says that for *a given* level of debt, monetary policy can improve government finances through two channels. The second term on the left-hand side indicates that a lower nominal interest rate will reduce the burden of debt rolled over to the next period. The second term on the right-hand side indicates that inflation will reduce the real value of outstanding debt, because all the debt is issued in nominal terms (namely, nominal bonds and the money supply). Equations (14)

Figure 2. Roadmap for Results under Coordination[a]



Source: Author's elaboration.
a. The presentation of the results when the central bank is goal independent has the same structure.

through (18) summarize the private sector equilibrium constraints. I now turn to government policy.

This paper is about government policy when sufficiently large deflationary shocks cause the nominal interest rate to decline to zero. I assume that r_t^e is temporarily negative at time 0, while $r_L^e < 0$ and returns to steady state with a probability α in each period. To ensure a bounded solution, I impose the restriction on α that $\alpha[1 - \beta(1 - \alpha)] - \sigma\kappa(1 - \alpha) > 0$. I call the date that r_t^e returns to steady state τ. Once it returns to steady state, it stays there forever.

To clarify the organization of the results, figure 2 provides a road map for the remainder of this section. I analyze the results in four steps. I first show the equilibrium when fiscal policy is inactive ($\hat{F}_t = \hat{T}_t = 0$), which is equilibrium A in figure 2. I then analyze the consequences of optimally increasing real government spending, $\hat{F}_t$, but holding the budget balanced (so that $\hat{T}_t = \hat{F}_t$) which is equilibrium B. In equilibrium C, the government optimally uses deficit spending,

$\hat{T}_t$, to stimulate demand, but real government spending is kept constant at its steady state ($\hat{F}_t = 0$). Finally, equilibrium D considers the effect of using both deficit and real spending optimally.

Applied to the Great Depression, equilibrium A corresponds to the policies of President Hoover because he aimed at both keeping the government small and balancing the budget (Eggertsson, 2008). In that model, this Hoover regime represents optimal discretion under the constraint of "balanced budget dogma" and "small government dogma." Roosevelt, in contrast, broke both these dogmas. His policy regime corresponded to equilibrium D, which is unconstrained discretion.

The policy rule the government follows under discretion is found by approximating the first-order conditions of the maximization problem (13). These conditions are shown in appendix A. Since there are seven first-order conditions and two complementary slackness conditions, it is cumbersome to write them out in the main text. Fortunately, however, one can infer the form of the solution—and even obtain some closed-form solutions—using almost no algebra by considering a second-order approximation of the household utility:

$$U_t = -\frac{1}{2}\sum_{T=t}^{\infty}\beta^{T-t}\left\{\pi_T^2 + \lambda_x x_T^2 + \lambda_F \hat{F}_T^2 + \lambda_T \hat{T}_T^2\right\}. \tag{19}$$

where the lambdas are derived in the appendix A as a function of the structural parameters. Consider first the solution in equilibrium A from the perspective of $t > \tau$, when the deflationary shock has subsided (recall that I impose $\hat{F}_t = \hat{T}_t = 0$). Under discretion, the government seeks to maximize this objective regardless of its actions in the past. The best possible equilibrium is thus when

$$\pi_t = x_t = 0 \text{ for } t \geq \tau. \tag{20}$$

which can be achieved at that time and is dynamically consistent.

Consider now the solution in period $t < \tau$. Ideally, the government would wish to achieve zero inflation and a zero output gap. The assumption that the shock r_t^e is negative makes this infeasible, however, since it would imply a negative nominal interest rate by equation (16). The government therefore tries to achieve maximum accommodation by setting the interest rate to zero. Because the shock is the same in all $t < \tau$, the solution for π_t and x_t solves the two equations

$$x_t = (1 - \alpha)x_t + \sigma(1 - \alpha)\pi_t + \sigma r_L^e \tag{21}$$

and

$$\pi_t = \kappa x_t + \beta(1 - \alpha)\pi_t \tag{22}$$

yielding

$$x_t = \frac{1-\beta(1-\alpha)}{\alpha(1-\beta(1-\alpha))-\sigma\kappa(1-\alpha)}\sigma r_L^e \text{ for } t<\tau \tag{23}$$

and

$$\pi_t = \frac{1}{\alpha(1-\beta(1-\alpha))-\sigma\kappa(1-\alpha)}\kappa\sigma r_L^e \text{ for } t<\tau \tag{24}$$

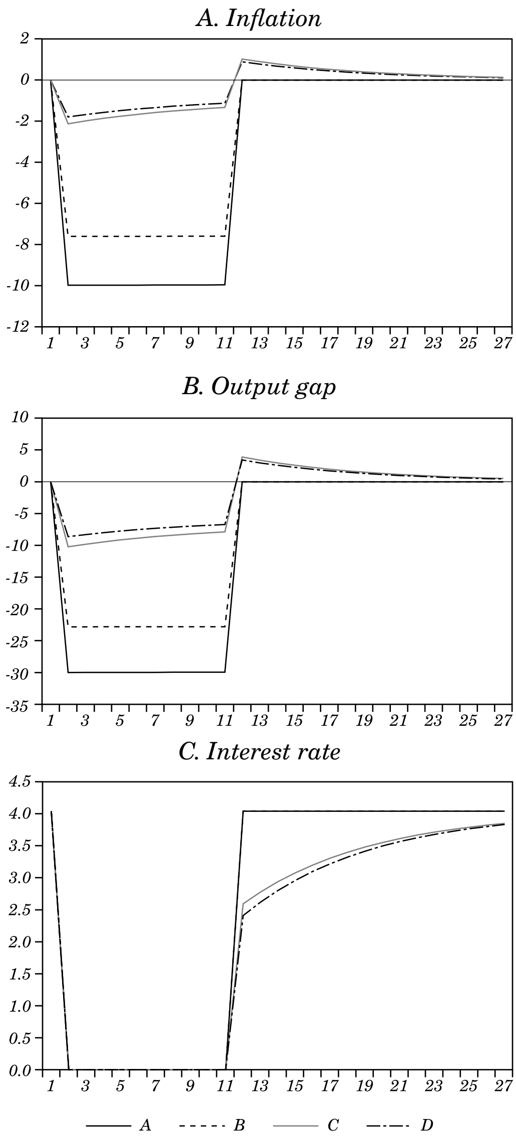
Figure 3 shows a numerical solution of the model that is calibrated to illustrate some basic qualitative features of the Great Depression in the United States. Each period is a quarter. The parameter $\beta = 0.99$ is set to match the 4 percent real interest rate, and $\sigma = 0.90$ is set to match 10 percent government spending in steady state. The parameter α is set at 0.1, so that the shock is expected to last for ten quarters. The parameter κ governs how much inflation reacts to movements in output. It is chosen to match data from 1932, when the average nominal interest rate was close to zero, and there was 10 percent deflation. There are no reliable data on the output gap at that time, but a reasonable lower bound for the output gap is that output had declined by about a third from its peak in 1929. Given the calibrated value of α, I can use equation (22) to pick a κ that matches these facts:

$$\kappa \equiv (1 - \beta(1 - \alpha))(\pi/x) = 0.0091$$

Finally, I use equation (23) to choose the value of the shock r_L^e to match a 30 percent output gap, which results in $r_L^e = -3$ percent.

The figure shows the case in which the natural interest rate returns to steady state in period $\tau = 10$ (which is the expected duration of the shock). Recall from equations (23) and (24) that these lines would look the same for any other contingency, but with a different breaking point corresponding to $t = \tau$ (that is, the lines would jump up at different times). Because of the choice of r_L^e the

Figure 3. Inflation, the Output Gap, and Interest Rates under the Optimal Policy under Discretion in Equilibria A, B, C, and D: Great Depression Calibration



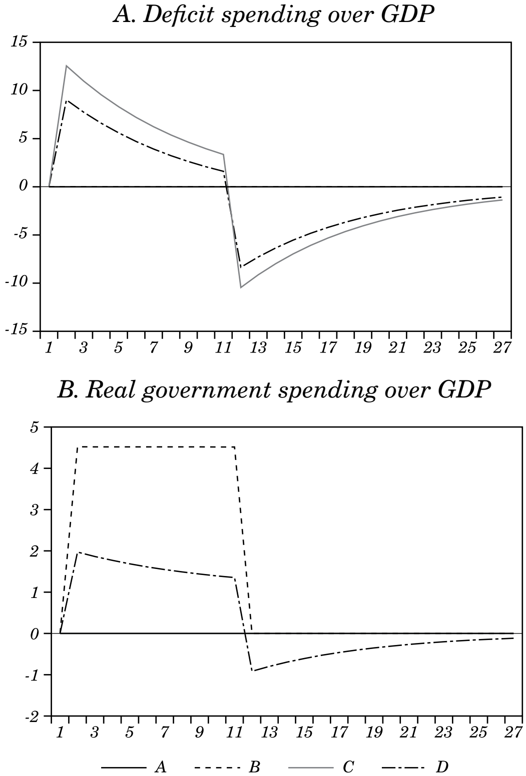
Source: Author's computations.

model generates a 30 percent collapse in output and a 10 percent deflation, and the contraction lasts as long as the duration of the shock (which is stochastic). The contraction at any time t is created by a combination of the deflationary shock in period $t < \tau$ and—more importantly—the *expectation* that there will be price and output contraction in future periods $t + j < \tau$ for $j > 0$. The contraction in period $t + j$, in turn, depends on expectations of contraction in periods $t + j + i < \tau$ for $i > 0$. This creates a vicious cycle that does not even converge unless the restriction on α is satisfied. The overall effect is an output and price collapse.

The contraction in the model is entirely driven by monetary forces and the zero bound. If the central bank were able to accommodate the shock by setting a negative nominal interest rate of –3 percent, there would be no output contraction and no deflation. The contraction is caused by a discrepancy between the long-term real interest rate and the long-term natural interest rate. Due to the zero bound and the expectation that inflation will be set at zero at $t > \tau$, this difference cannot be reduced by nominal interest rate cuts. The difference increases with expectations about future deflation, since expected deflation increases the short- and long-term real interest rates. Real interest rates can be particularly high when there are expectations of a deflation. During the contractionary phase of the Great Depression in the United States, the real rates were of the order of 10 percent (see table 2), and the Federal Reserve was unable to lower these rates in 1933 because the nominal interest rate was close to zero.

Printing money has no effect in this equilibrium. Because expectations are pinned down by equation (20), any increase in the money supply in periods $t < \tau$ will be expected to be reversed in period τ. Moreover, money and bonds are perfect substitutes in periods $t < \tau$ (so that equation 8 is slack), and printing money thus has no meaningful implication at the time the money is printed: households simply replace government bonds in their portfolio with money. It is impossible for a discretionary central bank to change expectations in period $t < \tau$ under the assumption of discretion. Even if it would be beneficial in period $t < \tau$ to create expectations of lower future interest rates and inflation in period $t \geq \tau$, the bank has an incentive to renege on this promise once the shock has subsided in period τ (because from that time on the government can achieve $\pi_t = x_i = 0$, which maximizes its objective). This problem of discretionary policy is coined the deflation bias in Eggertsson (2006b). While the classic inflation bias of Kydland and Prescott (1977) and Barro and Gordon

Figure 4. Deficit and Real Goverment Spending under Optimal Policy under Discretion in Equilibria A, B, C, and D: Great Depression Calibration



Source: Author's elaboration.

(1983) is a steady-state inefficiency, the deflation bias arises due to temporary deflationary shocks.

The dotted line in figures 3 and 4 shows equilibrium B in the diagram in figure 2. In this case the government is no longer constrained to keep real government spending constant. In addition to the parameters I have already specified, I need to calibrate the parameter ω, which is the inverse of the Frisch elasticity of labor supply. I calibrated it at $\omega = 2$, which strikes a middle ground between microeconomic studies (which are usually much higher than 2) and parameters often used in the RBC literature (which are usually around 0.5). The form of the solution can once again be inferred by inspecting equation (19). In periods $t > \tau$, the government can once again maximize its objective by setting $\pi_t = x_t = \hat{F}_t = 0$. In periods $t < \tau$, however, temporarily increasing $\hat{F}_t$ can improve the outcome. To see this, recall that the cause of the contraction is that the real interest rate is higher than the natural interest rate. The natural rate of interest, however, depends in fiscal spending, as seen in equation (15), so that increasing $\hat{F}_t$ in periods of the shocks increases the natural interest rate and thus reduces the output gap and deflation in periods $t < \tau$. The cost of doing this is that in these period there is an oversupply of public goods, causing the level of $\hat{F}_t$ to rise above what would be optimal in the absence of the demand-driven depression. A discretionary policymaker trades off the costs and benefits, and the resulting government expansion is shown in the figure.

Output increases more than the corresponding improvement in the output gap reported in the figure. The output effect of the fiscal expansion can be decomposed into an RBC channel and a New Keynesian channel. Output can be written as

$$\hat{Y}_t = x_t + \hat{Y}_t^n$$

so that the increase in output, by definition, is due to an improvement in the output gap and an increase in the natural rate of output. As shown in the RBC literature, an increase in government spending increases the natural level of output, and this effect can be seen by equation (14).

A multiplier of government spending answers the question of how much each dollar of real spending increases output, moving from the equilibrium in which $\hat{F}_t = 0$ (equilibrium A in figure 2) to the one in which $\hat{F}_t$ is optimally set (equilibrium B in figure 2). I measure each variable in net present value. This statistic can be analytically derived, yielding the following result:

$$MP_{A,B} \equiv \frac{E_0 \sum_{t=0}^{\infty} \beta^t (\hat{Y}_t^A - \hat{Y}_t^B)}{E_0 \sum_{t=0}^{\infty} \beta^t (\hat{F}_t^A - \hat{F}_t^B)} = \frac{\left[\frac{1}{1-\alpha} - \beta\right]\sigma^{-1} - \alpha^{-1}\kappa \frac{\sigma^{-1}}{\sigma^{-1} + \omega}}{\left[\frac{1}{1-\alpha} - \beta\right]\sigma^{-1} - \alpha^{-1}\kappa} > 1$$

This multiplier is 2.2 under the baseline calibration outlined above. The Keynesian channel, that is, the improvement in output due to the improvement in the output gap, accounts for 80 percent of the size of the multiplier.

In both equilibrium A and equilibrium B, the private sector expects zero inflation after the deflationary shocks have subsided. Even if the government expands the money supply, the private sector expects it to be reversed once deflationary pressures subside. Can a permanent increase in the money supply be credible? There is a straightforward policy tool for increasing inflation expectations in the model, even when the government is discretionary, as assumed. One way of making inflation policy credible is to expand government liabilities, that is, the sum of the monetary base and the government debt, given by the variable w_t in equation (18). This is what I call deficit spending or credit expansion; it is shown in the third line in figure 3, called equilibrium C. In this case, the government is no longer constrained to keep deficit spending constant, and instead I hold real spending constant. As the figure reveals, the government chooses to increase deficit spending in period $t < \tau$ and then runs surpluses when the deflationary shocks have subsided. This, in turn, has a large positive effect on both inflation and output.

The reason for the big impact of deficit spending on prices and output is that it changes expectation about future inflation, output, and nominal interest rates. As can be seen in figure 4, the deficit spending implies that the central bank will keep the nominal interest rate low for a substantially longer time than the duration of the shock and accommodate an output expansion and inflation in period $t > \tau$. These expectations feed into a large stimulus in period $t < T$ through several channels. The expectation of future inflation lowers the real interest rate, even if the nominal interest rate cannot be reduced further, thus stimulating spending. A commitment to a lower future nominal interest rate (once the deflationary pressures have subsided) stimulates demand for the same reason. Finally, the expectation of higher future income, as manifested by the expected output boom, stimulates current spending, in accordance with the permanent income hypothesis.

The reason why expansionary policy in periods $t > \tau$ is credible for the discretionary policymaker in equilibrium C but not in equilibrium A or B can be seen by inspecting equation (19) and the government budget constraint (18). The government accumulates additional debt in periods $t < \tau$. Because there is a cost of taxation, the government wishes to reduce the real value of its debt in periods $t > \tau$ by accommodating inflation (and I assume it only issues nominal bonds and money). It also wants to keep the real interest rate low because it is rolling its debt over from period to period. Both considerations give the government an incentive to keep the nominal interest rate low and accommodate inflation and output expansion in periods $t > \tau$ even if it could, in principle, stabilize prices and output at that time.

For the calculation reported in figure 3, I need to choose the cost of tax collection in the function,

$$\frac{\gamma}{2} T_T^2.$$

This parameter is chosen so that this cost corresponds to 10 percent of government spending to match the level of deficit spending once Roosevelt took power in 1933 (which was about 9 percent of GDP). A lower value for γ would have little effect on the results and only change the scale of the deficit spending. Since there was already some debt outstanding in 1933 (once Roosevelt embarked on an inflationary program), one could set this value much smaller and still match the evolution for deficit spending.

To usefully summarize the effect of the deficit spending or credit expansion on output through the multiplier, I need to make some adjustment to the definition of the multiplier. What I consider instead is a variable, $\tilde{T}_t$, defined as $\tilde{T}_t = \hat{T}_t$ if $\tilde{r}_t^n = r_t^L$ and $\tilde{T}_t = 0$ if $\tilde{r}_t^n = 0$. (The results derived for $\hat{F}_t$ would have been unchanged if I had defined $\tilde{F}_t$ in this way, because $\hat{F}_t = 0$ if $\tilde{r}_t^n = 0$). This variable captures the deficit spending used in the depression state. The value of this multiplier answers the following question: by how much does each dollar spent on deficit spending or credit expansion in a liquidity trap increase output? In the baseline calibration, the answer is 4. One can decompose the size of the multiplier into the RBC channel and the New Keynesian channel. No part of the multiplier can be explained by the RBC channel. The effectiveness of deficit spending comes entirely through increasing inflation expectations, and this is only valuable if one assumes sticky prices. Since prices are flexible in an RBC model, this channel has no role in that model.

4.2 Extensions: Exchange Interventions, Unconventional Open Market Operations, Bank Bailouts, Helicopter Money, and Long-Term Bonds

The last section emphasized cutting taxes relative to spending (deficit spending) in order to shift expectations about policy in periods $t \geq \tau$. Several other policy actions can also be described through the same mechanism. Government debt is the driving force for shifting expectations, not the tax cuts in themselves. Government debt can be increased in a variety of other ways, however, such as printing money (or bonds) or buying some private assets such as foreign exchange. As shown in Eggertsson (2003), these actions have the same implication for future government policy. Bailing out domestic banks by money printing or, even more exotically, dropping money from helicopters would have exactly the same effect. While Roosevelt did not drop money from helicopters in 1933, he took a variety of actions beyond deficit spending that expanded government credit, such as purchasing gold and refinancing private banks. These actions also had a large effect on the government balance sheet and should thus have fed into expectations about the future money supply.

It is sometimes suggested that monetary injection at a zero interest rate is somehow different from government debt because money does not have to repaid. Given our assumption that policy is discretionary in the future (that is, when the zero bound is no longer binding), this distinction is not valid. The reason for this is that the optimal future policy pins down the future price level and the future money supply from that date onwards, that is, at dates $t \geq \tau$. Hence, even if money is printed in period $t < \tau$ instead of issuing bonds (the distinction at that time is irrelevant, since both carry a zero interest rate), it will need to be "repaid" in the future once $t \geq \tau$ because the money supply at that time is uniquely determined by optimal policy.

It is often suggested that if long-term bonds have yields above zero, purchases of such bonds by the central bank should lower long-term interest rates and therefore increase spending.[15] As stressed by Eggertsson and Woodford (2003), however, the

15. The discussion in this paragraph is taken from Eggersson (2001). However, the results with respect to long-term debt are still "preliminary".

expectation theory of the term structure implies that this should not be possible, unless such actions are taken to signal a change in the bank's commitments regarding future monetary policy. Under coordination, if the central bank buys long-term bonds with money in a liquidity trap under cooperation, it is in effect changing the maturity structure of outstanding government debt (if the monetary base is considered a government liability). Since money and short-term bonds are perfect substitutes in a liquidity trap, replacing long-term bonds with money is equivalent to replacing long-term bonds with short-term bonds. The question of whether open market operations in long-term bonds is effective in a liquidity trap can thus be rephrased as follows: does changing the maturity structure of government debt increase inflation expectations? Preliminary results from work in progress suggest that the answer is yes. The logic behind this is straight forward. If the government holds long-term bonds, it reduces its incentives to lower the short-term real rate of return, as those returns will not apply to debt already issued. One of the two inflation incentives discussed earlier (for the case when all debt is short term) is thus reduced with a longer maturity. Since open market operations in long-term bonds shortens the maturity of outstanding debt, my preliminary results suggest that it may be effective to increase inflation expectations. An important caveat is that this channel will only be effective if the central bank is not independent.

5. Discretionary Equilibrium when the Central Bank is Independent

The preceding section assumes that monetary and fiscal policy are coordinated to maximize social welfare. This assumption may be questionable, however, given that many central banks have more narrow goals than social welfare. I now analyze the consequence of this alternative assumption, supposing the central bank is independent in the way defined in section 3.

The timing of events in the game is as follows. At the beginning of each period t, w_{t-1} is a predetermined state variable, and the exogenous disturbance b_t is realized and observed by the private sector, the treasury, and the central bank. The monetary and fiscal authorities simultaneously choose policy at time t given the state, and the private sector forms expectations:

$$\begin{bmatrix} F_t \\ T_t \end{bmatrix} = \begin{bmatrix} \bar{F}(w_{t-1}, b_t) \\ \bar{T}(w_{t-1}, b_t) \end{bmatrix} = \bar{T}r(w_{t-1}, b_t) \tag{25}$$

and

$$i_t = i(w_{t-1}, b_t) \tag{26}$$

Under discretion, the treasury maximizes the value function $J^{TR}(w_{t-1}, b_t)$ by its choice of policy instruments, taking the expectation functions $\bar{f}^e(w_t, b_t)$ and $\bar{S}^e(w_t, b_t)$ as given because it cannot commit to future policy. It solves

$$J^{Tr}(w_{t-1}, b_t) = \max_{T_t, F_t} \left\{ [\log C_t + \log G_t + \psi \frac{h_t^{1+\omega}}{1+\omega})]b_t + \beta E_t J^{Tr}(w_t, b_{t+1}) \right\} \tag{27}$$

subject to equations (4), (5), (6), (7), (11), (12), and (26). The central bank solves

$$J^{Cb}(w_{t-1}, b_t) = \max_{i_t} [-(\Pi_t - 1)^2 - \lambda \frac{Y^t}{Y_t^n} - 1)^2 + \beta E_t J^{Cb}(w_t, b_{t+1})] \tag{28}$$

subject to equations (6), (7), (11), (12), and (25).

The conditions that constrain the actions of the treasury and the central bank in equations (27) and (28) are the private sector equilibrium conditions and the strategy functions of the other government agency.[16] The debt is a state variable in the central bank's problem only because it enters in the strategy function of the treasury. Apart from the other players' strategy functions, these constraints are the same for both the treasury and the central bank, but with one important exception: the borrowing and budget constraint of the treasury is *only a restriction on the treasury taxing and borrowing strategies*; it does not impose any constraints on the central bank. To see why this is important,

16. Note that the government budget constraint can equivalently be interpreted as the budget constraint of the household and it thus belong in both maximization problems as a private sector equilibrium constraint.

suppose the contrary was true. This would create a much more complicated strategic game between the treasury and the central bank. The treasury could, for example, accumulate large amounts of debt up to its debt limit, $\bar{w}$, and then cut taxes further. In this case, in order not to violate the borrowing constraint, the central bank would need to inflate away some of the existing debt. The definition of an independent central bank proposed here is therefore that the central bank has its own objective and also carries no responsibility for government finances.

5.1 Results

I first consider the power of real government spending when the central bank is goal independent. To isolate the effect of real government spending, I constrain the budget to be balanced at all times so thatt $\hat{F}_t = \hat{T}_t$ (corresponding to equilibrium B in figure 2, when the central bank is goal independent). The solution does not depend on whether the central bank is goal independent. This can be proved in two steps. Observe first that the solution when the natural interest rate becomes positive (and the zero bound is no longer binding) is the same under either coordination or goal independence because the central bank will target zero inflation and a zero output gap at that time (and the Treasury will then set $\hat{F}_t = 0$). Consider now the solution when the zero bound is binding. Since monetary policy is constrained by the zero bound at this time, its different objective is irrelevant during this period as long as it implies a zero interest rate. The central bank interest rate policy, therefore, only matters in period $t \geq \tau$, and I have just argued that its policy will be the same in those periods as under coordination. The Treasury, in turn, maximizes social welfare, and the path for government spending will therefore be exactly the same as analyzed in last section when $t < \tau$. It follows that the solution is the same under coordination and goal independence. A formal way of verifying this is to write out the first-order conditions of the two maximization problems and verify that they are identical to the one implied by the joint maximization problem analyzed in the last section.[17]

Consider now the case of deficit spending when the central bank is goal independent and suppose that now real spending

17. See an earlier version of this paper (Eggertsson, 2006a).

is held constant, so that $\hat{F}_t = 0$. In this case, the power of deficit spending depends dramatically on whether the central bank is goal independent: If the central bank is goal independent, deficit spending has *no effect* on inflation or output.

Proposition 1: *If the central bank is goal independent and if* $\hat{F}_t = 0$*, then deficit spending has no effect on output and prices.*

A formal proof can be obtained by writing out the first-order conditions of each of the maximization problems of the treasury and the central bank.[18] The logic of the result is as follows. For a given path of F_t, Ricardian equivalence holds in the model, so that debt does not enter into any of the equilibrium conditions of the private sector apart from its budget constraint. Monetary policy is set to minimize $(\Pi_t - 1)^2 + \lambda_x x_t^2$. Government debt or deficits do not enter this objective or the constraints that limit the actions of the central bank. It follows that debt has no effect on the equilibrium determination of inflation, output, and interest rates, which are determined by exactly the same set of equations as if fiscal policy was completely inactive (that is, in equilibrium C in figure 2). It follows that if I set $\hat{F}_t = 0$ to be exogenously given, deficit spending has no effect on the equilibrium outcome when the central bank is goal independent. The central bank will determine inflation and the output gap without any reference to deficits or debt.[19] The effect of fiscal policy when coordinated with monetary policy is thus fundamentally different depending on whether or not monetary and fiscal policy are coordinated. When the central bank is goal independent, the deficit spending multiplier is zero.

5.2 Extensions: Irrelevant Policies such as Exchange Interventions, Unconventional Open Market Operations, Bank Bailouts, Helicopter Money, and Long-Term Bonds

In the context of the current crisis in the United States and the previous crisis in Japan, many commentators and researchers

18. See an earlier version of this paper (Eggertsson, 2006a).

19. If the treasury chooses F_t in each period, deficit spending can, in principle, have an effect by influencing the expectations about future spending, F_{t+j}. This is only a second-order effect in this model, however.

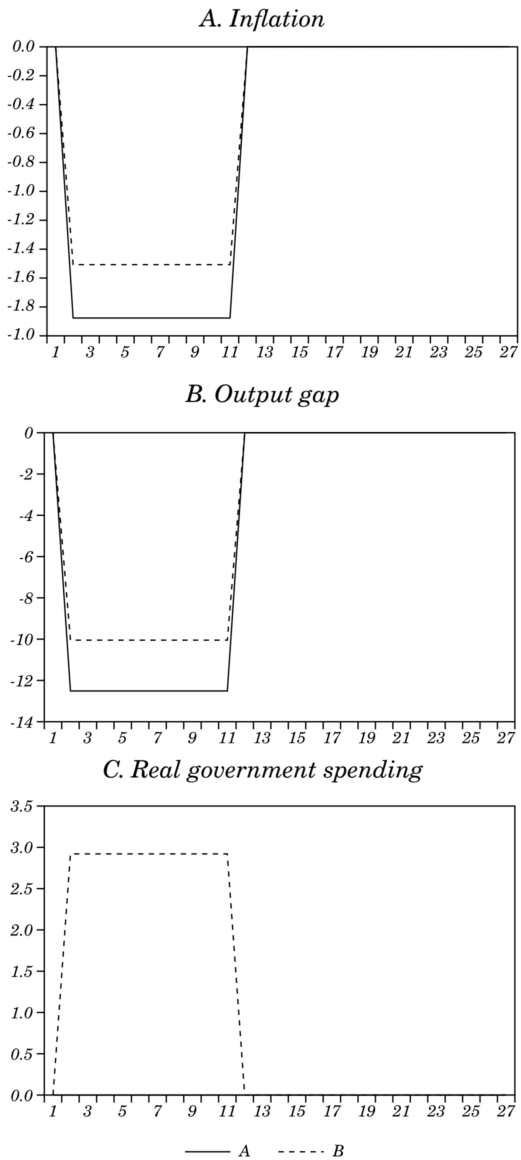
have suggested various policy options to stimulate demand, such as unconventional open market operations, helicopter money, purchases of long-term debt, and so on. None of these policies will have any effect, however, given an independent central bank, as described above. Their effect relies entirely on policy coordination and the extent to which a current fiscal burden implies an inflation incentive in the future. The theory laid out in this paper leaves no room for channels such as a portfolio effect or the different degrees of liquidity of various assets. While this is arguably unrealistic, the current setup clarifies that the signalling effect that many of those who suggest these policies rely on hinges critically on monetary and fiscal coordination.

Another mechanism may be important, even for an independent central bank. If the central bank cares about its own balance sheet, these operations may well operate under "independence" in a similar fashion as the "coordinated" solution implies. One can even argue that the balance sheet consideration may be so strong, that it would preclude a central bank from taking sufficiently strong actions.

6. Fiscal Multipliers and Policy Coordination: The United States during the Great Depression and Japan in the Great Recession

A possible reconciliation of the different outcomes in the United States during the Great Depression in 1933–37 and 1938–41 and Japan today is the different policy multipliers under coordination and central bank independence. To make the comparison more concrete, I recalibrate the model to match some basic features of the Great Recession in Japan. This calibration is not based on a estimation using Japanese data and is made purely for illustrative purposes. It should be interpreted in this light. I assume the same values for β and α as in the previous section, but I set $= 0.8$ to match the size of the Japanese government of 20 percent of steady state (recall the assumption of a log-utility function). I again pick the value of κ using equation (16). To do this, I need to take a stance on the size of the output contraction, or the output gap, in the Great Recession,as there is no reliable measure of this variable (the numerical example here is preliminary). In a recent study, Kamada (2005) reviews several measures of the output gap used at the Bank of Japan, which are in

Figure 5. Policy under Discretion under Central Bank Independence: Great Recession



Source: Author's computations.

Table 3. Coordination of Fiscal and Monetary Policy in the Great Depression in Japan
(in percent)

Year	*Change in GNP deflator*	*Change in CPI*	*Change in WPI*	*Change in GNP*	*Goverment surplus over GNP*
1929	–	–2.3	–2.8	0.5	–1.0
1930	–	–10.2	–17.7	1.1	2.0
1931	–12.6	–11.5	–15.5	0.4	0.4
1932	3.3	1.1	11.0	4.4	–3.5
1933	5.4	3.1	14.6	10.1	–3.0
1934	–1.0	1.4	2.0	8.7	–3.5
1935	4.1	2.5	2.5	5.4	–3.3
1936	3.0	2.3	4.2	2.2	–2.0

Source: Author's elaboration.

the range of 5–15 percent in this period. Using 10 percent as a value for the output gap and –1.5 percent for deflation, I obtain

$$\kappa \equiv (1-\beta(1-\alpha))\frac{\pi}{x} = 0.0041,$$

which is a lower number than I used for the United States during the Great Depression. This indicates that a higher degree of price rigidity is needed in Japan to account for the features I match. I assume a shock of $r_L^e = -4.5$ percent to match this output gap. In contrast to the other exercise, I assume that the central bank is goal independent, but that the treasury uses fiscal spending to stimulate demand.

Figure 5 shows the response of the output gap, inflation, and government spending policy to the shock r_L^e, given goal independence and discretionary government spending. The optimal response of the ministry of finance is to increase government spending by 3 percent of GDP. An interesting counterfactual is to ask what would have happened in the absence of the expansion of real government spending. The solid line shows that in this case, the Great Recession in Japan would have resulted in additional 2.5 percent decrease in the output gap (or 3.5 percent in output).

Table 3 compares the multiplier of real spending across the Great Depression in the United States and the Great Recession in Japan in our illustrative calibration examples. The multiplier is higher in the calibrated example for the United States, which is driven by the different parameter values assumed for κ and σ. I do not wish to dwell on whether these different result reflect important differences in the structure of the United States economy during the Great Depression versus Japan in the Great Recession, since the parameters picked to generate the results are only intended for illustration and were backed out to match the basic features of the data outlined above. If those parameters were assumed to be the same in the two calibrations, the real spending multiplier would be the same in the two countries. A formal estimation strategy may yield quite different results, and these calibrations simply show that the model can replicate certain features of the data.[20] The main point I wish to stress is the dramatic difference in the deficit spending multiplier in the two examples, and this is true regardless of the parameter values assumed. While the deficit spending multiplier is substantial for the United States during the Depression in 1933–37, it is zero in Japan during the Great Recession.

The result in the table illustrates that deficit spending, foreign exchange interventions, or any other actions by the treasury that affect the government balance sheet are completely irrelevant if the central bank is independent. This can explain the difference between the responses of the Japanese and the American economies to the various stimulative actions.

For comparison, the table also shows the multipliers for the scenario in which interest rates are positive. This scenario reflects the response of output when there are no deflationary pressures, but (counterfactually) the path for both the deficit and real spending is the same as if the shocks had occurred. In this case, the multipliers are much smaller, because the central bank counteracts the positive pressure on inflation and the output gap by raising interest rates. When the deflationary shock actually occurs, however, the central bank does not react in this way since both the output gap and inflation are below the level the central bank would wish them to be. This indicates that fiscal policy is mainly effective when the interest rate is zero.

The multipliers under coordination are much bigger than in the traditional Keynesian literature. The most cited paper on fiscal policy during the Great Depression, for example, is Brown (1956).

20. For an exercise that is closer to that spirit, see Denes and Eggertsson (2009).

In his baseline calibration the real spending multiplier is 0.5 and the deficit spending multiplier is 2.0.[21] The reason for this large difference is that the old models ignore the expectation channel. Modeling expectations is the key to understanding the large effect of government spending.

6.1 The Evolution of the Money Supply

So far I have not discussed the implied path of the money supply for the different policy regimes. As mentioned in section 2, the equilibrium can be fully characterized without any direct reference to the money supply. For a given path of output, prices, and interest rates, the money supply is given by equation (8), which I list again here:

$$M_t \geq \nu P_t Y_t. \tag{29}$$

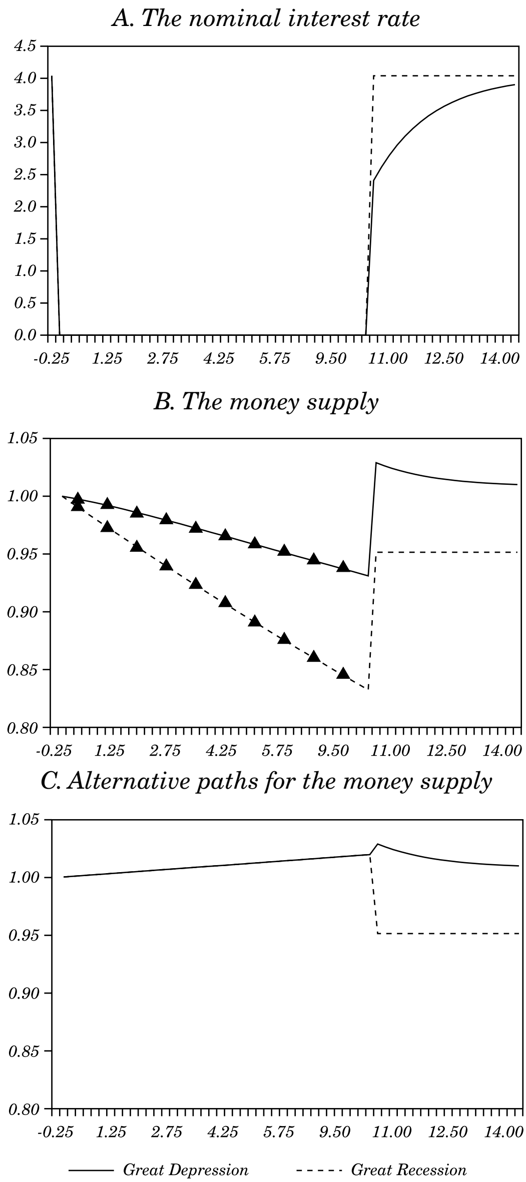
This inequality has to hold with equality at all times when the nominal interest rate is greater than zero. The reason is that at a positive interest rate, the household would prefer to aqcuire interest on its assets. At zero interest rate, however, the household is indifferent between holding money or government bonds as assets, so the money supply is indeterminate.[22] This has strong implications for the evolution of money supply during the Great Depression and the Great Recession.

Figure 6 shows the evolution of the nominal interest rate and the money supply for a scenario in which the natural interest rate stays negative for ten years for each of calibration examples (but interest rates remained close to zero in 1933–41 in Great Depression and in 1996–2006 in the Great Recession). Consider panel A in figure 6. For periods 0–10, the interest rates is zero in both policy regimes. In panel B, any money supply is consistent with the equilibrium in

21. See Brown (1956, table 1). Column 14 is his baseline calibration where he assumes "that the marginal propensity to spend disposable income and profits (a)" is 0.8 and " the marginal propensity to spend, national product (b)" is 0.6. The real spending multiplier in his model is $(1 - a) / (1 - b)$ and the deficit spending multiplier is $a / (1 - b)$, which give the numbers cited above.

22. A more detailed money demand specification would define velocity, ν, as a function of the nominal interest rate, but this is not required for the basic point I wish to make in this section. Additionally, with productivity growth, the implied money supply would be increasing at the phase of productivity.

Figure 6. Implied Money Supply and Nominal Interest Rate during the Great Depresson and the Great Recession



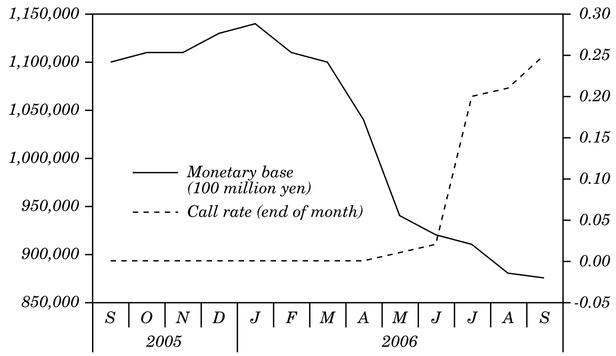
Source: Author's computations.

periods 0–10 (which is denoted by triangles) as long as it is above the triangulated lines, because during those periods the interest rate is zero and inequality (29) is therefore not binding. In other words, the *velocity of money* is indeterminate in periods 0 to 10. What is uniquely determined, however, is the money supply from period 10 onward, when the natural interest rate is positive again, in which case the nominal interest rate is no longer zero, as can be seen in panel A. What this means is that increases in the money supply in periods before 10 have no effect unless they change the expectations about the money supply in period 10 onward. Hence, according to the model, the fact that the Bank of Japan and the Federal Reserve both more than doubled the money supply in the periods in which interest rates were zero (roughly speaking 1996–2006 and 1933–41) had no effect unless it changed expectations about the money supply from 2006 onward, on the one hand, or 1941 onward, on the other. The expansionary stance of monetary policy in 1996–2006 versus 1933–41, therefore, cannot be gauged by the level of the money supply alone. Rather, what separates the two policy regimes is that the policy regime during the Great Depression implied a permanent increase in the money supply (post-1941), while policy during the Great Recession (post-2006) did not.

To illustrate this point, panel C in figure 6 shows a possible path for the money supply for the Great Recession and the Great Depression. This hypothetical evolution of the money supply is the same in the periods when the interest rate is zero. The only difference between the two regimes is that policy during the Great Recession implies that the money supply is lower in period 10 onward, so as soon as the deflationary pressure subsides, the central bank contracts the money supply aggressively.

A monetary contraction was, in fact, observed in Japan as soon as deflationary pressures started to wane in 2006. In the spring of 2006, as the deflationary pressures subsided, the Bank of Japan ended its period of quantitative easing. The Bank of Japan subsequently contracted the monetary base by about 30 percent, as shown in figure 7. No such contraction was observed during the Great Depression, apart from in a short period in 1937 through an increase in reserve requirements—a policy that was then reversed, as I discuss in the next section.

Figure 7. Contraction of the Money Supply in Japan in the Spring of 2006



Source: Federal Reserve Board and NBER Macrohistory Database.

7. The Role of Central Bank Independence during the Great Depression in the United States

The paper's model can be used to interpret the recovery from the Great Depression from the perspective of the independence of the Federal Reserve. If one takes the institutional arrangement described here literally, the model indicates that when the short-term nominal interest rate is zero, a move that coordinates monetary and fiscal policy would increase output and prices. This gives an interesting perspective on the recovery in 1933–37 in the United States, the recession in 1937–38, and the recovery from 1938 onward.

Roosevelt was inaugurated in March 1933. The following month, Congress passed a law, the Thomas Amendment, whose two most prominent features were that the president could reduce the gold value of the dollar and issue US$3 billion in currency. The US$3 billion corresponded to 30 percent of the monetary base at the time and more than half the currency in circulation.[23] While both provisions were only authorizations rather than required actions, they effectively ended the independence of the Federal Reserve for

23. The monetary base is defined as the sum of currency in circulation and nonborrowed reserves.

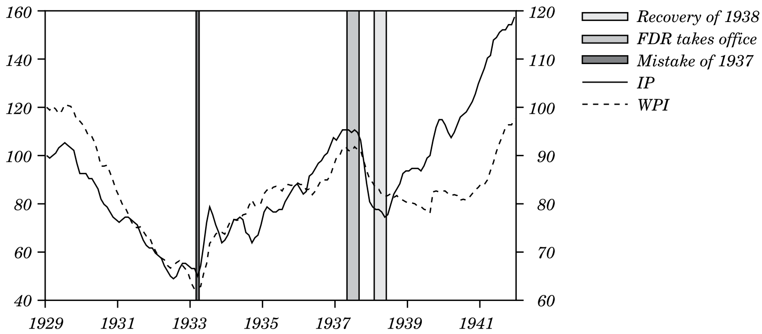
the time being. Roosevelt used this power to go off the gold standard. In addition, he said on several occasions that he wished to inflate the price level to pre-Depression levels. On 1 May of 1933, for example, Roosevelt was quoted in the *Wall Street Journal* as saying that "We are agreed in that our primary need is to insure an increase in the general level of commodity prices. To this end simultaneous actions must be taken both in the economic and the monetary fields."

Figure 8 shows that prices and output immediately responded to these announcements. In addition, the administration embarked on various spending programs that increased the budget deficit. Were these expansionary programs related to making inflation more credible? When the market seemed to doubt the administration's commitment to inflation in the fall of 1933, Roosevelt said in a radio address that "If we cannot do this [reflation] one way, we will do it another. Do it, we will [...] That is why powers are being given to the Administration to provide, if necessary, for an enlargement of credit [...] These powers will be used when, as, and if it may be necessary to accomplish the purpose [increasing inflation]".

The administration saw deficit spending—that is, the enlargement of government credit—as crucial to increase inflation. Newspaper articles from this era provide anecdotal support for this claim. The violation of what Eggertsson (2008) calls the balanced budget dogma created widespread anger among some commentators in the press who believed the government would embark on a path of uncontrolled inflation, citing experiences of deficit spending in some countries in the aftermath of World War I (such as Germany).

Perhaps even more interesting, from a theoretical perspective, is the cause of the 1937 recession. Eggertsson and Pugsley (2006) argue that this recession was caused by the administration's abandonment of the commitment to inflate the price level to predepression levels. Specifically, the administration—especially the Federal Reserve—started warning that inflation was too high in the early months of 1937, even though prices had not reached predepression levels. This resulted in a shift in expectations and a contraction, as can be seen in figure 8. Eggertsson and Pugsley (2006) do not explain why the Federal Reserve started warning against high inflation. However, the argument laid out here suggests that the Federal Reserve reneged on the administration's commitment to inflation because it saw its objective as that of an independent bank. In other words, the Federal Reserve wanted to avoid inflation because it thought output had reached potential, and in that scenario an independent bank should have raised interest rates.

Figure 8. Monthly Whole Sale Prices and Industrial Production during the Great Depression



Source: Federal Reserve Board and NBER Macrohistory Database.

This interpretation seems to be consistent with some narrative evidence. Given the high level of outstanding government debt in 1937, the Federal Reserve's warning that inflation was too high would, according to my theory, be consistent with itas objective (since it thought the depression was essentially over at that time; see Eggertsson and Pugsley, 2006), but inconsistent with the Treasury's objective that is, the agency responsible for financing the budget deficits and outstanding debt payments. Historical evidence indicates that the Treasury reacted strongly to the Federal Reserve's actions in 1937, which included implementing higher reserve requirements that raised short-term interest rates, precisely because it was inconsistent with the policy regime of coordinated monetary and fiscal policy. Marriner Eccles, the governor of the Federal Reserve, described the reaction of the Secretary of Treasury, Henry Morgenthau, to the increase in interest rates in May 1937 triggered by an increase in reserve requirements:

> I was out of Washington when this happened. After hurrying back to do what I could to correct the situation, I found Secretary Morgenthau understandably disturbed about the fall in government bond prices [that is, the increase in the short-term interest rate]. He insisted that the Federal Reserve Board rescind its order for the second part of the [reserve requirement] increase, which was to go into effect on May 1. In a tense meeting at his home on Saturday night, he let it be known that if the Board failed to do what he urged,

> he would release a substantial amount of sterilized gold and thereby create new reserves that could be used to bolster the government bond market (Eccles, 1951, p. 292).

What this quote illustrates is that the Secretary of the Treasury threatened to take monetary policy away from the Federal Reserve unless it kept interest rates low. As Eccles notes, the Secretary's threat "would indicate that the Secretary of the Treasury had taken over control of monetary and credit policy" because a release of sterilized gold would have led to a corresponding increase in the monetary base. This narrative evidence indicates that the Treasury wanted inflationary policies to protect the low interest rate it was paying on its outstanding debt, consistent with the coordinated solution.

The Federal Reserve did not budge in 1937. In 1938, however, the country had experienced another deep recession, as can be seen in figure 8, and a tumble in the price level. In early 1938, Roosevelt restored an inflationary policy by overriding the Federal Reserve, giving them explicit directions on how to conduct policy. The first announcement of considerable importance was made at a press conference on 15 February, where Roosevelt said that he believed, as he had announced in 1933, that prices should be inflated back to their predepression levels (Eggertsson and Pugsley, 2006).

Three days later Roosevelt called another press conference to illustrate overall coordination of monetary and fiscal policy. On that occasion, he read a statement prepared jointly by Federal Reserve Chairman Eccles, Treasury Secretary Henry Morgenthau, and several other senior government officials. Flanked by senior administration officials, Roosevelt announced that "it is clear that in the present situation a moderate rise in the general price level is desirable." Later that spring, the administration took several steps to support an inflationary program, such as lowering the reserve requirement back to its 1936 level, increasing deficit spending, and desterilizing government gold stocks. The 1938–42 recovery was even stronger than the 1933–37 recovery, and by most measures the economy had fully recovered by 1942.

It is often argued that it was wartime spending that finally lifted the United States economy out of the Great Depression. This "conventional wisdom" is probably colored by the Keynesian view that monetary policy was impotent during this period. There is no doubt that wartime spending helped stimulate demand. According to the current hypothesis, however, the turnaround from 1937–38 is more appropriately traced back to Roosevelt's recommitment to inflation and coordinated monetary and fiscal policy in the early months of 1938.

8. Coordination during the Great Depression in Japan

The main objective of this paper is to compare the United States during the Great Depression and Japan during the Great Recession. The choice of these specific episodes was primarily motivated by the fact that they are relatively well known by economists. It is impossible, however, to leave the topic of coordination without mentioning another historical episode, which, while less known, is of great interest to the analysis.[24]

Despite the experience of the 1990s and 2000s, Japan has an interesting historical precedent of a cooperative solution. In the late 1920s, Japan was slipping into a depression. Growth had slowed down considerably: GNP rose by only 0.5 percent in 1929, 1.1 percent in 1930, and 0.4 percent in 1931. At the same time, deflation was crippling the economy. This was registered by several macroeconomic indicators, as illustrated in table 4. In December 1931, Korekiyo Takahashi was appointed the Finance Minister of Japan. Takahashi took three immediate actions. First, he abolished the gold standard. Second, he subordinated monetary policy to fiscal policy by having the Bank of Japan underwrite government bonds. Third, he ran large budget deficits. These actions had dramatic effects (see table 3). All the macroeconomic indicators changed in the direction predicted by the model. As the budget deficit increased, GNP rose and deflation was halted. During the same period, interest rates were at a historical low. I do not have a good measure of the short-term riskfree nominal rate, but the commercial rate, while low, was not zero, and it declined even further with Takahashi's actions. In addition to the nominal interest rate cuts, the model indicates that the other actions taken—that is, aggressive deficit spending that was financed by underwriting of government bounds—could have had considerable effects on the real rate of return by increasing expected inflation. This channel may

24. See, for example, Patrick (1971), Nakamura (1971), and Nanto and Takagi (1985) for a discussion of this period in Japan.

be important for explaining the success of these policy measures in Japan during the Great Depression. In 1936, Takahashi was assassinated, and the government finances were subjugated to military objectives. The subsequent military expansion eventually led to excessive government debt and hyperinflation. Until Takahasi was assassinated, however, the economic policies in Japan in the 1930s were remarkably successful, as the table reveals. The resulting hyperinflation that followed in later years, however, reflects the dangers associated with coordination of this kind.

9. Conclusions

Inflation has been considered the main threat to monetary stability for several decades. In the aftermath of the double digit inflation of the 1970s, there was a movement to separate monetary policy from fiscal policy and assign it to independent central bankers whose primary responsibility was to prevent inflation. This development was reinforced by important contributions on the theoretical level, most notably by Kydland and Prescott (1977) and Barro and Gordon (1983) , who illustrated the inflation bias of a discretionary government. It is easy to forget that in the aftermath of the Great Depression, when deflation was the norm, the discussion at the political and theoretical level was quite the opposite. Paul Samuelson claimed that the Federal Reserve was "the prisoner of its own independence" during the Great Depression, exaggerating the slump by its inability to fight deflation.[25] Similarly, Milton Friedman argued that "monetary policy is much too serious a matter to be left to the central bankers."[26] This paper explains the different reactions of nominal demand during the Great Recession versus the Great Depression by illustrating the importance of central bank independence. Working out the normative implications of this is a hard task, which I do not attempt to address here. There are obvious and large benefits of central bank independence under regular circumstances, but there is a case for coordination when the economy is in dire straits. The case for coordination is weaker to the extent that the central

25. See Mayer (1990, p. 6).

26. However, he suggested rules to solve the problem, rather than coordinated discretion as I do here. See Friedman and Friedman (1980).

bank has high degree of credibility and is able to effectively use it to steer away from Depression-style contraction.

As I have stressed in this paper, the two key differences between policymaking in the Great Recession and the Great Depression are that monetary and fiscal policy were coordinated during the Great Depression and that the government made an explicit commitment to reflate the price level. What was the contribution of each of these channels? In the model analysis, I make a strong assumption that words had no weight so that the second channel played no role, which is essentially equivalent to assuming that the government had no credibility. One cannot, however, infer whether this assumption is correct in the data because words and actions went together (that is, the publicly communicated commitment to inflation in the United States was concurrent with the reduction in central bank independence). Is it possible that the change in the institutional arrangement was irrelevant and that all that mattered was the commitment of the government to price-level targeting? This is a question for future research.

APPENDIX A
Computation Method

I start by defining the following notation:

$$\Lambda_t \equiv \left[\Pi_t \;\; Y_t \;\; i_t \;\; F_t \;\; T_t\right], \text{ and } e_t \equiv \begin{bmatrix} f_t^e \\ S_t^e \end{bmatrix}.$$

I summarize conditions (2), (3), and (4) by the vector function Γ, so that

$$\Gamma(\Lambda_t, w_t, w_{t-1}, b_t) = 0 \tag{A1}$$

and the inequalities (5) and (7) by Υ, so that

$$\Upsilon\,(\Lambda_t, w_t, b_t) \geq 0 \tag{A2}$$

I summarize the utility as $U(\Lambda_t, b_t)$, so that the maximization problem can be written compactly as

$$J(w_{t-1}, \xi_t) = \max_{i_t, F_t, T_t}\left[U(\Lambda_t, b_t) + E_t\beta J(w_t, b_{t+1})\right] \tag{A3}$$

subject to equations (30) and (31).

I obtain the necessary conditions for a Markov perfect equilibrium by differentiating the Lagrangian:

$$L_t = U(\Lambda_t, \xi_t) + E_t\beta J(w_t, \xi_{t+1}) + \phi_t'\Gamma(e_t, \Lambda_t, w_t, w_{t-1}, \xi_t) + \delta_t'\Upsilon(\Lambda_t, w_t, \xi_t),$$

where ϕ_t is a (5×1) vector and γ_t is (2×1). The first-order conditions for $t \geq 0$ (where each derivative of L is equated to zero) are

$$\frac{dL}{d\Lambda_t} = \frac{dU(\Lambda_t, \xi_t)}{d\Lambda_t} + \phi_t' \frac{E_t d\Gamma(\Lambda_t, w_t, w_{t-1}, \xi_t)}{d\Lambda_t} + \delta_t' \frac{d\Upsilon(\Lambda_t, \xi_t)}{d\Lambda_t}; \tag{A4}$$

$$\frac{dL}{dw_t} = E_t \frac{d\beta J(w_t, \xi_{+1})}{dw_t} + \phi_t' \frac{E_t d\Gamma(\Lambda_t, w_t, w_{t-1}, \xi_t)}{dw_t} + \delta_t' \frac{d\Upsilon(\Lambda_t, w_t, \xi_t)}{dw_t};$$

$$\gamma_t \geq 0, \quad \Upsilon(\Lambda_t, w_t, \xi_t) \geq, 0 \quad \delta_t' \Upsilon(\Lambda_t, w_t, \xi_t). \tag{A5}$$

Here, $dL / d\Lambda_t$ is a (1×5) Jacobian. I use the following notation:

$$\frac{dL}{d\Lambda_t} \equiv \left[\frac{\partial L}{\partial \Pi_t}, \frac{\partial L}{\partial Y_t}, \frac{\partial L}{\partial i_t}, \frac{\partial L}{\partial F_t}, \frac{\partial L}{\partial T_t} \right],$$

so that equation (33) is a vector of six first-order conditions. The Markov equilibrium must also satisfy an envelope condition:

$$J_w(w_{t-1}, \xi_t) = \phi_t' \frac{d\Gamma(e_t, \Lambda_t, w_t, w_{t-1}, \xi_t)}{dw_{t-1}}, \tag{A6}$$

In addtion, the derivative of $J(.)$ with respect to all other elements of Λ_t is zero.

As proved in Eggertsson (2006b), this system has a steady state with $\Pi = 1$, $Y = \bar{Y}$, $1 + i = \beta^{-1}$, $F = \bar{F} = T = \bar{T}$ and $w = 0$ and $\phi_1 = (\gamma \bar{F} \beta)/(\bar{F}(1 - \gamma))$, while all the other elements of the vectors ϕ and δ are zero. The system is linearized around this steady state for each set of equalities that have to hold when the zero bound is binding and when it is not, and the resulting solution is accurate to the first order (Eggertsson, 2006b). I wrote a Matlab file to numerically approximate the linearized system. The numerical solution obtained is then found using the solution method in Eggertsson and Woodford (2003) and Eggertsson (2006b). This solution is shown in the Matlab files available online at www.ny.frb.org/research/economists/eggertsson/index.html.

Appendix B
Derivation of Objective

Here I do a linear quadratic approximation of the utility of the representative household to verify the statement in the text. The utility function of the household is:

$$E_t \sum_{t=0}^{\infty} \beta^t \{u(Y_t - F_t - d(\pi_t), \xi_t) + g(F_t - s(T_t), \xi_t) - v(Y_t, \xi_t)\},$$

using a slightly more general notation than in the text. In steady state,

$$u_c = C^{-\sigma^{-1}} u^{\sigma^{-1}} = 1;$$
$$u_{c\xi} = \sigma^{-1} C^{-\sigma^{-1}} u^{\sigma^{-1}-1} = C^{-1}\sigma^{-1};$$
$$u_{cc} = -\sigma^{-1} C^{-\sigma^{-1}-1} u^{\sigma^{-1}} = -C^{-1}\sigma^{-1};$$
$$v_y = \lambda_1 Y^{\omega} q^{-\omega} = 1;$$
$$v_{yy} = \omega\lambda_1 Y^{\omega-1} q^{-\omega} = \omega;$$
$$v_{y\xi} = -\lambda_1 \omega Y^{\omega} q^{-\omega} = -\omega;$$
$$g_G = \chi G^{-\sigma^{-1}} g^{\sigma^{-1}} = \chi;$$
$$g_{GG} = -\sigma^{-1}\chi G^{-\sigma^{-1}-1} g^{\sigma^{-1}} = -\chi G^{-1}\sigma^{-1};$$
$$g_{G\xi} = \sigma^{-1}\chi G^{-\sigma^{-1}} g^{\sigma^{-1}-1} = \chi G^{-1}\sigma^{-1};$$
$$(1 - s')\chi = 1.$$

Also recall that in steady state I normalize $Y = 1$. The first piece of the utility is

$$
\begin{aligned}
u\left[Y_t - F_t - d\left(\pi_t\right), \xi_t\right] &= u + u_c dY_t - u_c dF_t + u_c d' dp_t + u_\xi d\xi_t \\
&\quad -\frac{1}{2} c_{cc} dY_t^2 + u_{c\xi} d\xi_t dY_t - u_{c\xi} d\xi_t dF_t \\
&\quad - u_{c\xi} d\xi_t d' d\pi_t - u_{cc} dY_t dF_t + u_{cc} d' dY_t d\pi_t \\
&\quad + u_{cc} d' dF_t d\pi_t + \frac{1}{2} u_{cc} dF_t^2 - \frac{1}{2} u_c d'' d\pi_t^2 \\
&\quad + \frac{1}{2} u_{cc} \left(d'\right)^2 d\pi_t^2 + \frac{1}{2} \xi_t' u_{\xi\xi} \xi_t \\
&= \hat{Y}_t - \hat{F}_t + \begin{bmatrix} -\frac{1}{2}\sigma^{-1} C^{-1} \hat{Y}_t^2 + \sigma^{-1} C^{-1} \hat{Y}_t \hat{F}_t \\ +\sigma^{-1} C^{-1} \hat{Y}_t \hat{u}_t - \sigma^{-1} C_t^{-1} \hat{F}_t \hat{u}_t \\ -\frac{1}{2} d'' d\pi_t^2 - \frac{1}{2}\sigma^{-1} C^{-1} \hat{F}_t^2 \end{bmatrix} \\
&\quad + \text{TIP},
\end{aligned}
$$

where TIP stands for terms independent of policy. The second piece is

$$
\begin{aligned}
g\left[F_t - s\left(T_t\right), \xi_t\right] &= \bar{g} + g_G dF_t - g_G s' dT_t + g_\xi d\xi_t + \frac{1}{2} g_{GG} dF_t^2 \\
&\quad + \frac{1}{2} g_{GG} \left(s'\right)^2 dT_t^2 - \frac{1}{2} g_G s'' dT_t^2 + g_{G\xi} d\xi_t dF_t \\
&\quad - g_{G\xi} d\xi_t s' dT_t + \frac{1}{2} \xi_t{}' g_{\xi\xi} \xi_t \\
&= \chi \hat{F}_t - s' \chi \hat{T}_t - \frac{1}{2} \chi \sigma^{-1} G^{-1} \hat{F}_t^2 - \frac{1}{2} \chi \sigma^{-1} G^{-1} \left(s'\right)^2 \hat{T}_t^2 \\
&\quad - \frac{1}{2} s'' \chi dT_t^2 + \chi G^{-1} \sigma^{-1} \hat{F}_t \hat{g}_t - \chi G^{-1} \sigma^{-1} s' \hat{T}_t \hat{g}_t + \text{TIP}.
\end{aligned}
$$

Combine period utility to yield

$$\hat{Y}_t - \hat{F}_t - \frac{1}{2}\sigma^{-1}C^{-1}\hat{Y}_t^2 - \sigma^{-1}C^{-1}\hat{Y}_t\hat{F}_t + \sigma^{-1}C^{-1}\hat{Y}_t\hat{u}_t - \sigma^{-1}C^{-1}\hat{F}_t\hat{c}_t - \frac{1}{2}d''d\pi_t^2$$
$$-\frac{1}{2}\sigma^{-1}C^{-1}\hat{F}_t^2 + \chi\hat{F}_t - s'\chi\sigma^{-1}G^{-1}\hat{F}_t^2 - \frac{1}{2}\chi\sigma^{-1}G^{-1}\left(s'\right)^2\hat{T}_t^2$$
$$+\chi G^{-1}\sigma^{-1}\hat{F}_t\hat{g}_t - \chi G^{-1}\sigma^{-1}s'\hat{T}_t\hat{g}_t - \hat{Y}_t - \frac{1}{2}\omega\hat{Y}_t^2 + \omega\hat{Y}_t\hat{q}_t$$
$$= \left(\chi - 1\right)\hat{F}_t - s'\chi\hat{T}_t - \frac{1}{2}d''\pi_t^2$$
$$+\left[-\frac{1}{2}\left(\sigma^{-1}C^{-1} + \omega\right)\hat{Y}_t^2 + \sigma^{-1}C^{-1}\hat{Y}_t\hat{F}_t + \sigma^{-1}C^{-1}\hat{Y}_t\hat{u}_t + \omega\hat{Y}_t\hat{q}_t\right]$$
$$+\left[-\frac{1}{2}\sigma^{-1}\left(C^{-1} + \chi G^{-1}\right)\hat{F}_t^2 + \chi G^{-1}\sigma^{-1}\hat{F}_t\hat{g}_t - \sigma^{-1}C_t^{-1}\hat{F}_t\hat{u}_t\right]$$
$$+\left\{-\frac{1}{2}\chi\left[\sigma^{-1}G^{-1}\left(s'\right)^2 + s''\right]\hat{T}_t^2 - \chi G^{-1}\sigma^{-1}s'\hat{T}_t\hat{g}_t\right\}$$

Welfare criterion can now be written as

$$\sum_{t=0}^{\infty}\beta^t\left\{\begin{array}{l} -\frac{1}{2}d''\pi_t^2 - \frac{1}{2}(\sigma^{-1}C^{-1} + \omega)(\hat{Y}_t - \hat{Y}_t^n)^2 \\ -\frac{1}{2}\sigma^{-1}(C^{-1} + \chi G^{-1})(\hat{F}_t - \hat{F}_t^n)^2 \\ -\frac{1}{2}\chi[\sigma^{-1}G^{-1}(s')^2 + s'')(\hat{T}_t - \hat{T}_t^n)^2] \end{array}\right\},$$

where:

$$\hat{Y}_t^n \equiv \frac{\sigma^{-1}C^{-1}}{\sigma^{-1}C^{-1} + \omega}\hat{F}_t + \frac{\sigma^{-1}C^{-1}}{\sigma^{-1}C^{-1} + \omega}\hat{u}_t + \frac{\omega}{\sigma^{-1}C^{-1} + \omega},$$

$$\hat{F}_t^n \equiv \frac{\chi G^{-1}}{C^{-1} + \chi G^{-1}}\hat{g}_t - \frac{C^{-1}}{C^{-1} + \chi G^{-1}}\hat{u}_t,$$

and

$$\hat{T}_t^n \equiv -\frac{G^{-1}\sigma^{-1}s'}{\sigma^{-1}G^{-1}(s')^2+s''}g_t,$$

because

$$\sum_{t=0}^{\infty}\beta^t\left(\chi-1\right)dF_t - s'\chi dT = w_{-1} + \sum_{t=0}^{\infty}\beta^t\left[-1+\chi\left(1-s'\right)\right]dF_t = w_{-1} = 0.$$

Table B1. Japan 1990-2006
(in ten billion Japanese yen)

	1990	*1991*	*1992*	*1993*	*1994*	*1995*	*1996*	*1997*
Nominal GDP	4,401.67	4,682.91	4,805.14	4,841.42	4,865.23	4,931.40	5,028.72	5,125.67
Government expenditure	1,395.65	1,474.95	1,559.29	1,657.46	1,693.06	1,763.92	1,823.40	1,797.02
Percent of GDP	31.71	31.50	32.45	34.24	34.80	35.77	36.26	35.06
Deficit (-) / Surplus (+)	90.24	84.83	37.90	−115.10	−182.70	−232.45	−254.81	−194.44
Percent of GDP	2.05	1.81	0.79	−2.38	−3.76	−4.71	−5.07	−3.79
Nominal monetary base	3,922.01	3,981.29	3,892.81	4,024.69	4,209.61	4,415.16	4,778.78	5,144.47
Short-term interest rates (percent)	8.25	5.50	3.84	2.38	2.22	0.40	0.38	0.44
Real GDP	100.00	105.81	109.97	112	109.17	111.22	114.16	115.74
Percent change	5.26	3.33	0.95	0.20	−2.52	1.87	2.65	1.39
Real monetary base	100.00	98.26	94.31	96.33	100.05	105.22	113.93	121.05
GDP deflator	100.00	100.55	99.27	98.20	101.24	100.74	100.08	100.61
Percent change	−3 .00	0.55	−1.28	−1.07	3.09	−0.50	−0.65	0.53
CPI	100.00	103.31	105.25	106.53	107.28	106.99	106.95	108.36
Percent change	3.10	3.31	1.88	1.22	0.71	−0.27	−0.04	1.32

Table B1. (continued)

	1998	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005*
Nominal GDP	5,027.52	4,956.31	5,013.39	4,968.74	4,897.47	4,907.74	4,961.24	5,026.07
Government expenditure	1,815.90	1,659.28	1,789.89	1,810.81	1,845.99	1,830.20	1,812.10	1,867.69
Percent of GDP	36.12	37.70	38.22	37.68	38.13	36.75	36.75	37.16
Deficit (-) / Surplus (+)	277.27	−318.13	−350.11	−294.35	−381.73	−373.36	−321.50	−322.99
Percent of GDP	−5.51	−7.23	−7.48	−6.13	−7.88	−7.67	−6.52	−6.42
Nominal monetary base	5,585.80	5,993.81	6,450.79	6,930.20	8,711.11	10,142.94	10,865.43	11,079.76
Short-term interest rates (percent)	0.34	0.01	0.22	0.00	0.00	0.00	0.00	0.00
Real GDP	1,13.59	113.47	116.76	117.19	117.35	119.49	122.20	125.40
Percent change	−1.86	−0.11	2.9	0.37	0.14	1.82	2.27	2.62
Real monetary base	130.35	140.46	152.67	165.89	210.65	246.23	264.04	270.69
GDP deflator	100.55	99.24	97.55	96.33	94.81	93.31	92.24	91.06
Percent change	−0.06	−1.31	−1.7	−1.25	−1.57	−1.58	−1.15	−1.28
CPI	109.27	108.80	107.74	106.52	105.44	105.03	104.92	104.36
Percent change	0.84	−0.42	−0.98	−1.13	−1.01	−0.39	−0.10	−0.53

Source: Federal Reserve Board.

Table B2. United States 1930-1941
(in millions of US dollars)

	1930	*1931*	*1932*	*1933*	*1934*	*1935*
Nominal GDP	97,400.00	83,800.00	67,600.00	57,600.00	61,200.00	69,600.00
Government expenditure	3,545.90	4,300.30	4,572.30	5,115.60	5,216.00	6,843.80
Percent of GDP	3.64	5.13	6.76	8.88	8.52	9.83
Deficit (-) / Surplus (+)		−1,402.00	−1,520	−3,305	−5,502.50	−5,440.00
Percent of GDP		−1.67	−2.25	−5.74	−8.99	−7.82
Nominal monetary base	6,393.00	6,426.00	7,364.00	7,821.00	9,402.00	11,405.00
Short-term interest rates (per cent)	1.25	2.75	0.05	0.50	0.20	0.15
Real GDP	100.00	93.60	81.43	80.37	89.05	96.98
Percent change	−8.60	−6.40	−13.00	−1.30	10.80	8.90
Real monetary base	100.00	110.53	141.10	158.22	183.77	217.25
GDP Deflator	100.00	89.60	79.03	76.95	81.20	82.84
Percent change	−3.67	−10.38	−11.76	−2.70	5.57	2.01
CPI	100.00	90.94	81.63	77.33	80.03	82.12
Percent change	−2.55	−9.06	−10.23	−5.28	3.50	2.61

Table B2. (continued)

	1936	*1937*	*1938*	*1939*	*1940*	*1941*
Nominal GDP	78,500.00	87,800.00	89,000.00	89,100.00	96,800.00	114,100.00
Government expenditure	8,532.80	8,835	8,453.34	9,319.80	9,794.45	19,052.80
Percent of GDP	10.87	9.38	9.50	10.46	10.12	16.70
Deficit (-) / Surplus (+)	−6,659.00	−3,158.00	−738.00	−5,558.00	−5,735.00	−7,038.00
Percent of GDP	−8.48	−3.60	−0.83	−6.24	−5.92	−6.17
Nominal monetary base	13,014.00	13,283.00	15,428.00	18,883.00	22,539.00	23,597.00
Short-term interest rates (per cent)	0.20	0.12	0.05	0.05	0.06	0.35
Real GDP	109.59	115.18	111.26	120.27	130.86	153.23
Percent change	13.00	5.10	−3.40	8.10	8.80	17.10
Real monetary base	245.42	241.61	286.20	354.88	420.55	419.24
GDP Deflator	83.80	87.35	84.84	84.06	85.01	90.73
Percent change	1.12	4.32	−2.91	−0.97	1.17	6.70
CPI	82.95	86.00	84.33	83.24	83.84	88.05
Percent change	1.01	3.68	−1.95	−1.29	0.72	5.02

Source: Federal Reserve Board.

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Floats, Pegs, and the Transmission of Fiscal Policy

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One of the most popular pieces of wisdom in economic policy is the idea that fiscal policy is more effective in a fixed exchange rate regime or a currency union than in a flexible exchange rate regime. In this paper, we revisit the theoretical foundations of the conventional wisdom on the relative effectiveness of fiscal policy under alternative exchange rate regimes, using a standard New Keynesian model of a small open economy. We do so by focusing our analysis on the inherent link between the macroeconomic effects of a short-run stimulus and private expectations about medium-run monetary and fiscal policy developments. We do not, however, deviate from the assumption of perfect credibility of the peg, and we do not consider the case of prospective deficit monetization, discussed in an important contribution by Dornbusch (1980).[1] Rather, we look at

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1. According to Dornbusch, the prediction that a fiscal expansion causes the exchange rate to appreciate is an unappealing feature of the Mundell-Fleming model, in apparent contrast with the practical experience in policymaking. To address this issue, Dornbusch encompasses medium-term monetary developments in the model, focusing on the case in which government expansions in the short run foreshadow deficit monetization over the medium run. The anticipation of a future monetary expansion already weakens the exchange rate in the short run.

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plausible monetary and fiscal policy regimes, assumed to remain in place over the medium run.

Specifically, the New Keynesian model calls attention to the real long-term rate as a core indicator of the overall stance of stabilization policy: for private demand to increase in response to a shock, this rate must fall (see Woodford, 2003). Then, under the expectation hypothesis, long-term rates reflect the entire path of (current and future anticipated) monetary and fiscal decisions, via the effects of the latter on short-term rates over time, as stressed by Corsetti, Meier, and Müller (2009). Based on this consideration, we are able to derive sharp predictions regarding the macroeconomic dynamics following any given fiscal expansion in a small open economy, as a function of the regimes governing the evolution of fiscal policy and monetary or exchange rate policy.

The main conclusion of our analysis is that fiscal policy is not necessarily less effective under flexible exchange rates. Specifically, while approximating the central bank's behavior with a Taylor rule, we generate two findings. First, a high degree of monetary accommodation can greatly amplify the expansionary effects of a fiscal stimulus under flexible rates, up to making fiscal stimulus approximately as powerful as under a peg. Second, a plausible regime of medium-run fiscal consolidation, in which both spending and taxes are adjusted after the initial stimulus so as to stabilize debt, can actually undermine the ranking according to the conventional wisdom. The transmission mechanism for the case of a float is analyzed in detail by Corsetti, Meier, and Müller (2009), who show that, everything else equal, the long-term real interest rate tends to fall if agents anticipate a contraction in government spending in the near future, boosting private and thus aggregate demand. A specific contribution of this paper is to show that a fall in long real rates in response to a fiscal expansion is not possible under a peg, whether or not agents anticipate spending cuts in the medium term.

We provide a simple analytical characterization of the initial effect of temporary shocks (including fiscal ones) on the long-term rate under an exchange rate peg. Namely, assuming complete financial markets and additively separable utility, we show that under a peg the long-term real rate moves one-to-one with the initial (unexpected) change in the consumer price index (CPI) up to a first-order approximation. In other words, the initial bout of inflation in response to a fiscal expansion approximates the rise in long-term real rates on impact. In turn, this rise in long-term real rates drives down consumption demand proportionately.[2] The crowding out of consumption thus reduces the multiplier. Different outcomes, instead, are possible under a float, depending on the interaction of monetary and fiscal policy in the medium run.

A corollary of our analysis is that under a peg, short-term real rates and long-term real rates comove negatively in response to a fiscal shock: the latter necessarily rise on impact, even if the former fall one-to-one with the inflation rate. This characterization of the transmission mechanism casts doubts on the argument underlying the so-called Walters critique.[3] According to this critique, under a fixed exchange rate regime, exogenous cyclical shocks (including fiscal shocks) that cause inflation are bound to be amplified by the implied endogenous procyclical movements in the real interest rate. A fixed exchange rate regime is therefore inherently destabilizing. This argument relies on the maintained (but incorrect) assumption that real rates necessarily move in the same direction over the whole maturity structure.

We carry out a robustness analysis by enriching the baseline New Keynesian small open economy framework with features capturing financial imperfections and frictions. After establishing that our main conclusions hold under incomplete financial markets, we study the case of economies with limited asset market participation—a fraction of households are excluded from financial markets, possibly because of (nonmodeled) access costs. Fiscal stabilization is typically motivated by pointing out that a significant fraction of households may face financial constraints, making monetary policy less potent. We show that our main results carry over to this environment, where fiscal policy becomes more effective overall.

Our results provide a fresh perspective on the relative merits of fiscal policy as a stabilization tool under fixed and floating exchange rates, as well as a rationale for why fiscal policy is used as an actual stabilization tool under both exchange rate regimes. For analytical purposes, we focus on the transmission of exogenous innovations in government spending, but our results also shed light on how an endogenous policy response to shocks is likely to affect the economy under a peg or float. Specifically, to the extent that variations in

2. The constant of proportionality depends on the curvature of the utility function. While this condition does not hold exactly if markets are incomplete or if preferences are not additively separable, the main insight of a positive relation between initial unexpected inflation and the movement in the long-term rate remains valid in more general model specifications.

3. See Newman, Milgate, and Eatwell (1992); Buiter, Corsetti, and Pesenti (1998).

government spending in response to shocks are partly reversed in the future, they are likely to be at least as effective a stabilization tool under floating as under fixed exchange rates.

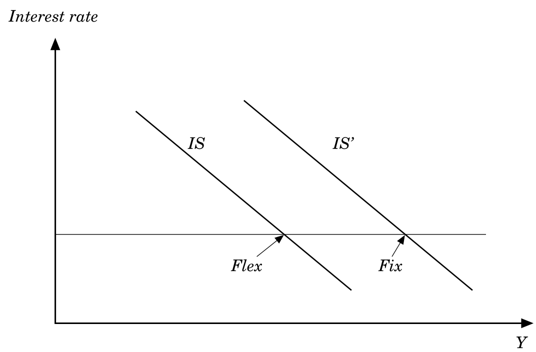
This paper is organized as follows. section 1 reviews the conventional wisdom based on the traditional Mundell-Fleming model. section 2 presents our New Keynesian model of a small open economy, and section 3 provides a brief overview of the linearized equilibrium conditions. section 4 then reconsiders the conventional wisdom in the New Keynesian framework, focusing on the special case of an exogenous autoregressive fiscal disturbance. section 5 derives analytical results regarding the fiscal transmission mechanism. section 6 carries out experiments for a general specification of fiscal policy with endogenous correction of both taxes and spending. section 7 explores the robustness of our results in the presence of financial frictions, and section 8 concludes.

1. The Conventional Wisdom

The conventional wisdom typically refers to the textbook version of the Mundell-Fleming model, as illustrated graphically by figure 1. Aggregate demand, Y, is measured on the horizontal axis, and the nominal interest rate is measured on the vertical axis. The downward sloping line is the IS curve, derived from the equilibrium condition that investment equals savings, with output expresssed as a declining function of the interest rate. The position of the IS curve depends on the level of the exchange rate: with preset prices, a nominal depreciation (which in this case is the same as a real depreciation) moves the IS to the right, through a positive competitiveness effect on real exports. In the background of this curve, the exchange rate is determined by the uncovered interest parity condition, so that a fixed exchange rate requires equality between the domestic and foreign interest rates in nominal terms. Under a floating rate, one needs to make an assumption about agents' expectations of future exchange rates. Without loss of generality, for our purpose it is analytically convenient to assume that the exchange rate follows a random walk.[4] Money demand is a positive function of output and a negative function of the nominal interest rate.

4. Many textbook models assume stationary expectations instead: the exchange rate in the future is expected to revert to some given value.

Figure 1. Expansion of Government Spending in Textbook Mundell-Fleming Model



Source: Authors' construction.

In a small open economy (in which foreign interest rate and prices are given), a spending expansion has a large multiplier effect on output under fixed exchange rates, while it just crowds out net exports one to one under flexible exchange rates. The reason for these differential results is a different degree of monetary accommodation across the two regimes. Under a peg, the central bank is committed to stemming any change in the demand for money that may compromise the sustainability of the official exchange rate parity. Hence, there must be full monetary accommodation. If government interventions drive up employment and income, households and firms raise their demand for cash, and the central bank has to raise its money supply by the same amount. Otherwise, the interest rate would rise, and a higher interest rate would tend to make the currency appreciate (via the uncovered interest parity condition). This implies a multiplier larger than one for the case of a peg.

Under a flexible rate regime, the central bank is not committed to any particular exchange rate parity. If a spending expansion were successful in raising employment, incomes, and the demand for money, there would be an upward pressure on interest rates that would in turn make the currency appreciate. A stronger currency reduces aggregate demand and income by crowding out net exports, which then counteracts the effects of the initial stimulus on interest rates. Since in equilibrium there cannot be any upward pressure on the interest rate or the exchange rate, on impact the latter must appreciate by enough to rule out any change in the level of aggregate demand, output, and money demand. A government expansion therefore results exclusively in nominal and real appreciation and a different composition of final demand, with more public demand and fewer exports.[5]

Such sharp results are sensitive to the parameterization of expectations. Assuming a stationary exchange rate, for instance, the impact appreciation of the exchange rate under a floating regime would create expectations of depreciation in the future. In equilibrium, the domestic interest rate would rise above the foreign rate, with crowding out effects on domestic investment. The substance of the above analysis would not be affected, but there would be some response in equilibrium policy rates and the composition of final demand, whereby more government spending would imply both lower net exports and lower investment. A further observation is that when we include price dynamics in the model, the inflationary consequences of a spending expansion should be more pronounced under a fixed exchange rate.

The presumption that the degree of monetary accommodation is necessarily higher under a peg is nonetheless controversial, even in the traditional literature. Implicit in the analysis by Dornbusch (1980), for instance, is the notion that, in practice, monetary accommodation tends to be quite pronounced under a floating regime—a position motivated by the empirical observation that the nominal exchange rate tends to depreciate with fiscal expansions.[6]

2. A Small Open Economy Model

This section outlines a New Keynesian small open economy model similar to Galí and Monacelli (2005) and Ghironi (2000). Our exposition follows Corsetti, Meier, and Müller (2009), except that, for clarity of exposition, we assume complete international financial markets in the baseline scenario. In a later section, we consider alternative assumptions regarding the set of internationally traded

5. In this simple exercise, monetary accommodation works through changes in the money supply, while the interest rate actually remains constant in both regimes. The analysis of the flexible exchange rate regime is indeed typically carried out under the assumption of a constant money supply.

6. See Corsetti, Meier, and Müller (2010) for recent evidence.

assets and the fraction of households that participate in domestic asset markets. Our exposition focuses on the domestic economy and its interaction with the rest of the world.[7]

2.1 Final-Good Firms

The final consumption good, C_t, is a composite of intermediate goods produced by a continuum of monopolistically competitive firms both at home and abroad. We use $j \in [0,1]$ to index intermediate-good firms and their products and prices. Final-good firms operate under perfect competition and purchase domestically produced intermediate goods, $Y_{H,t}(j)$, as well as imported intermediate goods, $Y_{F,t}(j)$. Final-good firms minimize expenditures subject to the following aggregation technology:

$$C_t = \left\langle (1-\omega)^{\frac{1}{\sigma}} \left\{ \left[\int_0^1 Y_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}} \right\}^{\frac{\sigma-1}{\sigma}} + \omega^{\frac{1}{\sigma}} \left\{ \left[\int_0^1 Y_{F,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj \right]^{\frac{\varepsilon}{\varepsilon-1}} \right\}^{\frac{\sigma-1}{\sigma}} \right\rangle^{\frac{\sigma}{\sigma-1}}, \quad (1)$$

where σ measures the trade-price elasticity, that is, the extent of substitution between domestically produced goods and imports for a given change in the terms of trade. The parameter $\varepsilon > 1$ measures the price elasticity across intermediate goods produced within the same country, while ω measures the weight of imports in the production of final consumption goods, where a value lower than one-half corresponds to home bias in consumption.

Expenditure minimization implies the following price indexes for domestically produced intermediate goods and imported intermediate goods, respectively:

$$P_{H,t} = \left[\int_0^1 P_{H,t}(j)^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}};$$
$$P_{F,t} = \left[\int_0^1 P_{F,t}(j)^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}}. \quad (2)$$

7. Our small open economy can be interpreted as the limiting case, within a two-country world, of an economy that has a relative size of zero; see De Paoli (2009).

By the same token, the consumption price index is

$$P_t = \left[(1-\omega)P_{H,t}^{1-\sigma} + \omega P_{F,t}^{1-\sigma}\right]^{\frac{1}{1-\sigma}}. \tag{3}$$

Regarding the rest of the world, we assume an isomorphic aggregation technology. The law of one price is assumed to hold at the level of intermediate goods, such that

$$P_{F,t}\mathrm{NER}_t = P_t^*, \tag{4}$$

where NER_t is the nominal exchange rate (the price of domestic currency in terms of foreign currency) and P_t^* denotes the price index of imports measured in foreign currency. It corresponds to the foreign price level, as imports account for a negligible fraction of rest-of-world consumption. For future reference, we define the terms of trade and the real exchange rate as

$$S_t = \frac{P_{H,t}}{P_{F,t}} \tag{5}$$

and

$$Q_t = \frac{P_t \mathrm{NER}_t}{P_t^*},$$

respectively. While the law of one price holds throughout, deviations from purchasing power parity (PPP) are possible in the short run, due to home bias in consumption. Below we consider the dynamics of the model around a symmetric steady state such that PPP holds in the long run.

2.2 Intermediate-Good Firms

Intermediate goods are produced on the basis of the following production function: $Y_t(j) = H_t(j)$, where $H_t(j)$ measures the amount of labor employed by firm j.

Intermediate-good firms operate under imperfect competition. We assume that price setting is constrained exogenously by a discrete-time version of the mechanism suggested by Calvo (1983). Each firm has the opportunity to change its price with a given probability $1 - \xi$. Given this possibility, a generic firm j will set $P_{H,t}(j)$ in order to solve

$$\max E_t \sum_{k=0}^{\infty} \xi^k \rho_{t,t+k} \left[Y_{t,t+k}(j) P_{H,t}(j) - W_{t+k} H_{t+k}(j) \right], \tag{6}$$

where $\rho_{t,t+k}$ denotes the stochastic discount factor and $Y_{t,t+k}(j)$ denotes demand in period $t + k$, given that prices have been set optimally in period t. E_t denotes the expectations operator.

2.3 Households

For our baseline scenario, we assume that there is a representative household that ranks sequences of consumption and labor effort, $H_t = \int_0^1 H_t(j)dj$, according to the following criterion:

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{C_{t+k}^{1-\gamma}}{1-\gamma} - \frac{H_{t+k}^{1-\varphi}}{1-\varphi} \right). \tag{7}$$

We assume that the household trades a complete set of state-contingent securities with the rest of the world. Letting Ξ_{t+1} denote the payoff in units of domestic currency in period $t + 1$ to the portfolio held at the end of period t, the household's budget constraint is given by

$$W_t H_t + \Upsilon_t - T_t - P_t C_t = E_t \left(\rho_{t,t+1} \Xi_{t+1} \right) - \Xi_t \tag{8}$$

where T_t and Υ_t denote lump-sum taxes and profits of intermediate-good firms, respectively.

2.4 Monetary and Fiscal Policy

The specification of monetary policy depends on the exchange rate regime. Under flexible exchange rates, we assume that the central bank sets the nominal short-term interest rate following a Taylor-type rule:

$$\log(R_t) = \log(R_t) + \phi_\pi (\Pi_{H,t} - \Pi_H), \tag{9}$$

where $\Pi_{H,t} = P_{H,t} / P_{H,t-1}$ measures domestic inflation and variables without a time subscript refer to the steady-state value of a variable (here as well as in the following equations). In this case, the nominal exchange rate is free to adjust in accordance with the equilibrium conditions implied by the model. Several monetary regimes are possible under a float, and the specification of monetary policy is key for our comparison of fiscal policy transmission under pegs and floats.

Under an exchange rate peg, the monetary authorities are required to adjust the policy rate so that the exchange rate remains constant at its steady-state level. A feasible policy that ensures this, as well as equilibrium determinacy, is given by

$$\log(R_t) = \log(R_t^*) + \phi_{\text{NER}} \log\left(\frac{\text{NER}_t}{\text{NER}}\right), \tag{10}$$

with $\phi_{\text{NER}} > 0$.[8]

With regard to fiscal and budget policy, we assume that government spending falls on an aggregate of domestic intermediate goods only:

$$G_t = \left[\int_0^1 Y_{H,t}(j)^{\frac{\varepsilon-1}{\varepsilon}} dj\right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{11}$$

We also posit that intermediate goods are assembled so as to minimize costs. The price index for government spending is thus given by $P_{H,t}$. Government spending is financed either through lump sum taxes, T_t, or through the issuance of nominal one-period debt, D_t. The government's period budget constraint reads as follows:

$$R_t^{-1} D_{t+1} = D_t + P_{H,t} G_t - T_t. \tag{12}$$

Defining $D_t^r = D_t / P_{t-1}$ as a measure for real, beginning-of-period, debt and $T_t^r = T_t / P_t$ as taxes in real terms, we posit that fiscal policy is described by the following feedback rules from debt accumulation to the level of spending and taxes:

$$G_t = (1-\rho)G + \rho G_{t-1} - \psi_G D_{Rt} + \varepsilon_t, T_{Rt} = \psi_T D_{Rt}, \tag{13}$$

8. See Ghironi (2000) and Benigno, Benigno, and Ghironi (2007).

where ε_t measures an exogenous, independent and identically distributed (i.i.d.) shock to government spending. The ψ parameters capture the responsiveness of spending and taxes to government spending and debt. Standard analyses of the fiscal transmission typically assume that $\psi_G = 0$. When taxes are lump-sum, Ricardian equivalence obtains in this case, as the path of government spending is exogenously given, and the time path of debt and taxes becomes irrelevant for the real allocation. Compared with this benchmark, allowing for $\psi_G > 0$ fundamentally alters the fiscal transmission mechanism; see Corsetti, Meier, and Müller (2009). For once, strictly speaking, Ricardian equivalence fails in this case, even when taxes are lump sum. A debt-financed cut in taxes dynamically leads to an adjustment in real spending, which affects the real allocation. Moreover, the time profile of adjustment affects the intertemporal price of consumption, with sharp implications for macroeconomic dynamics. Below we analyze the fiscal transmission mechanism in light of these considerations, contrasting results under a floating exchange rate regime with those obtained under a pegged exchange rate regime.

2.5 Equilibrium

Equilibrium requires that firms and households behave optimally for given initial conditions, exogenously given developments in the rest of the world, and government policies. Market-clearing conditions also need to be satisfied. At the level of each intermediate good, supply must equal total demand stemming from final-good firms, the rest of the world, and the government:

$$Y_t(j) = \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\varepsilon} \left[(1-\omega)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \omega\left(\frac{P^*_{H,t}}{P_t}\right)^{-\sigma} C^*_t + G_t\right], \tag{14}$$

where $P^*_{H,t}$ and C^*_t denote the price index of domestic goods expressed in foreign currency and rest-of-world consumption, respectively. It is convenient to define an index for aggregate domestic output:

$$Y_t = \left[\int_0^1 Y_t^{\frac{\varepsilon-1}{\varepsilon}}(j)dj\right]^{\frac{\varepsilon}{\varepsilon-1}}.$$

Substituting for $Y_t(j)$ using equation (14) gives the aggregate relationship,

$$Y_t = (1-\omega)\left(\frac{P_{H,t}}{P_t}\right)^{-\sigma} C_t + \omega\left(\frac{P^*_{H,t}}{P^*_t}\right)^{-\sigma} C^*_t + G_t. \tag{15}$$

We also define the trade balance in terms of steady-state output:

$$TB_t = \frac{1}{Y}\left(Y_t - \frac{P_t}{P_{H,t}} C_t - G_t\right). \tag{16}$$

In what follows, we consider a first-order approximation of the equilibrium conditions of the model around a deterministic steady state with balanced trade, zero debt, zero inflation, and purchasing power parity. Further, we consider only shocks that originate in the domestic economy and thus do not affect the rest of the world.

3. Linearized Equilibrium Conditions

This section presents a set of equilibrium conditions that can be used to approximate the equilibrium allocation in response to government spending shocks in the neighborhood of the steady state. Lowercase letters indicate percentage deviations from steady state, while a hat indicates that such deviations are measured in percent of steady-state output. Details of the derivation can be found in appendixes A and B. Under a float and for an exogenously given path of government spending, three equations are sufficient to characterize the equilibrium: a dynamic IS equation, the New Keynesian Phillips curve, and a characterization of monetary policy.[9] A three-equation representation of the equilibrium is not possible, however, for a richer specification of fiscal policy featuring an endogenous feedback effect from debt to spending or in case of an exchange rate peg.

9. This is often referred to as the canonical representation of the New Keynesian model (see, for example, Galí and Monacelli, 2005). Our representation differs from Galí and Monacelli (2005) because they abstract from government spending. We prefer to represent the canonical form using output, rather than the output gap, in view of the fact that changes in government spending also alter the natural level of output. Galí and Monacelli (2008) consider a very similar setup, but focus on the special case in which the intertemporal elasticity of substitution and the trade price elasticity are equal to one.

The dynamic IS equation is given by:

$$y_t = Ey_{t+1} - \frac{(1-\chi)^{\bar{\varpi}}}{\gamma}(r_t - E_t\pi_{H,t+1}) - E_t\Delta\hat{g}_{t+1}, \tag{17}$$

where $\pi_{H,t}$ denotes domestic (producer price) inflation, $\hat{g}_t$ denotes the deviation of government spending from steady state measured in percent of steady-state output, χ measures the government spending-to-output ratio in the steady state, and

$\overline{\omega} = 1 + \omega(2-\omega)\,(\sigma\gamma-1).$

The open-economy New Keynesian Phillips curve is given by

$$\pi_{H,t} = \beta E_t\pi_{H,t+1} + \kappa\left[\varphi + \frac{\gamma}{(1-\chi)\varpi}\right]y_t - \kappa\frac{\gamma}{(1-\chi)\varpi}\hat{g}_t, \tag{18}$$

where $\kappa = (1-\beta\xi)(1-\xi)/\xi$.

Either monetary policy is characterized by an interest rate feedback rule (in which case the nominal exchange rate is free to adjust), or monetary authorities adjust the policy rate so as to peg the exchange rate to its steady-state level. Formally, we have

$$r_t = \phi_\pi\pi_{H,} \tag{19}$$

or

$$r_t = \phi_{NER}\mathrm{NER}_t.$$

Variables pertaining to the rest of the world are zero in terms of deviations from the steady state, as we only consider shocks in the domestic economy.

The evolution of public debt, government spending, and taxes is given by

$$\beta\hat{d}^r_{t+1} = \hat{d}^r_t + \chi\omega s_t + \hat{g}_t - \hat{t}^r_t \tag{20}$$

$$\hat{g}_t = \rho\hat{g}_{t-1} - \psi_G\hat{d}^r_t + \varepsilon_t, \tag{21}$$

and

$$\hat{t}_t^r = \psi_T \hat{d}_t^r. \tag{22}$$

To fully specify the equilibrium dynamics, we relate the nominal exchange rate to the dynamics of output and inflation as follows. The definition of the terms of trade, $s_t = p_{H,t} - p_{F,t}$, and the law of one price imply

$$s_t = p_{H,t} + \text{NER}_t. \tag{23}$$

Using the good-market-clearing condition and the risk-sharing condition, we can express the terms of trade in terms of output net of government spending:

$$\frac{1-\chi}{\gamma}\varpi s_t = -(y_t - \hat{g}_t). \tag{24}$$

Given initial conditions and a sequence for innovations to government spending, $\{\varepsilon_t\}_{t=0}^{\infty}$, equations (17) to (24) pin down a sequence for nine variables, $\{y_t, \pi_{H,t}, p_{H,t}, \hat{g}_t, e_t, s_t, \hat{t}_t^r, d_{t+1}\}_{t=0}^{\infty}$, where $\pi_{H,t} = p_{H,t} - p_{H,t-1}$.

4. Revisiting the Conventional Wisdom: Exchange Rate Regime and Monetary Accommodation

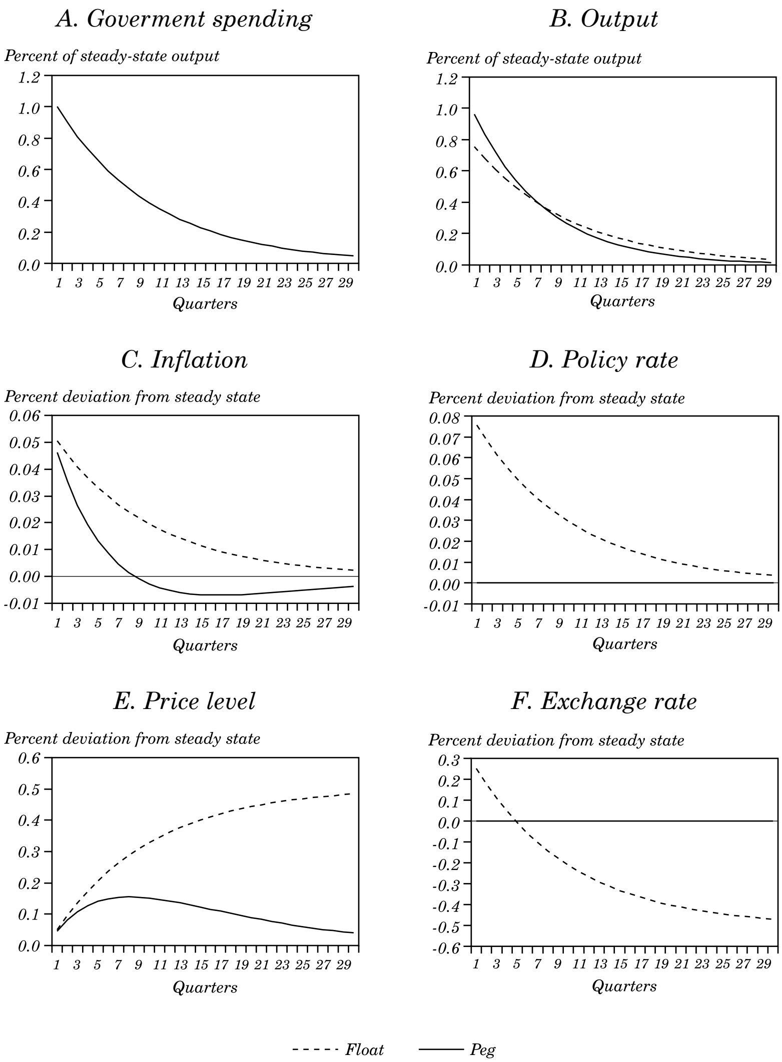
Theoretical studies of the macroeconomic effects of fiscal policy typically assume that government spending follows an exogenously given first-order autoregressive, or AR(1), process. In our framework, this assumption corresponds to the case of no feedback from debt accumulation to spending, $\psi_G = 0$, which, as mentioned, implies Ricardian equivalence. While restrictive, this conventional parameterization provides a useful starting point for our analysis. Specifically, we take up the issue of how and why the exchange rate regime may alter the transmission of an autoregressive spending shock matched by higher lump-sum taxes. We use model simulations to show that under standard assumptions on parameter values, this basic exercise supports a particular aspect of the conventional wisdom, namely, that fiscal policy is more effective in stimulating economic activity under fixed exchange rates than under floating exchange rates (in which the central bank follows a Taylor rule).

For our numerical experiments, we adopt the following parameter values. A period in the model corresponds to one quarter. The discount factor, β, is set to 0.99. We assume that the coefficient of relative risk aversion, γ, and the inverse of the Frisch elasticity of labor supply, φ, take the value of one. The trade price elasticity, σ, is also set equal to unity. Regarding openness, we assume $\omega = 0.3$. As price rigidities are bound to play an important role in the transmission of government spending shocks, we assume a fairly flat Phillips curve by setting $\xi = 0.9$, a value that implies an average price duration of 10 quarters. This parameterization conflicts with evidence from microeconomic studies such as Nakamura and Steinsson (2008). Nonetheless, the choice of a relatively high degree of price rigidity seems appropriate in the context of our framework, since we abstract from several model features that would imply a flatter Philips curve for any given value of ξ (for example, nonconstant returns to scale in the variable factor of production or nonconstant elasticities of demand).[10] We also abstract from wage rigidities. We set $\varepsilon = 11$, such that the steady-state markup is equal to 10 percent. In specifying monetary policy, we set $\phi_\pi = 1.5$. As discussed below, this parameter plays a central role in the transmission of fiscal shocks. Finally, the average share of government spending in GDP is set to 20 percent, and we assume that the persistence of government spending is $\rho = 0.9$.

Figure 2 displays the impulse response to an exogenous increase in government spending by 1 percent of GDP, for two economies that are identical in all respects except for the exchange rate (and thus the monetary) regime. The responses of output and government spending are measured in percent of steady-state output. The responses of the other variables are measured in percentage deviations from steady state. The horizontal axes indicate quarters. The solid line refers to the exchange rate peg, while a dashed line marks the floating regime. The AR(1) process of government spending, identical across exchange rate regimes, is shown in panel A.

10. See Galí, Gertler, and López-Salido (2001) or Eichenbaum and Fisher (2007) for further discussion of how real rigidities interact with nominal price rigidities in the context of the New Keynesian model. The latter study also considers a nonconstant price elasticity of demand, which further increases the degree of real rigidities.

Figure 2. Effect of a Government Spending Shock: Peg versus Float[a]



Source: Authors' construction.
a. Floating exchange rates with $\phi_\pi = 1.5$. Inflation and price level pertain to the price of domestically produced goods.

A first notable result is that, in both regimes, the response of output (panel B) is positive, but smaller than unity throughout. This is quite different from the Mundell-Fleming model for a small open economy with perfect capital mobility, which predicts that government spending multipliers on output should be larger than one under a peg and zero under a float. Our results do agree with the conventional theory in relative terms: in response to a positive (autoregressive) fiscal shock, GDP under the peg exceeds that under the float by approximately 25 percent on impact, and the response of GDP remains stronger under the peg for the first couple of quarters after the initial impulse.

Further notable results shown in figure 2 concern the response of inflation and the price level. On impact, the response of domestic inflation (panel C) is positive irrespective of the exchange rate regime. Over time, however, inflation follows divergent paths. Under a peg, inflation falls below its steady-state value after about two years, whereas it remains positive throughout under a float. This has direct implications for the policy rate. Under a float, the Taylor rule implies that the policy rate rises sharply on impact and only gradually reverts to its steady-state level. In nominal terms, the policy rate under a float thus remains above the constant nominal rate, dictated by the need to maintain the peg. Moreover, as the Taylor principle is satisfied under a float, real short-term interest rates (not shown) rise above steady-state levels throughout the expansionary fiscal stance, such that the long-term real interest rate rises as well.

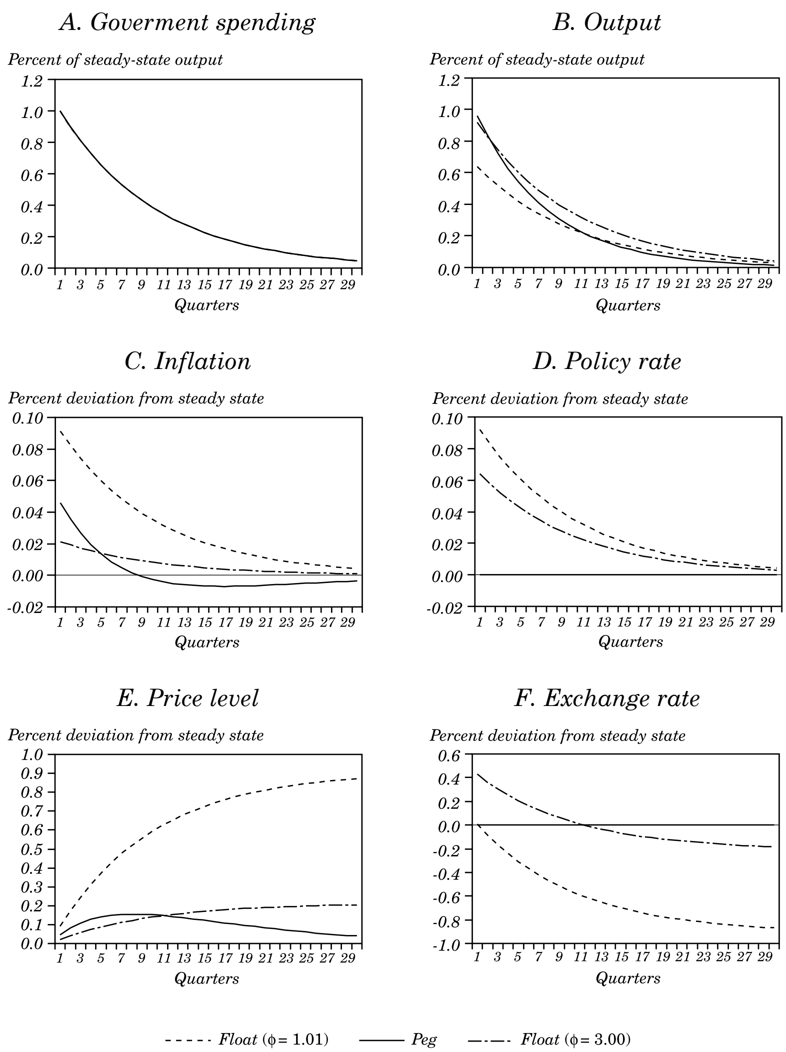
The differential behavior of inflation also maps into an apparent long-run divergence in the price level for domestically produced goods ($p_{H,t}$) and thus in the nominal exchange rate. With the central bank following a Taylor rule under a float, monetary authorities adjust the policy rate in response to the growth rate of prices, and nominal prices drift to a permanently higher level. Since purchasing power parity (PPP) must be satisfied in the long-run, the nominal exchange rate depreciates proportionally over time. Thus, both the level of domestic prices and the nominal exchange rate display a unit root behavior under a float.

When the exchange rate remains (credibly) pegged to its initial level, long-run PPP requires domestic prices to revert to their initial steady-state level. Inflation must therefore fall below its steady-state rate after the initial positive bout. In the short run, firms respond to the additional demand from the government by raising prices, which makes them less competitive in the world market. As government spending progressively reverts to its initial level, domestic firms need to regain competitiveness: they reoptimize prices by setting lower prices as government demand falls.

In figure 2, government spending is exogenously determined and identical across exchange rate regimes, so larger output effects under a peg reflect a relatively more accommodative monetary policy, as maintained by conventional wisdom. Given the role that monetary accommodation plays in the transmission mechanism, our results are somewhat sensitive to the parameterization of the monetary policy rule under a float, a point illustrated by figure 3. In this figure, we contrast results for high and low values of the coefficient ϕ_π. With a coefficient as high as $\phi_\pi = 3.00$, implying that the central bank targets near price stability, the impact multiplier is about 0.6, which is more in line with the traditional Mundell-Fleming view of relatively weak output effects of government spending under a float. Conversely, a lower coefficient of $\phi_\pi = 1.01$, indexing a mild reactivity of the central bank to current inflation, yields very similar impact multipliers under a float and under a peg (and cumulative multipliers, obtained by summing up the output effects over time, are actually larger).

In light of the above results, we can rephrase the key lesson from the conventional wisdom: since the effectiveness of fiscal policy depends on the degree of monetary accommodation, comparing fiscal transmission across exchange rate regimes requires a precise specification of how monetary policy is and will be conducted. The New Keynesian model provides a clear and transparent framework for accomplishing this.

Figure 3. Effect of a Government Spending Shock for alternative values of ϕ_π: Peg versus Float



Source: Authors' construction.

5. Inspecting the Role of Long-Term Real Interest Rates

To analyze more closely how the transmission of fiscal shocks is bound to depend on the interaction of fiscal and monetary policy over different time horizons, we now turn to a simple analytical characterization of fiscal transmission under a float (cum Taylor rule) and under a peg. The main insight is that fiscal policy cannot be modeled without specifying a medium- and long-term policy framework. Relative to the Mundell-Fleming world, New Keynesian analysis provides a more suitable framework for this purpose, as it assigns a much greater role to optimal intertemporal allocation by households in response to changes in relative prices and, most notably, to the path of real interest rates.

In the baseline New Keynesian model, the optimal path of consumption is characterized by the consumption Euler equation. We use a linearized version of the model (see appendix A) and solve forward, which yields

$$c_t = \frac{1}{\gamma} E_t \underbrace{\sum_{s=0}^{\infty} (r_{t+s} - \pi_{t+1+s})}_{\equiv \bar{r}_t}, \tag{25}$$

where we have used the fact that the economy is stationary and thus always reverts to the steady state (that is, $\lim_{s \to \infty} C_{t+s} = 0$). Equation (25) shows that in terms of deviations from the steady state, current consumption is determined by expectations over the entire path of future ex ante real interest rates. Since the expectation hypothesis holds in the model, the latter can be interpreted as a measure of the real return on a bond of infinite duration, that is, as a measure of the long-term real interest rate.[11]

The long-term real rate synthesizes fiscal and monetary interactions across all time horizons, in response to fiscal and other shocks (see Corsetti, Meier, and Müller, 2009). As mentioned, under a float, monetary policy is not constrained by the need to bring the

11. The long-term real interest rate is also tightly linked to the real exchange rate, via risk sharing: $-\gamma c_t = q_t = \bar{r}_t$ (see appendix A). Movements in the long-term interest rate may thus simultaneously rationalize changes in consumption and the real exchange rate. Specifically, Corsetti, Meier, and Müller (2009) discuss how the expected path of future government spending alters the behavior of long-term real interest rates and the short-run adjustment to an exogenous innovation in government spending.

price level back to its initial steady-state level in the long run. With a Taylor rule in place, the monetary stance in response to a fiscal expansion is contractionary in both the short and long runs, to a degree that depends on the parameterization of coefficient ϕ_π. The increase in spending causes inflation to remain persistently positive, so short-term rates are expected to remain above or at their steady-state value over time; this implies a rise in long rates on impact. In appendix C we show formally that under a float, long-term rates always increase for plausible parameter values, as long as $\psi_G = 0$.

Consider now the case of a currency peg. As shown in figure 2, monetary policy appears to be more accommodative in the short run under a peg, since in real terms short-term interest rates fall one-to-one with the rise in inflation. Short real rates rise in the medium and long runs, however, when, for an unchanged nominal exchange rate, purchasing power parity drives inflation into negative territory (in deviations from the steady state). Given the dynamics of inflation displayed in figure 2, for instance, real short-term rates initially fall below steady state, but become positive after about eight quarters.

This observation raises the issue of determining in which direction the long-term rate moves on impact. A simple analytical insight on this question can be derived using our simplifying assumptions (namely, a small open economy and constant foreign variables). Recall that under complete financial markets, the economy is stationary and always reverts to the steady state after a temporary increase in domestic government spending. As PPP holds in the long run, $\lim_{t\to\infty} P_t = P^*$ under an exchange rate peg: in the long run, the domestic price level is pinned down by the foreign price level. It follows that

$$\sum\nolimits_{t=0}^{\infty} \pi_t = 0.$$

At the same time, the domestic interest rate is pegged to the foreign rate, the latter being constant by assumption. Therefore,

$$\bar{r}_t = \underbrace{\left(-\sum_{t=0}^{\infty} \pi_{t+1}\right) - \pi_0}_{=0} + \pi_0 = \pi_0.$$

Hence, the response of the real long-term interest rate on impact is equal to the initial, unanticipated change in CPI inflation (and the future evolution of inflation is not relevant). Since the initial effect of an increase in government spending on inflation is positive, the long-term rate increases, and consumption cannot but decline. Moreover, a positive differential between domestic and foreign long-term real rates causes the exchange rate to appreciate in real terms.

The above result has a number of implications for the literature on macroeconomic adjustment and stabilization policy under a fixed exchange rate regime. A point in case concerns the so-called Walters critique. This starts from the observation that, holding the nominal interest rate constant, the inflationary effects of a positive demand shock translate into a fall in the short-term real interest rate. The endogenous movement in the real interest rate is expansionary, according to this argument: it boosts demand further, rather than stabilizing it. In its extreme form, the Walters critique states that a small open economy pursuing a currency peg or participating in a currency union becomes unstable, since shocks are amplified by procyclical movements in the monetary stance.

The traditional counterargument points out that with positive domestic inflation, rising prices would eventually crowd out exports, naturally stabilizing demand through the real exchange rate channel. The modern paradigm clarifies a deeper issue. As shown above, under a peg, the long-run real rates, which drive private demand, actually rise one-to-one with the initial bout of inflation. The short-run inflationary consequences of a positive demand shock simultaneously reduce short-term rates in real terms, but these are not directly relevant for private spending decisions.

A reference to the effects of rising prices on competitiveness is still appropriate in the modern framework: competitiveness is the economic force behind PPP. What the New Keynesian model emphasizes is that one cannot contrast the real exchange rate channel and the interest rate channel, treating them as independent of each other. In equilibrium, they both shape the intertemporal price relevant for private consumption and saving decisions.

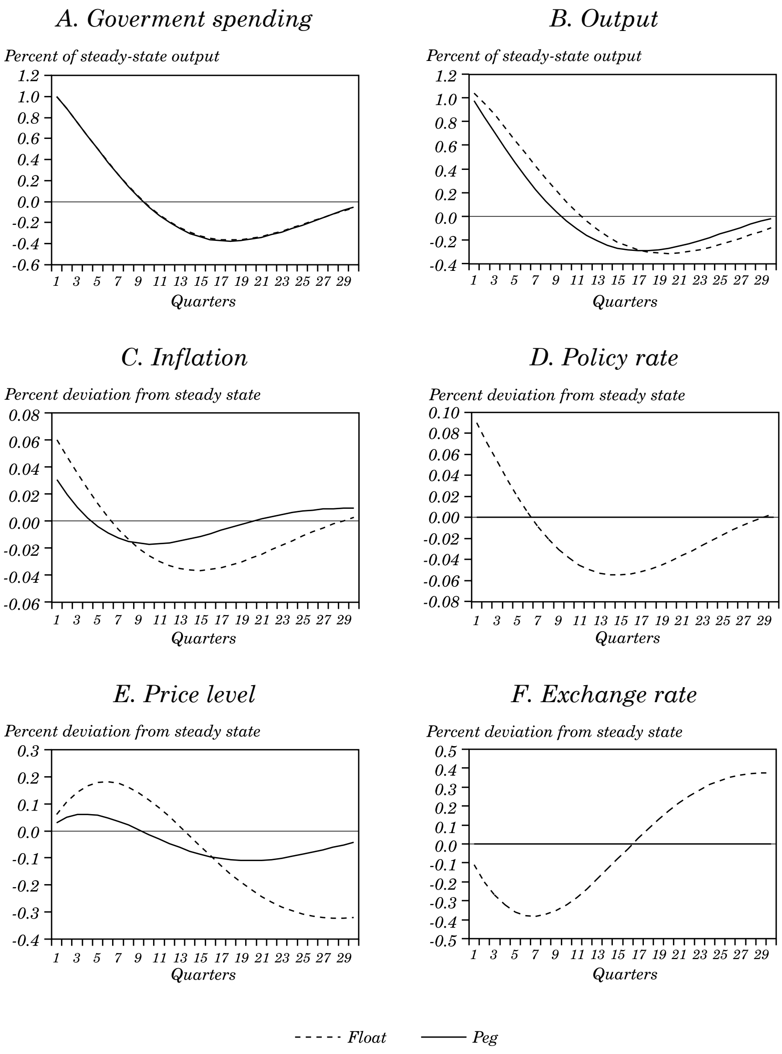
6. Overturning the Conventional Wisdom: The Medium-Term Fiscal Framework

The role of intertemporal prices in the transmission of fiscal policy heightens the importance of broadening the analysis to encompass general specifications of the medium-term framework—beyond the case of $\psi_G = 0$. To explore this new direction of the analysis, we draw on Corsetti, Meier, and Müller (2009) and contrast results for $\psi_G = 0$ and $\psi_G = 0.02$, while setting $\psi_T = 0.02$; compare equation (13). With a positive ψ_G, an expansion of government spending leads to an endogenous adjustment of spending over time. From a quantitative perspective, our assumptions imply that government spending is cut and taxes are increased, by 0.02 basis points for every 1 percent increase in government debt (all measured in units of steady-state output).

For economies with floating exchange rates, the relevance of debt stabilization for the effectiveness of fiscal stimulus cannot be overstated. Corsetti, Meier, and Müller (2009) analyze in detail the implications of endogenous dynamic spending cuts, dubbed spending reversals, and show that the spending multiplier on consumption may be positive on impact: consumption demand is actually crowded in, and the response of output is therefore larger. The transmission mechanism is analogous to the one discussed under the peg in the previous section. Following the same logic as before, we focus on the response of inflation. The inflation rate, which is positive in the short run, turns negative over time (relative to the steady state) in anticipation of spending cuts, and it thus falls even before these cuts are actually implemented. This is because, with sticky prices, forward-looking firms optimally adjust prices downward ahead of the fall in demand. Since lower inflation means lower policy rates relative to the case of $\psi_G = 0$, a spending expansion in the short run may actually be accompanied by a fall (not a rise) in the long-term interest rate, crowding in private demand and boosting output more than one for one on impact. The exchange rate therefore depreciates, instead of appreciating. This is consistent with a recent body of evidence for economies that have adopted floating exchange rates (see the discussion in Corsetti, Meier, and Müller, 2010).

The Corsetti, Meier, and Müller (2009) case of a spending reversal is especially relevant for present analysis because the consequences for the transmission mechanism differ sharply across exchange rate regimes. figure 4 reports impulse responses for the float and the peg to government spending shocks characterized by reversals (the endogenous behavior of spending over time is shown in panel A). The results contrast sharply with those shown in figure 2, computed in the absence of spending reversals. In particular, the output response, shown in panel B, is apparently at odds with the conventional wisdom: for the first two years, the output response is larger under a float than under a peg.

Figure 4. Effect of a Government Spending Shock with Spending Reversals: Peg versus Float



Source: Authors' construction.

While the regime of debt consolidation (with reversals) is quite consequential for the short-run output effects under a float, it plays no quantitatively important role under a peg. This is consistent with our analytical characterization of the transmission under a peg, according to which the long-term real rate always rises on impact with impact inflation—irrespective of the exact path of future short-term real rates and thus irrespective of the type and intensity of debt consolidation.

These results add an important dimension to the conventional wisdom on fiscal transmission across exchange rate regimes. Not only does the relative effectiveness of fiscal policy vary with the relative degree of monetary accommodation across regimes, but holding the degree of monetary accommodation constant, the ranking is also sensitive to the specification of the medium-term fiscal outlo

7. Robustness and Extensions: The Case of Incomplete Financial Markets

So far, we have developed our analysis under the assumption of complete financial markets. We now explore the extent to which our results are sensitive to financial frictions, using two alternative assumptions regarding the structure of financial markets. First, we relax the assumption that financial markets are complete at the international level and allow for trade in nominally noncontingent bonds only. Second, we assume that in addition, access to domestic financial markets is restricted. Specifically, only a subset of the population has access to asset markets, and households without access consume their disposable income in each period. That setup is similar to the closed-economy variants of Galí, López-Salido, and Vallés (2007) and Bilbiie, Meier, and Müller (2008).

7.1 Model Setup

Our model is amended by the assumption that out of a continuum of households in [0, 1] residing in our small open economy, a fraction $1 - \lambda$ are asset holders, indexed by a subscript A. These households own the firms and may trade one-period bonds both domestically and internationally. The remaining households (a fraction, λ, of the total) do not participate at all in asset markets, that is, they do not hold assets. They are indexed by a subscript N.

A representative asset-holding household chooses consumption, $C_{A,t}$, and supplies labor, $H_{A,t}$, to intermediate-good firms in order to maximize

$$E_t \sum_{k=0}^{\infty} \beta^k \left(\frac{C_{A,t+k}^{1-\gamma}}{1-\gamma} - \frac{H_{A,t+k}^{1-\varphi}}{1-\varphi} \right) \tag{26}$$

subject to the period budget constraint

$$R_t^{-1} A_{t+1} + \frac{R_{F,t}^{-1} B_{t+1}}{\text{NER}_t} + P_t C_{A,t} = A_t + \frac{B_t}{\text{NER}_t} + W_t H_{A,t} - T_t + \Upsilon_t \tag{27}$$

where A_t and B_t are one-period bonds denominated in domestic and foreign currency, respectively. R_t and $R_{F,t}$ denote the gross nominal interest rates on both bonds. Ponzi schemes are ruled out by assumption.

We assume that the interest rate paid or earned on foreign bonds by domestic households is determined by the exogenous world interest rate, R_t^*, plus a spread that decreases in the real value of bond holdings scaled by output, that is,

$$R_{F,t} = R_t^* - \alpha \frac{B_{t+1}}{\text{NER}_t Y_t P_t}. \tag{28}$$

This assumption ensures the stationarity of bond holdings (even for very small values of α) and thus allows us to study the behavior of the economy in the neighborhood of a deterministic steady state.[12]

A representative non-asset-holding household chooses consumption, $C_{N,t}$, and supplies labor, $H_{N,t}$, to intermediate-good firms in order to maximize its utility flow on a period-by-period basis. The objective is thus given by

12. Our particular specification draws on Kollman (2002), who studies a model similar to ours. Schmitt-Grohé and Uribe (2003) consider a real model of a small open economy and suggest the above mechanism of a debt-elastic interest rate as one of several ways to close small open economy models (that is, to induce stationarity) with incomplete markets.

$$\max \frac{C_{N,t}^{1-\gamma}}{1-\gamma} - \frac{H_{N,t}^{1+\varphi}}{1+\varphi}. \tag{29}$$

subject to the constraint that consumption expenditure equals net income:

$$P_t C_{N,t} = W_t H_{N,t} - T_t. \tag{30}$$

For non-asset-holding households, consumption equals disposable income in each period, and they are thus sometimes also referred to as hand-to-mouth consumers.

Aggregate consumption and labor supply are given by

$$\beta \hat{d}_{t+1}^{r} = \hat{d}_t^{r} + \chi\omega s_t + \hat{g}_t - \hat{t}_t^{r}. \tag{31}$$

and

$$H_t = \lambda H_{N,t} + (1-\lambda) H_{A,t} \tag{32}$$

where $H_t = \int_0^1 H_t(j)dj$ is aggregate labor employed by domestic intermediate-good firms.

Regarding asset markets, we assume that foreigners do not hold domestic bonds. Market clearing for domestic currency bonds therefore requires

$$(1-\lambda) A_t - D_t = 0 \tag{33}$$

The market for foreign currency bonds clears by Walras' law.

7.2 Transmission with Imperfect Risk Sharing

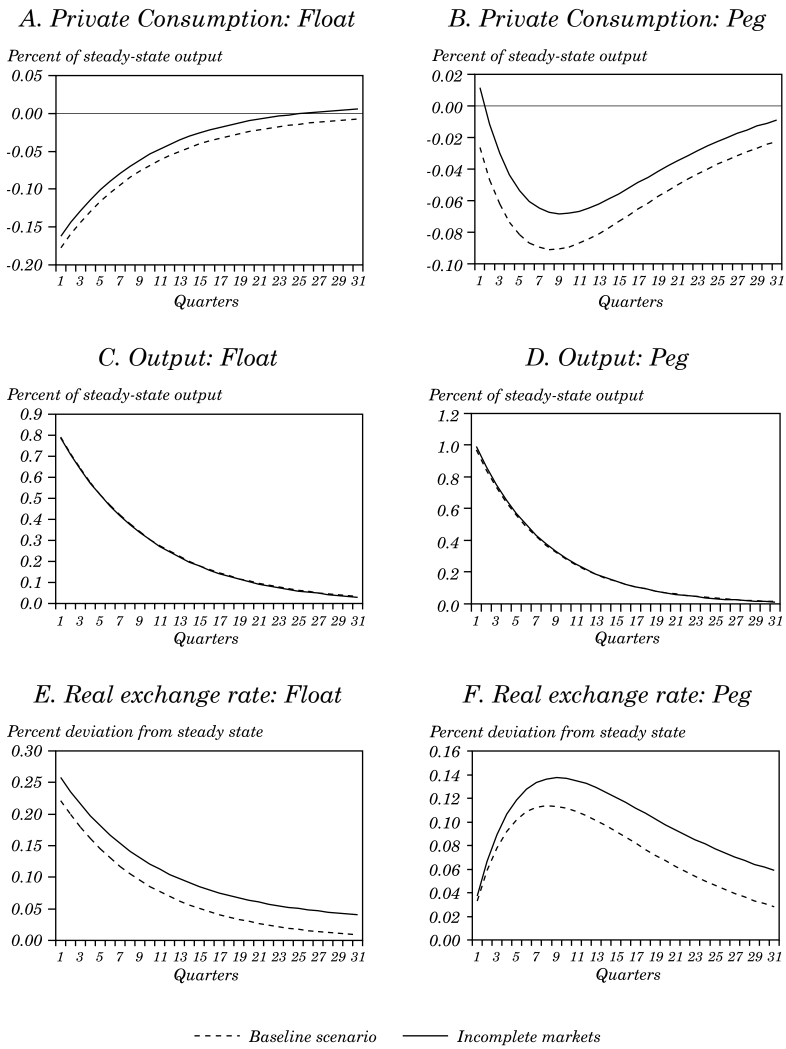
This section presents model simulations under either incomplete markets or both incomplete markets and limited market participation, as specified above. In appendix A, we provide a detailed list of the equilibrium conditions used in the simulations. We maintain the same parameter values as in section 4, except for the trade price elasticity σ. At a value of one for this elasticity (assumed above), relative prices move in such a way that they ensure complete risk sharing even under incomplete international asset markets (see Cole and Obstfeld, 1991). Since we are interested in the sensitivity of our results to environments with imperfect risk sharing, we set $\sigma = 2/3$, a value in the (admittedly wide) range considered in the recent macroeconomics literature.[13] For the sake of brevity, we focus only on the case of exogenous autoregressive spending shocks with $\psi_G = 0$ and do not examine the case of spending reversals here.

Figure 5 contrasts the results for the baseline scenario (complete financial markets) with those obtained under the assumption that international financial markets are incomplete. As before, we posit an exogenous increase in government spending by 1 percent of steady-state output (not shown). The response of consumption is somewhat higher with incomplete markets in both exchange rate regimes, corresponding to the different dynamics of long-term real interest rates. From a quantitative perspective, however, differences in the response of consumption and output are modest.[14]

13. See Corsetti, Dedola, and Leduc (2008) for further discussion.

14. This finding is in line with earlier research, which finds that the allocation under incomplete financial markets is quite close to the allocation under complete markets, unless the trade price elasticity is substantially different from one on either side and, for the case of a high elasticity, shocks are persistent or follow a diffusion process (see Corsetti, Dedola, and Leduc, 2008).

Figure 5. Effect of a Government Spending Shock under Complete and Incomplete International Financial Markets



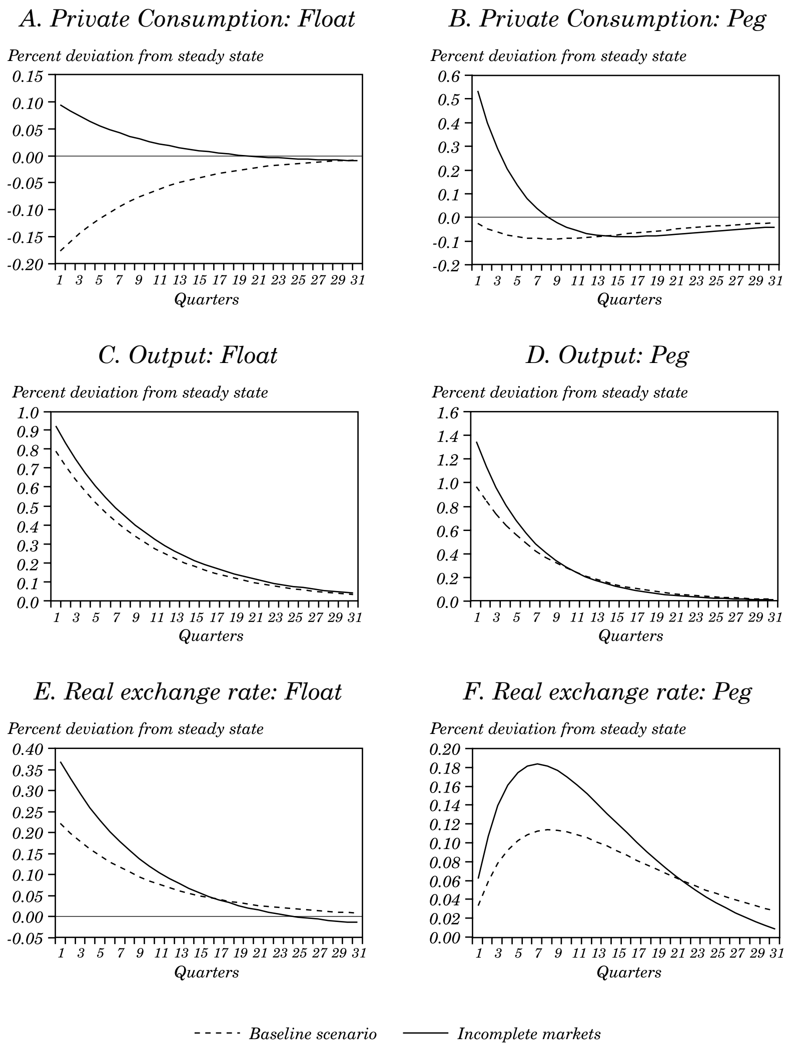
Source: Authors' construction.

7.3 Limited Asset-Market Participation

Figure 6 contrasts the results for the baseline scenario (complete financial markets) with the case of limited participation. In this case, we assume both that the set of assets traded across countries is restricted to trade in noncontingent bonds and that access to trade in bonds wthin a country is restricted, so that only a fraction $1 - \lambda$ has access. Specifically, we assume that $\lambda = 1/3$. We report the responses of consumption, long-term real interest rates, and output to an exogenous increase in government spending by 1 percent of GDP.

With limited asset market participation, the dynamic adjustment of consumption is quite different from our results in section 4. On impact, consumption now increases, both under the float and under the peg. Importantly, this occurs despite the fact that the response of long-term real rates is actually positive throughout. The reason is straightforward: in our specification, a considerable fraction of households do not have access to asset markets. Their consumption is a function of current income and not directly linked to changes in long-term interest rates. Because of the strong consumption response, we also find a considerably stronger effect of government spending on output. This model variant thus lends support to the conventional wisdom: absent a reversal of spending (with $\psi_G = 0$) the macroeconomic transmission of fiscal shocks is somewhat stronger under the peg, with an impact multiplier above one.

Figure 6. Effect of a Government Spending Shock under Unrestricted and Restricted Financial Markets[a]



Source: Authors' construction.

a. Restricted markets assume that at the international level only bonds are traded and $\lambda = 1/3$.

8. Conclusions

Does a fixed exchange rate regime enhance the ability of fiscal policies to determine economic activity? Can small countries in the euro area expect more from fiscal stabilization than countries outside the area? Decades of practice in economic policy have already qualified the affirmative answers that textbook treatments of the Mundell-Fleming model provide to these questions. In this paper, we have explored theoretical reasons for reframing the conventional wisdom in a still richer way.

Building on Corsetti, Meier, and Müller (2009), our analysis brings a simple insight to bear on the role of the exchange rate regime for fiscal policy transmission: the effectiveness of fiscal stimulus depends on the medium-term policy framework, that is, on both monetary and fiscal policies over the medium term. In particular, the short-run effect of fiscal measures not only depends on the exchange rate regime and the monetary strategy more generally, but also hinges on the future fiscal mix. The main message of the conventional wisdom was that one cannot assess fiscal stimulus independently of the exchange rate regime. We have shown here that this message needs to be extended to include both the monetary regime and the medium-term fiscal regime.

As a result of fiscal and monetary interactions, the textbook rendition of the conventional wisdom cannot be taken at face value. For example, if budget adjustments are implemented through spending cuts in addition to tax hikes (the empirical relevance of which was highlighted in Corsetti, Meier, and Müller, 2009), the anticipation of a future retrenchment of government spending tends to magnify the output effects of fiscal expansions under flexible exchange rates. Such anticipation has limited or no effects under a peg, however, as we show in the current paper. These results raise a number of analytical, empirical, and policy issues, which, when properly addressed, should help define the preconditions for successful fiscal stabilization.

Our analysis in this paper has abstracted from the possibility that monetary policy is constrained by the zero lower bound on policy rates. Recent research by Christiano, Eichenbaum, and Rebelo (2009) and others within a closed economy context illustrates that government spending can be a much more effective stabilization tool when monetary policy is constrained. In that context, we have shown in related work of ours that spending reversals of the kind analyzed in section 6 of this paper are likely to enhance the short-run effects of fiscal stimulus when the zero lower bound is binding, provided that they are not phased in too early along the recovery path (Corsetti and others 2010). A detailed analysis of the interaction of fiscal and monetary policy in a small open economy that takes the zero lower bound constraint into account is certainly an important direction of research. In light of our earlier work, we conjecture that such an analysis will further strengthen the case for fiscal policy as a stabilization tool, especially under floating exchange rates.

Appendix A

Equilibrium Conditions of the Linearized Model

This appendix outlines the linearization of the model and states the equilibrium conditions used in the simulations. Lowercase letters denote percentage deviations from steady-state values; hats denote deviations from steady-state values scaled by steady-state output. Throughout we assume that variables in the rest of the world are constant. We consider the model that allows for a fraction of households without access to asset markets (see section 7.2), which nests the model with full asset market participation for $\lambda = 0$.

A.1 Definitions and derivations

Price indexes. The law of one price, the terms of trade, the consumption price index, and CPI inflation can be written as

$$p_{F,t} = p_t^* - \mathrm{NER}_t s, \tag{A.1}$$

$$s_t = p_{H,t} - p_{F,t}, \tag{A.2}$$

$$p_t = (1-\omega) p_{H,t} + \omega p_{F,t} = p_{H,t} - \omega s_t, \tag{A.3}$$

$$\pi_t = \pi_{H,t} - \omega \Delta s_t, \tag{A.4}$$

and

$$q_t = (1-\omega) s_t, \tag{A.5}$$

where q_t measures the real exchange rate.

Intermediate-good firms. The production function of intermediate goods is given by $Y_t(j) = H_t(j)$. Using equations (15) in (14) gives the demand function for a generic good j,

$$Y_t(j) = \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\varepsilon} Y_t, \tag{A.6}$$

so that

$$\int_0^1 Y_t(j)\,dj = \zeta_t Y_t, \tag{A.7}$$

where $\zeta_t = \int_0^1 \left[\frac{P_{H,t}(j)}{P_{H,t}}\right]^{-\varepsilon} dj$ measures price dispersion. Aggregating yields

$$\zeta_t Y_t = \int_0^1 H(j)_t\,dj = H_t. \tag{A.8}$$

A first-order approximation is given by $y_t = h_t$.

The first-order condition to the price-setting problem is given by

$$E_t \sum_{k=0}^{\infty} \xi^k \rho_{t,t+k} \left[Y_{t,t+k}(j) P_{H,t}(j) - \frac{\varepsilon}{\varepsilon - 1} W_{t+k} H_{t+k} \right] = 0. \tag{A.9}$$

In the steady state, we have a symmetric equilibrium:

$$P_H = \frac{\varepsilon}{\varepsilon - 1}\frac{WH}{Y} = \frac{\varepsilon}{\varepsilon - 1} MC^n, \tag{A.10}$$

where the second equation defines nominal marginal costs.

Linearizing equation (A.9) and using the definition of price indexes, one obtains a variant of the New Keynesian Phillips curve (see, for example, Galí and Monacelli, 2005):

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa m c_t^r, \tag{A.11}$$

where $\kappa = (1 - \xi)(1 - \beta\xi) / \xi$ and marginal costs are defined in real terms, deflated with the domestic price index,

$$mc_t^r = w_t - p_{H,t} = w_t^r - \omega s_t. \tag{A.12}$$

Here $w_t^r = w_t - p_t$ is the real wage (deflated with the CPI).

Profits per capita are defined as follows

$$\Upsilon_t^{pc} = P_{H,t} Y_t - W_t H_t. \tag{A.13}$$

Linearized we have (deflated with the CPI)

$$\hat{\Upsilon}_t^{r,pc} = \omega s_t + y_t - \frac{\varepsilon - 1}{\varepsilon}\left(w_t^r + h_t\right). \tag{A.14}$$

Households. The first-order conditions in deviations from the steady state are familiar:

$$w_t - p_t = \gamma c_{A,t} + \varphi h_{A,t}; \tag{A.15}$$

$$c_{A,t} = E_t c_{A,t+1} - \frac{1}{\gamma}\left(r_t - E_t \pi_{t+1}\right). \tag{A.16}$$

In terms of output units (defining $\chi \equiv G/Y$), this becomes

$$\left(1-\chi\right)w_t^r = \gamma \hat{c}_{A,t} + \left(1-\chi\right)\varphi h_{A,t}; \tag{A.17}$$

$$\hat{c}_{A,t} = E_t \hat{c}_{A,t+1} - \frac{\left(1-\chi\right)}{\gamma}\left(r_t - E_t \pi_{t+1}\right). \tag{A.18}$$

The first-order conditions for non-asset-holding households are

$$P_t C_{N,t} = W_t H_{N,t} - T_t; \tag{A.19}$$

$$C_{N,t} = \frac{W_t}{P_t} H_{N,t} - T_t^R. \tag{A.20}$$

The first-order approximation is

$$Y\hat{c}_{N,t} = \frac{WH}{P}\left(w_t^r + h_{N,t}\right) - Y\hat{t}_t^r, \tag{A.21}$$

or after rearranging

$$\hat{c}_{N,t} = \frac{\varepsilon - 1}{\varepsilon}\left(w_t^r + h_{N,t}\right) - \hat{t}_t^r. \tag{A.22}$$

The first-order condition for labor supply is given by

$$\left(1-\chi\right)w_t^r = \gamma \hat{c}_{N,t} + \left(1-\chi\right)\varphi h_{N,t}. \tag{A.23}$$

Regarding international financial markets, we consider as the baseline scenario a complete set of assets. In this case, consumption is tightly linked to the real exchange rate (see, for example, Galí and Monacelli, 2005):

$$\gamma c_{A,t} = -q_t. \tag{A.24}$$

Alternatively, we assume that there is trade in nominally riskless bonds only. In this case, we have to keep track of the net foreign asset position, using the flow budget constraint of asset holders:

$$R_t^{-1} A_{t+1} + \frac{R_{F,t}^{-1} B_{t+1}^*}{\text{NER}_t} + P_t C_{A,t} = A_t + \frac{B_t^*}{\text{NER}_t} + W_t H_{A,t} - T_t + \psi_t. \tag{A.25}$$

Recall that $D_t = (1 - \lambda)A_t\theta$, that is, government debt is held by domestic asset holders, and that profits go to asset holders only: $(1-\lambda)\psi_t = \psi_t^{pc}$. Linearization around the zero debt steady state gives

$$\frac{\beta \hat{d}_{t+1}^r}{(1-\lambda)} + \beta \hat{b}_{t+1}^r + \hat{c}_{A,t} = \frac{\hat{d}_t^r}{(1-\lambda)} + \hat{b}_t^r + \frac{\varepsilon - 1}{\varepsilon}\left(w_t + h_{A,t}\right) - \hat{t}_t^r + \frac{\hat{\Upsilon}_t^{r,pc}}{(1-\lambda)}. \tag{A.26}$$

Uncovered interest rate parity would imply: $r_t - r_{F,t} = -\Delta E_t \text{ner}_{t+1}$, but interest rates on foreign currency bonds (assuming constant world interest rates) are given by

$$r_{F,t} = -\alpha \frac{B_{t+1}}{\beta Y \text{NER}_t P_t},$$

such that

$$r_t + \alpha\beta \hat{b}_{t+1}^r = -\Delta E_t \text{NER}_{t+1}. \tag{A.27}$$

Government. Rewriting the interest rate feedback rule in terms of deviations from the steady state (with zero inflation), we have under a float

$$r_t = \phi \pi_{H,t}. \tag{A.28}$$

Recall that $r_t = (R_t - R)/R$. Rewriting the fiscal rules gives

$$\frac{G_t - G}{Y} = \rho \frac{G_{t-1} - G}{Y} - \psi_G \frac{D}{YP_{t-1}} + \varepsilon_{g,t}$$

and

$$T_{r,t} = \phi_T \frac{D_t}{P_{t-1}},$$

or

$$\hat{g}_t = \rho \hat{g}_{t-1} - \psi_G \hat{d}_t^r + \varepsilon_t \tag{A.29}$$

and

$$\hat{t}_t^r = \psi_T \hat{d}_t^r. \tag{A.30}$$

Finally, the government budget constraint is given by

$$\beta \hat{d}_{t+1}^r = \hat{d}_t^r + \chi \omega s_t + \hat{g}_t - \hat{t}_t^r. \tag{A.31}$$

Equilibrium and additional definitions. Good-market clearing (equation 15) in terms of deviations from steady state is given by

$$y_t = -\sigma(1-\omega)\omega(1-\chi)s_t + (1-\omega)\hat{c}_t - \omega\sigma(1-\chi)s_t + \omega\hat{c}_t^* + \hat{g}_t. \tag{A.32}$$

Rearranging under the assumption that rest of the world variables are constant, we have

$$y_t = -(2-\omega)\sigma\omega(1-\chi)s_t + (1-\omega)\hat{c}_t + \hat{g}_t. \tag{A.33}$$

We define trade balance in percent of steady state output:

$$TB_t = \frac{P_{H,t}Y_t - P_t C_t - P_{H,t}G_t}{P_{H,t}Y} = \frac{Y_t - C_t\left(P_t/P_{H,t}\right) - G_t}{Y}. \tag{A.34}$$

Approximatively, around the steady state we have

$$\widehat{tb}_t = y_t - \hat{c}_t + (1-\chi)\omega s_t - \hat{g}_t. \tag{A.35}$$

A.2 Equilibrium conditions used in model simulation

Optimality of household behavior implies

$$\gamma \hat{c}_{A,t} = \gamma E_t \hat{c}_{A,t+1} - (1-\chi)(r_t - E_t \pi_{t+1}); \tag{A.36}$$

$$\hat{c}_{N,t} = \frac{(\varepsilon - 1)}{\varepsilon}(w_t^r + h_{N,t}) - \hat{t}_t^r; \tag{A.37}$$

$$\hat{c}_t = \lambda \hat{c}_{N,t} + (1-\lambda)\hat{c}_{A,t}; \tag{A.38}$$

$$(1-g_t)w_t^r = \gamma \hat{c}_{A,t} + (1-\chi)\varphi h_{A,t}; \tag{A.39}$$

$$(1-g_t)w_t^r = \gamma \hat{c}_{N,t} + (1-\chi)\varphi h_{N,t}; \tag{A.40}$$

$$h_t = \lambda h_{N,t} + (1-\lambda)h_{A,t}. \tag{A.41}$$

Asset market structures differ across simulations. For incomplete financial markets, we need the budget constraint of asset holders (equation A.26) and the uncovered interest rate parity condition (equation A.27)

$$\frac{\beta \hat{d}_{t+1}^r}{(1-\lambda)} + \beta \hat{b}_{t+1}^r + \hat{c}_{A,t} = \frac{\hat{d}_t^r}{(1-\lambda)} + \hat{b}_t^r + \frac{\varepsilon - 1}{\varepsilon}(w_t^r + h_{A,t}) - \hat{t}_t^r + \frac{\hat{\Psi}_t^{r,pc}}{1-\lambda}; \tag{A.42}$$

$$r_t + \alpha\beta \hat{b}_{t+1}^r = -\Delta E_t \text{NER}_{t+1}. \tag{A.43}$$

Under complete markets, we use the risk-sharing condition (A.24) and zero foreign bond holdings:

$$\gamma \hat{c}_{A,t} = -(1-\chi) q_t; \tag{A.42$'$}$$

$$\hat{b}_{t+1} = 0. \tag{A.43'}$$

Intermediate-good firms' behavior is governed by marginal costs (equation A.12), the Philips curve (equation A.11), and the production function:

$$mc_t^r = w_t^r - \omega s_t; \tag{A.44}$$

$$\pi_{H,t} = \beta E_t \pi_{H,t+1} + \kappa mc_t^r; \tag{A.45}$$

$$y_t = h_t. \tag{A.46}$$

Government policies (equations A.28, A.29, and A.30), the government budget constraint (equation A.31), and market clearing (equation A.33) are given by

$$r_t = \phi \pi_{H,t} \quad \text{or} \quad \Delta \text{NER}_t = 0 \tag{A.47}$$

$$\hat{t}_t^r = \psi_t \hat{d}_t^r; \tag{A.48}$$

$$\hat{g}_t = \rho \hat{g}_{t-1} - \psi_G \hat{d}_t^r + \varepsilon_t; \tag{A.49}$$

$$\beta \hat{d}_{t+1}^r = \hat{d}_t^r + \chi \omega s_t + \hat{g}_t - \hat{t}_t^r; \tag{A.50}$$

$$y_t = -(1-\chi)(2-\omega)\sigma\omega s_t + (1-\omega)\hat{c}_t + \hat{g}_t. \tag{A.51}$$

Definitions for the trade balance, relative prices, inflation, and profits are given by

$$tb_t = y_t - \hat{c}_t + (1-\chi)\omega s_t - \hat{g}_t; \tag{A.52}$$

$$\pi_t = \pi_{H,t} - \omega \Delta s_t; \tag{A.53}$$

$$\Delta \text{NER}_t = (1-\omega)\Delta s_t - \pi_t; \tag{A.54}$$

$$q_t = (1-\omega)s_t; \tag{A.55}$$

$$\hat{\Psi}_t^{pc,r} = \omega s_t + y_t - \frac{\varepsilon - 1}{\varepsilon}\left(w_t^r + h_t\right). \tag{A.56}$$

Appendix B
Key Equations of the Simple Model

In this appendix, we reduce the number of equations that characterize the equilibrium in order to obtain the canonical representation used in section 2. We only consider the case $\lambda = 0$.

B.1 Dynamic IS

Combining good-market clearing and the risk-sharing condition, $\gamma c_t = -(1-\omega) s_t$, gives

$$y_t = -\frac{1-\chi}{\gamma}\underbrace{\left[1+\omega(2-\omega)(\sigma\gamma-1)\right]}_{\equiv\varpi} s_t + \hat{g}_t.$$

Hence, we have

$$s_t = -\frac{\gamma}{(1-\chi)\varpi}\left(y_t - \hat{g}_t\right), \tag{B.1}$$

which is equation (24) in the main text

Alternatively, we substitute for the terms of trade to obtain

$$c_t = \frac{1-\omega}{\varpi(1-\chi)}(y_t - \hat{g}_t).$$

This is helpful in rewriting the Euler equation:

$$\begin{aligned} c_t &= E_t c_{t+1} - \frac{1}{\gamma}\left[r_t - E_t\left(\pi_{H,t+1} - \omega \Delta s_{t+1}\right)\right] \\ &= E_t c_{t+1} - \frac{1}{\gamma}\left[r_t - E_t \pi_{H,t+1} - \frac{\omega\gamma}{(1-\chi)\varpi} E_t\left(\Delta y_{t+1} - \Delta\hat{g}_{t+1}\right)\right], \end{aligned} \tag{B.2}$$

where we use $\pi_t = \pi_{H,t} - \omega\Delta s_t$ in the first equation.

Substituting for consumption gives

$$y_t = E_t y_{t+1} - E_t \Delta\hat{g}_{t+1} - \frac{(1-\chi)\varpi}{\gamma}(r_t - E_t \pi_{H,t+1}),$$

which is equation (17) in the main text.

B.2 Phillips curve

Consider once more marginal costs:

$$\begin{aligned} mc_t^r &= w_t^r - \omega s_t = -s_t + \varphi y_t \\ &= \frac{\gamma}{(1-\chi)\varpi}\left(y_t - \hat{g}_t\right) + \varphi y_t . \end{aligned}$$

Substituting in equation (A.11) gives equation (18) in the main text.

Appendix C

Long-Term Interest Rates under Floating Exchange Rates

This appendix focuses on the response of long-term real interest rates in the case of exogenous government spending. Under a float, the allocation is characterized by equations (17), (18), and the Taylor rule (equation 19). Assuming $\psi_G=0$, we solve the model using the method of undetermined coefficients. Assuming that $y_t = \phi_{yg}\hat{g}_t$ and $\pi_{H,t} = \phi_{\pi g}\hat{g}_t$ and substituting in (17) yields

$$\hat{\sigma}(1-\rho)\phi_{yg} = -(\phi_\pi - \rho)\phi_{\pi g} + \hat{\sigma}(1-\rho),$$

where $\hat{\sigma} \equiv \gamma / ((1-\chi)\varpi)$. This will be positive if $\varpi > 0$, which in turn requires $1 > \varpi (2-\omega)(1-\sigma\gamma)$ (which we assume to be satisfied).

Substituting in equation (18) gives

$$\phi_{yg} = \frac{(1-\beta\rho)\phi_{\pi g} + \kappa\hat{\sigma}}{\kappa(\hat{\sigma}+\varphi)}.$$

Combining the two expressions yields the result

$$\phi_{\pi g} = \frac{\hat{\sigma}(1-\rho)\varphi\kappa}{\hat{\sigma}(1-\rho)(1-\beta\rho)+\kappa(\varphi+\hat{\sigma})(\phi_\pi-\rho)} > 0,$$

as long as $\rho<1$ and $\phi_\pi>0$ (which we assume throughout).

As shown in the main text (see equation 25), an expression of long-term real interest rates is given by

$$\overline{r}_t = E_t\sum_{s=0}^{\infty}\left(r_{t+s} - \pi_{t+1+s}\right) = E_t\sum_{s=0}^{\infty}\left[r_{t+s} - \left(\pi_{H,t+s+1} - \omega\Delta s_{t+s+1}\right)\right] \qquad \text{(C.1)}$$

where the second equality follows from equation (B.2).

Given the solution of the model, we have

$$E_t r_{t+s} = \phi_\pi\phi_{\pi g}\rho^s\hat{g}_t,$$

$$E_t \pi_{H,t+s+1} = \phi_{\pi g} \rho^{s+1} \hat{g}_t,$$

and

$$E_t \Delta s_{t+s+1} = \hat{\sigma}\left(1-\phi_{yg}\right)\left(\rho-1\right)\rho^{s} \hat{g}_t,$$

where the last relationship follows from equation (B.1). Substituting in equation (C.1) gives (after some algebra)

$$\overline{r}_t = \underbrace{\frac{\left(1-\omega\right)\left(\phi_{\pi}-\rho\right)\phi_{\pi g}}{1-\rho}}_{>0} \hat{g}_t \tag{C.2}$$

That is, long-term rates always increase in response to government spending innovations under a float (as long as $\psi_G = 0$).

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Non-Ricardian Aspects of Fiscal Policy in Chile

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In this paper, we examine the effects of government spending shocks in the Chilean economy. The study of the effects of such shocks in an emerging market economy is of special interest because of the potential presence of non-Ricardian households, that is, households that do not own any assets or have any liabilities and just consume their current labor income.[1] The existence of non-Ricardian households has been suggested as a key ingredient in the transmission mechanism of government spending shocks in some developed economies. Several factors may explain non-Ricardian behavior, including myopia and lack of access to capital markets. Such behavior is likely to be especially important in less developed economies.

The Chilean fiscal rule ties total government spending to structural revenues. Structural revenues correspond to the sum of cycle-adjusted tax revenues and copper-related fiscal revenues evaluated at what could be considered a long-term copper price.

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1. See, for example, Campbell and Mankiw (1991); Mankiw (2000); Galí, López-Salido, and Vallés (2007).

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Under this fiscal rule, government spending plus a structural fiscal surplus target must be equal to permanent (structural) revenues. Shocks to GDP (deviations from potential output) and to copper prices that transitorily affect fiscal revenues do not alter the path of government spending (which is only affected by changes in potential output and the long-term copper price). For example, the rule implies that if effective copper prices are transitorily above the estimated long-term copper price, the government saves the amount of copper-related fiscal revenues associated with this transitory copper price shock.[2] When officially implemented in 2001, the government announced a structural fiscal surplus target equivalent to one percent of GDP (that is, structural revenues minus government expenditure equals one percent of GDP). We show that the specification of a fiscal policy rule that approximates the Chilean rule leads to consumption and output fiscal multipliers that are positive in the short run, in a way consistent with the evidence.[3]

The structure of the paper is as follows. Section 1 presents VAR evidence on non-Ricardian effects of fiscal policy for the Chilean case. Section 2 introduces a dynamic stochastic general equilibrium model for Chile.[4] The model is calibrated and estimated, and results are reported in Section 3. Numerical simulations of the estimated model are presented in Section 4. Therein we examine impulse response functions and dynamic fiscal multipliers. Finally, Section 5 concludes.

1. Some Evidence on the Effects of Government Spending in Chile

This section provides some evidence on the macroeconomic effects of government spending shocks, using Chilean data for the past two decades. Following much of the literature, we rely on

2. Potential output and the long-term copper price are determined by two committees of experts that are independent of the government. See Frankel (in this volume) for a description of the Chilean fiscal rule.

3. The exercise of implementing a zero deficit rule provides a good benchmark; however, results are not reported. Briefly, a zero-deficit fiscal rule instrumented by transfers leaving public expenditure exogenous (as in Forni, Monteforte, and Sessa, 2009) yields positive fiscal multipliers (of consumption and GDP). If the shock is on government expenditures, we find a negative fiscal multiplier for consumption but a positive one for GDP.

4. An appendix with full derivations is available in the working paper version of this article (Céspedes, Fornero, and Galí, 2012).

estimated VARs. While the literature largely focuses on the effects of government purchases (often restricted to military spending), we also examine the impact of changes in transfers, since the latter constitute an important stabilization tool in Chile and have historically been subject to large changes. In both cases, we report impulse response functions, as well as estimates of the size of the output and consumption multipliers.

1.1 The Effects of Government Purchases

We first consider a small VAR specification including four variables: government purchases (government consumption plus public investment), GDP (excluding copper and other natural resources), private consumption (of durables and nondurables), and government deficit (excluding copper-related revenues).[5] The first three variables are expressed in logs and normalized by the size of the population. The deficit is normalized by lagged GDP. Data availability restricts the sample to the period 1990:1 to 2010:1. Our VAR includes four lags of all the variables, a constant term, and a second-order polynomial in time.

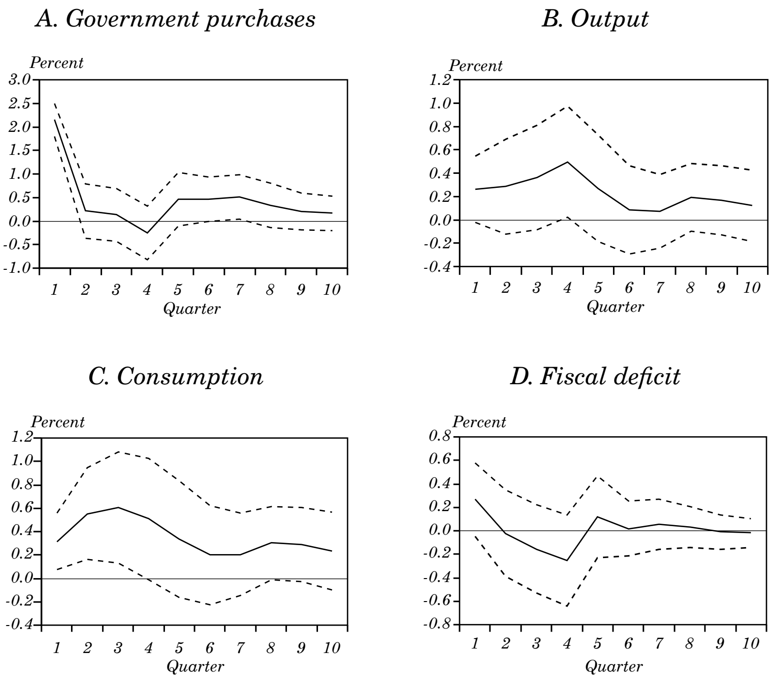
Following much of the literature, identification relies on the assumption that government purchases are predetermined relative to the other variables included in the VAR.[6] In other words, we interpret reduced-form innovations to government purchases as exogenous shocks to that variable. This is equivalent to ordering government purchases first in a Cholesky factorization of the VAR.

Figure 1 reports the impulse responses to a one-standard-deviation shock to government purchases, together with the corresponding 95 percent confidence intervals. Government purchases increase by nearly close to two percent on impact. Both GDP and consumption rise in response to that fiscal expansion. These two variables display a pattern that is roughly similar over time, with the peak occuring four quarters after the shock in the case of output and three quarters in the case of consumption. Not surprisingly, the deficit increases on impact.

5. We exclude copper and other natural resources from GDP because they are mainly affected by supply conditions. This strategy is consistent with the way in which we model GDP in our theoretical model.

6. See, for example, Blanchard and Perotti (2002); Fatás and Mihov (2001); Galí, López-Salido, and Vallés (2007); Perotti (2008).

Figure 1. Impulse Response to Government Purchases Shock: Small VAR



Source: Authors' computations.

Table 1. Effects of Goverment Purchases: Small VAR

	Basic		*Cumulative*	
Time / multipliers	dC/dG	dY/dG	dC/dG	dY/dG
$t = 1$	0.59	0.67	0.56	0.67
$t = 2$	1.03	0.73	1.47	1.27
$t = 4$	0.94	1.27	3.53	3.46
$t = 6$	0.37	0.22	3.17	3.06
$t = 8$	0.56	0.5	3.01	2.79

Source: Authors' computations.

Table 1 reports the corresponding multipliers for both GDP and consumption at different horizons. The basic multiplier measures dX_{t+k} / dG_t for $k = \{1, 2, 4, 6, 8\}$, where dG_t is the corresponding response in the level of GDP (when $X = Y$) or consumption (when $X = C$), k periods after the shock.[7] The GDP multiplier is above one-half (0.7) on impact, and it peaks close to 1.3 at a four-quarter horizon, before it declines. These values are similar to those obtained with U.S. data by a variety of authors (see Hall, 2009, for a survey of existing results). A look at the consumption multiplier points to the importance of that variable in generating the large GDP multiplier, suggesting the presence of non-Ricardian effects.

In addition to the basic multiplier, we also report estimates of the cumulative multiplier at different horizons, defined as

$$\frac{\sum_{j=1}^{k} dX_{t+j}}{\sum_{j=1}^{k} dG_{t+j}}.$$

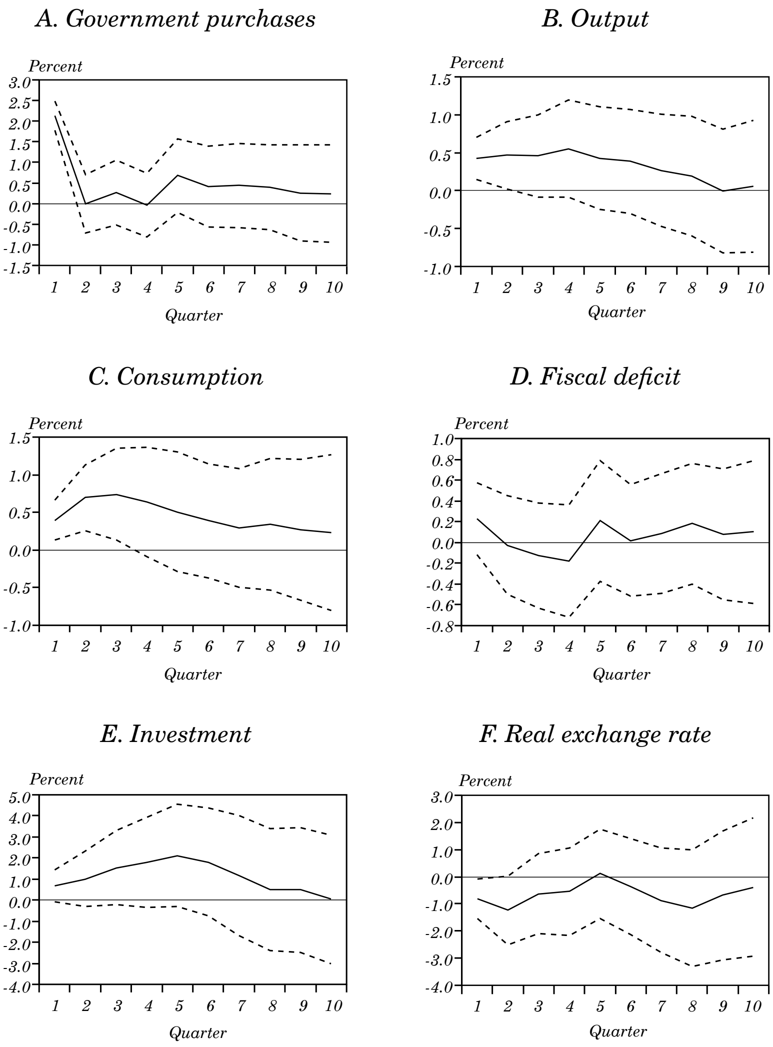
The latter takes into account not only the size of the initial increase in government purchases, but also its subsequent pattern of adjustment. As shown in table 1, both the GDP and consumption cumulative multipliers increase in the first year, reflecting the persistence of the GDP and consumption responses in that horizon, beyond that of government purchases.

We explore the robustness of these findings to the use of a larger VAR, which includes the real copper price, total private investment, and the real exchange rate in addition to the four variables listed above. Given the fiscal rule in place, whereby the government is allowed to spend only the fraction of the increase in copper revenues considered to be permanent, it is natural to order that price before government purchases, which now appears in second place in the VAR.[8] Figure 2 displays the estimated impulse response functions to a government purchases shock using the larger VAR. The corresponding multipliers are shown in table 2. The picture that emerges is qualitatively and

7. Using the impulse response functions for the logs, we compute the multiplier as $(dX_{t+k}/dG_t) = (d\log X_{t+k}/d\log G_t)\,(X_{t+k}/G_t)$.

8. The fiscal policy rule in place in Chile establishes that government spending is linked to structural revenues (that is, the permanent component of effective revenues). One component of those structural revenues corresponds to copper-related revenues. Structural copper revenues correspond to the revenues that the government would collect if the price of copper was equal to its long-run or permanent price.

Figure 2. Impulse Response to Government Purchases Shock: Large VAR



Source: Authors' computations.

quantitatively very similar to that obtained using the small VAR. In this case, investment also rises in response to the increase in government purchases, suggesting that it could play a complementary role to consumption in generating the large GDP multiplier. That amplification effect is likely to be partially offset by the real exchange rate appreciation, which should dampen the growth of aggregate demand. The pattern of the deficit response estimated using the large VAR is also very similar, with a deficit increase on impact.

Table 2. Effects of Goverment Purchases: Large VAR

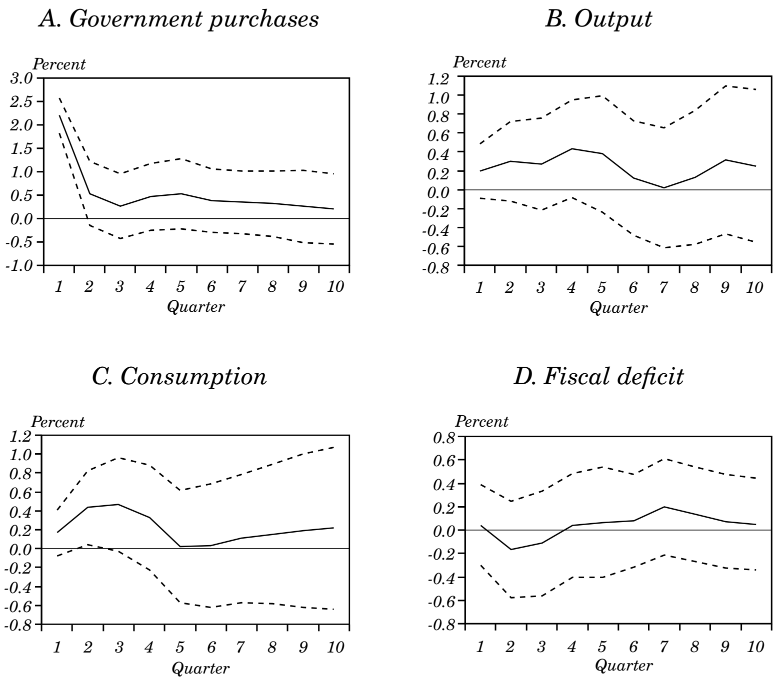
	Basic		*Cumulative*	
Time / multipliers	*dC / dG*	*dY / dG*	*dC / dG*	*dY / dG*
$t = 1$	0.74	1.10	0.74	1.10
$t = 2$	1.30	1.20	2.05	2.31
$t = 4$	1.19	1.43	4.18	4.45
$t = 6$	0.72	1.00	3.89	4.34
$t = 8$	0.64	0.50	3.72	4.08

Source: Authors' computations.

1.2 The Effects of Government Transfers

Next we report estimates of the dynamic effects of government transfers, using an approach analogous to the one in the previous subsection, with total government transfers substituting for government purchases in the two VARs. Figure 3 reports the impulse responses to a transfer shock. As shown in the first panel, the increase in transfers appears to have a similar persistence to the increase in government purchases studied above. The resulting responses of output, consumption, and the deficit show a pattern not too different from that obtained for government purchases. Also, the sign of the response of the deficit is less clear-cut in the case of a shock to transfers. The estimated multipliers shown in table 3 point to similar orders of magnitude for both GDP and consumption. The evidence based on the large VAR, reported in figure 4 and table 4, provides a similar picture, although the real exchange depreciates in response to an increase in transfers.

Figure 3. Impulse Response to Government Transfers Shock: Small VAR



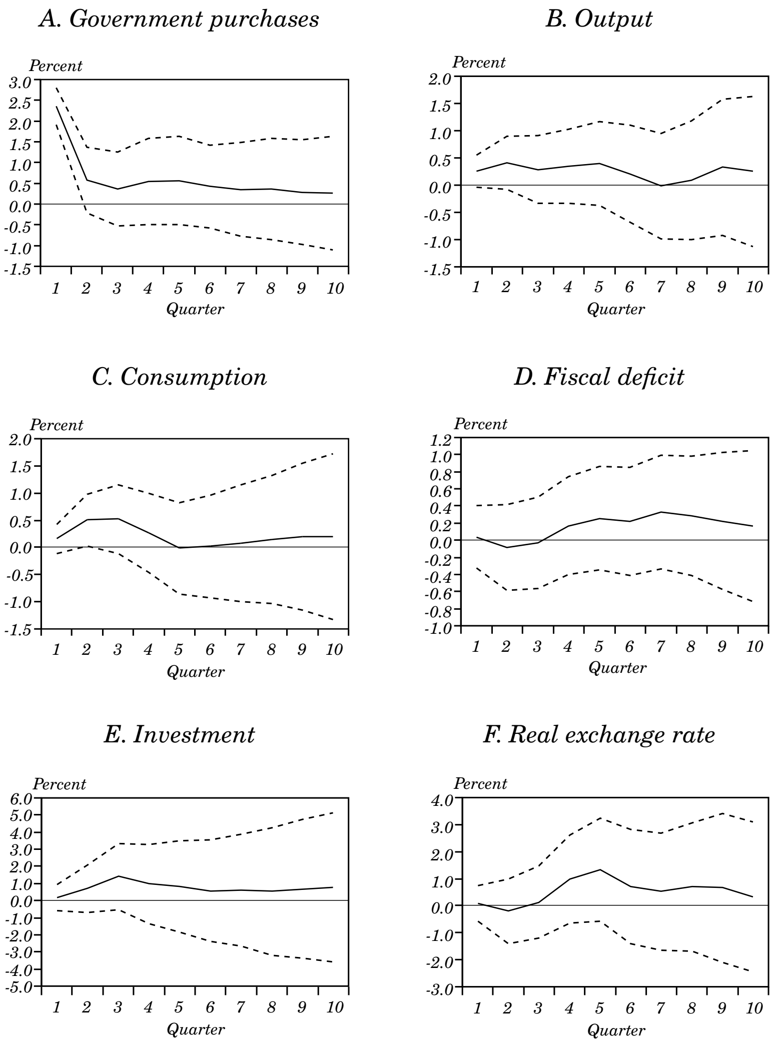
Source: Authors' computations.

Table 3. Effects of Government Transfers: Small VAR

	Basic		*Cumulative*	
Time / multipliers	*dC / dG*	*dY / dG*	*dC / dG*	*dY / dG*
$t = 1$	0.45	0.72	0.45	0.72
$t = 2$	1.17	1.11	1.30	1.47
$t = 4$	0.87	1.61	2.38	2.82
$t = 6$	0.09	0.45	1.96	3.16
$t = 8$	0.41	0.49	2.00	2.98

Source: Authors' computations.

Figure 4. Impulse Response to Government Transfers Shock: Large VAR



Source: Authors' computations.

Table 4. Effects of Government Transfers: Large VAR

	Basic		*Cumulative*	
Time/multipliers	*dC/dG*	*dY/dG*	*dC/dG*	*dY/dG*
$t = 1$	0.40	0.88	0.40	0.88
$t = 2$	1.27	1.42	1.34	1.85
$t = 4$	0.68	1.21	2.25	2.76
$t = 6$	0.04	0.72	1.79	3.22
$t = 8$	0.36	0.31	1.78	2.92

Source: Authors' computations.

1.3 Discussion

The evidence presented on the effects of shocks to government purchases and government transfers points to the existence of positive multiplier effects on GDP. The sign and size of the estimated response of consumption is suggestive of strong non-Ricardian effects, which would account for the size of both the GDP and consumption multipliers. In the next section, we develop an open economy New Keynesian model that tries to account for these regularities.

2. A Small Open Economy Model for Chile

This section presents the structure of a dynamic stochastic general equilibrium (DSGE) model along the lines of Altig and others (2005), Adjemian, Darracq-Pariès, and Smets (2008), and Adolfson and others (2007), which we have extended to incorporate a role for fiscal policy. We build on the work by Galí, López-Salido, and Vallés (2007) and Coenen, McAdam, and Straub (2008), who develop versions of a New Keynesian model allowing for a fraction of non-Ricardian households, but modified to capture particular features of the Chilean economy. The relevant features include copper income as a nonnegligible share of government income, a fiscal rule that seeks to keep government spending closely linked to structural (permanent) fiscal revenues, and an inflation-targeting monetary policy regime. A complementary appendix with the main model's derivations is available on request.

2.1 Consumers

There are two types of consumers: Ricardian (with weight $\lambda - 1$) and non-Ricardian (with weight λ), denoted with superscript $j = \{R,N\}$. Ricardian consumers are assumed to have access to financial markets to smooth consumption over time, whereas non-Ricardian consumers do not. Implicitly, though, we make an exception to the latter assumption to simplify the analysis: we assume full insurance of the risk generated by Calvo wage setting among consumers of a given type (as in Coenen, McAdam, and Straub, 2008).

Both consumer types are assumed to maximize an objective function of the form

$$\sum_{t=0}^{\infty} \beta^t U_t^j(h),$$

with period utility given by

$$U_t^j(h) = \ln\left[C_t^j(h) - bC_{t-1}^j(h)\right] - \bar{\zeta}\zeta_t \frac{L_t^j(h)^{1+\sigma_L}}{1+\sigma_L}, \tag{1}$$

Where $C_t^j(h)$ is a consumption index, $L_t^j(h)$ denotes hours of work, b measures the degree of internal habit formation, $\bar{\zeta}$ is a constant, σ_L is the inverse of the Frisch elasticity, and ζ_t is a shock to the disutility from work. The latter parameter is assumed to follow a first-order autoregressive, or AR(1), process with unconditional mean of one, persistence ρ_ζ, and constant variance σ_ζ^2.[9]

The consumption index takes the form

$$C_t^j(h) \equiv \left[(1-\alpha)^{\frac{1}{\eta}} C_{H,t}^j(h)^{1-\frac{1}{\eta}} + \alpha^{\frac{1}{\eta}} C_{F,t}^j(h)^{1-\frac{1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{2}$$

where

$$C_{H,t}^j(h) \equiv \left[\int_0^1 C_{H,t}^j(h,i)^{1-\frac{1}{\varepsilon_H}} di\right]^{\frac{\varepsilon_H}{\varepsilon_H-1}}$$

9. We abuse of notation declaring $C_t^j(h)$ for $j = \{R,N\}$, but the decisionmaker is the individual h.

and

$$C_{F,t}^{j}(h) \equiv \left[\int_0^1 C_{F,t}^{j}(h,i)^{1-\frac{1}{\varepsilon_F}} di\right]^{\frac{\varepsilon_F}{\varepsilon_F - 1}}.$$

are constant elasticity of substitution (CES) indexes for domestic and imported consumption goods, respectively, with parameter α determining the degree of openness and $\eta > 1$ being the CES between domestic and imported goods. Notice that ε_H and ε_F are (constant) elasticities of substitution among varieties and are greater than 1

2.1.1 Ricardian consumers

Ricardian consumers ($h = R$) maximize utility subject to two constraints. The first is a flow budget constraint of the form

$$\begin{aligned} & B^R(s^t,h) + S_t B^{R,*}(s^t,h) + (1-\tau_{w,t})\mathcal{S}_{WR} W_t^R(h) L_t^R(h) \\ & + R_t^k u_t^R(h) K_{t-1}^R(h) - P_t \Phi\left[u_t^R(h)\right] K_{t-1}^R(h) + P_t\left[Tr_t^R(h) - TX_t^R(h)\right] \\ & + (1-\tau_{\mathrm{Pr},t})\mathrm{Pr}_t^R(h) \leq \sum_{s^{t+1}|s^t} Q(s^{t+1},s^t) B^R(s^{t+1},h) \\ & + S_t \mathrm{RP}_t \sum_{s^{t+1}|s^t} Q^*(s^{t+1},s^t) B^{R,*}(s^{t+1},h) \\ & + \int_0^1 P_{H,t}(i)\left[C_{H,t}^R(h,i) + I_{H,t}^R(h,i)\right] di \\ & + \int_0^1 P_{F,t}(i)\left[C_{F,t}^R(h,i) + I_{F,t}^R(h,i)\right] di. \end{aligned} \quad (3)$$

The terms on the left-hand side represent consumer h's cash inflows, which include the following: maturing one-period nominal discount bonds (domestic and foreign); labor income (given by the wage after taxes and subsidies—S_{WR} is a subsidy to eliminate monopolistic distortions—times the number of hours worked); income from capital leased to firms net of utilization costs;[10] transfers, $Tr_t^R(h)$, net of

10. In our notation, $K_{t-1}^{j}(h)$, reflects agent h's end-of-period stock of physical capital ready to be used in the productive process in period t.

lump-sum taxes, $TX_t^R(h)$; and transfers and profits in the form of net of tax distributed dividends, $(1 - \tau_{\text{Pr},t})\,\text{Pr}_t^R(h)$. The nominal exchange rate is denoted by S_t, which measures the number of Chilean pesos (Ch\$) needed to buy one U.S. dollar (USD). The utilization rate of physical capital, $u_t^R(h)$, is a choice variable. Following Adolfson and others (2007), the utilization cost function $\Phi(\cdot)$ takes the form

$$\Phi\left[u_t^R(h)\right] \equiv \frac{\theta}{2}\left[u_t^R(h) - 1 + r^k\right]\left[u_t^R(h) - 1\right], \tag{4}$$

where $\theta > 0$ is a parameter that directly influences the sensitivity of the cost function when $u_t^R(h)$ varies and r^k is the real steady-state capital rental rate. Capital income simplifies to $R_t^k K_{t-1}^R(h)$ when capital is fully utilized, at $u_t^R(h) = 1$, because $\Phi(1) = 0$.[11]

The right-hand side of equation (3) includes the various purchases incurred by the Ricardian consumer: consumption, investment, and purchases of (state-contingent) domestic and foreign assets. The risk premium factor,

$$\text{RP}_t \equiv \exp\left(-\phi_a\left(\frac{S_t B_{t+1}^*}{P_{t+1}}\right) - \phi_{\Delta S}\left(E_t\left[\frac{S_{t+1}}{S_t}\right] - 1\right) + \phi_t\right),$$

adjusts the return at which domestic consumers can borrow from or lend to the rest of the world. It depends on the country's aggregate net foreign asset position, B_t^*, the expected rate of depreciation, $E_t[S_{t+1} / S_t]$, and an exogenous risk premium shock, ϕ_t.[12] The risk premium function can be viewed as a measure of international asset market incompleteness (such as asymmetric information, entry costs to build the portfolio, and so on). I_t^R is an investment index given by

11. It follows that $\Phi'(\cdot) = \theta\left[u_t^R(h) - 1\right] + r^k$. At the steady state, $\Phi'(1) = r^k$ and $\Phi''(1) = \theta > 0$.

12. B_t^* is the sum of the net debt position maintained by Ricardian agents, $(1-\lambda)B_t^{R,*} \equiv \int_\lambda^1 B^{R,*}\left(s^t, h\right)dh$, and the government. Besides the usual mechanism stressed by Schmitt-Grohé and Uribe (2001) (that is, the mechanism involving deviations from the targeted net foreign position, which in this case we assume is zero for Chile), we follow Adjemian, Darracq-Pariès, and Smets (2008) and Adolfson and others (2009) by adding a second argument that captures the deviation of the expected exchange gross depreciation rate from one. Including this additional explanatory variable induces a negative correlation between the expected depreciation rate and the risk premium, which is a relevant empirical finding (Duarte and Stockman, 2005).

$$I_t^R \equiv \left[(1-\alpha)^{\frac{1}{\eta}} \left(I_{H,t}^R \right)^{1-\frac{1}{\eta}} + \alpha^{\frac{1}{\eta}} \left(I_{F,t}^R \right)^{1-\frac{1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{5}$$

where, in a way analogous to consumption,

$$I_{H,t}^R \equiv \left[\int_0^1 I_{H,t}^R \left(j \right)^{1-\frac{1}{\varepsilon_H}} dj \right]^{\frac{\varepsilon_H}{\varepsilon_H - 1}},$$

$$I_{F,t}^R \equiv \left[\int_0^1 I_{F,t}^R \left(j \right)^{1-\frac{1}{\varepsilon_F}} dj \right]^{\frac{\varepsilon_F}{\varepsilon_F - 1}}$$

represent indexes of domestic and imported investment goods.

The second constraint is given by the law of motion of physical capital:

$$K_t^R\left(h\right) = \left(1-\delta\right) K_{t-1}^R\left(h\right) + \varepsilon_{I,t} I_t^R\left(h\right) - \frac{1}{2} \Psi \left[\frac{\varepsilon_{I,t} I_t^R\left(h\right)}{K_{t-1}^R\left(h\right)} - \delta \right]^2 K_{t-1}^R\left(h\right) \tag{6}$$

where δ is the depreciation rate, $\varepsilon_{I,t}$ is an investment-specific technology shock, and $\Psi \geq 0$ is a parameter that scales the quadratic installation costs associated with any positive net investment. The first-order conditions are presented in the working paper version of this study.[13]

2.1.2 Non-Ricardian consumers

Non-Ricardian consumers ($j = N$) are assumed to have no access to financial markets, so they consume in the same period their wage income and the transfers they receive from the government.[14] Their consumption is thus given by

$$\begin{aligned} &\int_0^1 P_{H,t}\left(i\right) C_{H,t}^N\left(h,i\right) di + \int_0^1 P_{F,t}\left(i\right) C_{F,t}^N\left(h,i\right) di \\ &= \left(1-\tau_{w,t}\right) \mathcal{S}_{WN} W_t^N\left(h\right) L_t^N\left(h\right) + P_t\left[Tr_t^N\left(h\right) - TX_t^N\left(h\right) \right]. \end{aligned} \tag{7}$$

13. See section 8.1 in the appendix to the working paper version (Céspedes, Fornero, and Galí, 2012).

14. As in Galí, López-Salido, and Vallés (2007), we rule out the possibility that non-Ricardian households can smooth consumption through money holdings, in contrast with Coenen, McAdam, and Straub (2008).

2.1.3 Wage setting

Wage setting closely follows the formalism in Erceg and Levin (2003), with indexation as in Smets and Wouters (2007). Each consumer is specialized in a differentiated labor service, which is demanded by all firms. The wage elasticity of the demand for each type of labor is constant. Each period, a given consumer can optimally reset the nominal wage for his labor type with probability ϕ_L. Once the new wage is set, the consumer fully meets the demand for its labor type at the quoted wage. Between reoptimization periods, we allow the nominal wage to be adjusted mechanically according to the following indexation rule:

$$W_t^j(h) = \left(\Pi_{t-1}\right)^{\xi_L} \left(\bar{\Pi}\right)^{1-\xi_L} W_{t-1}^j(h),$$

which makes the rate of change of the individual wage a weighted geometric average of lagged price inflation, Π_{t-1}, and steady-state price inflation, $\bar{\Pi}$, with ξ_L representing the weight of the former. Presumably, non-Ricardian agents will react more to wages than Ricardian agents. Thus, in contrast to Medina and Soto (2007), we allow for each agent type to supply different number of hours.[15]

2.2 Firms

There are two types of firms operating in the economy: intermediate goods producers and importers. There are also foreign firms, but we do not model their behavior explicitly.

2.2.1 Domestic producers

We assume a continuum of monopolistically competitive firms, each of which produces a differentiated good. Firm *i*'s production function depends on an exogenous technology, capital, and labor:

$$Y_{H,t}(i) = A_{H,t}\left[u_t^R K_{t-1}(i)\right]^{\gamma} L_t(i)^{1-\gamma} - FC_H, \tag{8}$$

where FC_H is a nonnegative fixed cost, measured in terms of output.

15. See appendix for details.

The labor input bundle, $L_t(i)$, is given by the CES function

$$L_t(i) \equiv \left[\lambda^{\frac{1}{\eta_L}} L_t^N(i)^{1-\frac{1}{\eta_L}} + (1-\lambda)^{\frac{1}{\eta_L}} L_t^R(i)^{1-\frac{1}{\eta_L}} \right]^{\frac{\eta_L}{\eta_L - 1}}, \tag{9}$$

where η_L is the elasticity of substitution between Ricardian and non-Ricardian labor and where

$$L_t^R(i) \equiv \left[\left(\frac{1}{1-\lambda} \right)^{\frac{1}{\varepsilon_{LR}}} \int_{\lambda}^{1} L_t^R(i,h)^{1-\frac{1}{\varepsilon_{LR}}} dh \right]^{\frac{\varepsilon_{LR}}{\varepsilon_{LR}-1}}$$

and

$$L_t^N(i) \equiv \left[\left(\frac{1}{\lambda} \right)^{\frac{1}{\varepsilon_{LN}}} \int_{0}^{\lambda} \left(L_t^N(i,h) \right)^{1-\frac{1}{\varepsilon_{LN}}} dh \right]^{\frac{\varepsilon_{LN}}{\varepsilon_{LN}-1}}.$$

Firms minimize costs subject to equation (8) and conditional on any given output level. The resulting real marginal cost function is as follows (where we drop the *i* index since firms have identical costs):

$$MC_{H,t} = \frac{1}{A_{H,t}} \frac{\left(r_t^k\right)^{\gamma} w_t^{1-\gamma}}{\gamma^{\gamma}(1-\gamma)^{1-\gamma}}. \tag{10}$$

Each period, each domestic firm decides how much of each type of labor to hire, given the wage $W_t^j(h)$, and how much capital services to rent, given the rental rate R_t^K. In addition, and with probability ϕ_H, any given firm can optimally readjust the price of its good, setting a price $\tilde{P}_{H,t}(i)$. In the absence of reoptimization, the firm's price is adjusted mechanically according to the indexation rule

$$P_{H,t}(i) = \left(\Pi_{t-1}\right)^{\xi_H} \left(\bar{\Pi}\right)^{1-\xi_H} P_{H,t-1}(i).$$

Given its price at any point in time, the firm produces a quantity that fully meets the demand for its good.

2.2.2 Importers

There is a continuum of firms that import a good produced overseas at a price $S_t P_{F,t}^*$, repackage it, and sell it as a differentiated good in the domestic market. Each importer reoptimizes the price of its good with a probability ϕ_F, setting a price $\tilde{P}_{F,t}(i)$, subject to a sequence of demand constraints. In the absence of reoptimization, the price is adjusted according to the indexation rule:

$$P_{F,t}(i) = (\Pi_{t-1})^{\xi_F} (\bar{\Pi})^{1-\xi_F} P_{F,t-1}(i).$$

Like domestic producers, importers meet the demand for their good at the prevailing price.

2.3 Fiscal Policy

The government purchases goods from both domestic firms and importers. Those purchases are assumed not to have any effect on private utility or productivity. The government allocates its consumption expenditures, given by

$$\int_0^1 P_{H,t}(i) G_{H,t}(i) di + \int_0^1 P_{F,t}(i) G_{F,t}(i) di,$$

among the different goods in order to maximize

$$G_t \equiv \left[(1-\alpha_G)^{\frac{1}{\eta}} G_{H,t}^{1-\frac{1}{\eta}} + (\alpha_G)^{\frac{1}{\eta}} G_{F,t}^{1-\frac{1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \tag{11}$$

where

$$G_{H,t} \equiv \left[\int_0^1 G_{H,t}(i)^{1-\frac{1}{\varepsilon_G}} di \right]^{\frac{\varepsilon_G}{\varepsilon_G - 1}}$$

and

$$G_{F,t} \equiv \left[\int_0^1 G_{F,t}(i)^{1-\frac{1}{\varepsilon_G}} di \right]^{\frac{\varepsilon_G}{\varepsilon_G - 1}}.$$

The solution to that problem yields a set of demand functions for each good, which have to be added to the demand for private consumption and investment purposes. The associated Lagrange multiplier is the true price index, $P_{G,t}$:

$$P_{G,t}^{1-\eta} = (1-\alpha_G) P_{H,t}^{1-\eta} + \alpha_G P_{F,t}^{1-\eta}. \tag{12}$$

In addition to purchasing goods, the government taxes consumption, labor income, and profits, transfers resources to consumers, and issues debt in the domestic and foreign goods markets. That activity is summarized in the government budget constraint, which takes the following form:

$$\begin{aligned}
&P_t Tr_t + g_t P_t Y_t + B_t + S_t B_t^* + (\mathcal{S}_F - 1) P_{F,t} \int_0^1 C_{F,t}(h)\,dh \\
&+ (\mathcal{S}_F - 1) P_{F,t} \int_\lambda^1 I_{F,t}^R(h)\,dh + (\mathcal{S}_F - 1) P_{F,t} G_{F,t} \\
&+ (\mathcal{S}_{WR} - 1) \int_\lambda^1 W_t^R(h) L_t^R(h)\,dh \\
&+ (\mathcal{S}_{WN} - 1) \int_0^\lambda W_t^N(h) L_t^N(h)\,dh = \frac{B_{t+1}}{R_t} + \frac{S_t B_{t+1}^*}{R_t^* \mathrm{RP}_t} \qquad (13) \\
&+ \tau_{w,t} \left[\mathcal{S}_{WR} \int_\lambda^1 W_t^R(h) L_t^R(h)\,dh + \mathcal{S}_{WR} \int_0^\lambda W_t^N(h) L_t^N(h)\,dh \right] \\
&+ \tau_{\mathrm{Pr},t} \int_\lambda^1 \mathrm{Pr}_t^R(h)\,dh + P_t \int_0^1 TX_t(h)\,dh + P_{cu,t} \kappa X_{cu,t} Y_t \\
&+ \tau_{cu,t} P_{cu,t} (1-\kappa) X_{cu,t} Y_t + P_{mo,t} X_{mo,t} Y_t.
\end{aligned}$$

The terms on the left-hand side represent different government outlays. These include transfers,

$$Tr_t \equiv \int_0^1 Tr_t(h)\,dh = \int_\lambda^1 Tr_t^R(h)\,dh + \int_0^\lambda Tr_t^N(h)\,dh;$$

government consumption, $P_{G,t} G_t \equiv g_t P_t Y_t$, where $g_t \equiv P_{G,t} G_t / P_t Y_t$ is the share of government consumption in GDP; repayment of maturing government bonds (both domestic, B_t, and foreign, $S_t B_t^*$); and subsidies on foreign goods expenditures and employment Those outlays are funded through the issuing of new debt (domestic, B_{t+1} / R_t, and foreign, $S_t B^*_{t+1} / R_t^* \mathrm{RP}_t$), labor income taxes, taxes on profits, lump-sum taxes, and copper-related revenues. The latter are briefly explained next.

Copper production is assumed to be stochastic and exogenous. Consistent with the market structure of copper production in Chile, the state-owned company accounts for a share κ of production, all of which accrues to the government as revenue. The remaining share corresponds to foreign companies, which are taxed at a rate of $\tau_{cu,t}$. We assume that world copper prices, $P^*_{cu,t}$, are exogenously given, implying a domestic copper price of $P_{cu,t}$, $= S_t P^*_{cu,t}$. The share of copper production to GDP, $X_{cu,t}$, follows an exogenous process, described below. In addition, $X_{mo,t}$ represents the output of molybdenum (a byproduct of copper production) as a share of GDP. The world molybdenum price is exogenous and given by $P^*_{mo,t}$. All revenues from molybdenum production accrue to the government.

Following Forni, Monteforte, and Sessa (2009), tax rates on wages, benefits, and copper production are allowed to vary

$$\tau_{w,t} = \left(1 - \rho_{\tau_w}\right)\tau_w + \rho_{\tau_w}\tau_{w,t-1} + \varepsilon_{\tau_w,t}, \tag{14}$$

$$\tau_{\mathrm{Pr},t} = \left(1 - \rho_{\tau_{\mathrm{Pr}}}\right)\tau_{\mathrm{Pr}} + \rho_{\tau_{\mathrm{Pr}}}\tau_{\mathrm{Pr},t-1} + \varepsilon_{\tau_{\mathrm{Pr}},t}, \tag{15}$$

$$\tau_{cu,t} = \left(1 - \rho_{\tau_{cu}}\right)\tau_{cu} + \rho_{\tau_{cu}}\tau_{cu,t-1} + \varepsilon_{\tau_{cu},t}, \tag{16}$$

where τ_w, τ_{Pr}, and τ_{cu} are long-run tax rates, ρ_{τ_w}, $\rho_{\tau_{\mathrm{Pr}}}$, and $\rho_{\tau_{cu}}$ explain the degree of persistency, and $\varepsilon_{\tau_w,t}$, $\varepsilon_{\tau_{\mathrm{Pr}},t}$, and $\varepsilon_{\tau_{cu},t}$ are independent and identically distributed (i.i.d.) shocks with zero means and constant variances.

Fiscal policy in Chile is conducted within the framework of a structural balance rule.[16] As discussed in the introduction, the Chilean fiscal rule ties government spending to structural, or

16. Previous papers that analyze the effects of the Chilean fiscal rule in DSGE models include García and Restrepo (2007), Medina and Soto (2007), and Kumhof and Laxton (2009).

permanent, government revenues. The Chilean government has followed this rule explicitly since 2001 and implicitly since the early 1990s.[17] We formalize the rule by assuming that total government spending (including interest payments) plus a time-varying surplus target (SURPLUS) must be equal to structural revenues. Structural revenues correspond to the revenues that the government would collect if (i) the prices of copper and molybdenum were equal to their long-run or reference values (denoted by $P^{ref}_{cu,t}$ and $P^{ref}_{mo,t}$, respectively) and (ii) the economy were producing at its steady-state level (potential output). The surplus target—that is, the difference between government spending and structural revenues—is set by the fiscal authorities. When the fiscal rule was introduced in 2001, the structural surplus target was set at 1 percent of GDP. The idea was to acknowledge that public debt was at a higher level than was considered appropriate for a small open economy facing exogenous credit constraint shocks and given potential future pension liabilities. Although fiscal policy was not conducted using an explicit rule in the 1990s, the "shadow" structural surplus averaged 1 percent of GDP in that decade. Again, the goal behind the structural balance rule was to reduce government debt to some long-run (sustainable) level. Motivated by the observed practice, we assume that the structural surplus (SURPLUS_t) is a function of the difference between current government debt and a long-term target for government debt ($\bar{B} = B + SB^*$):

$$\text{SURPLUS}_t = F\left(\bar{B}_t - \bar{B}\right) + s_t, \tag{17}$$

where $F' > 0$. If government debt is higher than its long-run target, the structural surplus is positive, which reduces government spending given structural revenues. Additionally, we assume that the surplus target depends on an exogenous shock, s_t, that follows an AR(1) process. In particular, we assume that

$$s_t = \rho_s s_{t-1} + \varepsilon_{s,t}, \tag{18}$$

where $\varepsilon_{s,t}$ follows an i.i.d. process with mean zero and constant variance $\sigma^2_{\varepsilon_s}$.

17. By implicitly, we mean that even though there was no explicit commitment to any fiscal policy rule in that period, fiscal policy outcomes in the 1990s resemble the ones that could have been obtained by the implementation of the Chilean fiscal rule of the 2000s.

In practice, we assume that $\bar{B} = 0$ (Chile held a net credit position of around 3 percent of GDP by the end of the last decade). This formulation allows us to have a well-specified fiscal rule (in which government debt is stationary), while capturing the most relevant aspects of the Chilean fiscal rule. A negative surplus shock (that is, a reduction in s) makes room for a rise in total government spending, which can be allocated to transfers or consumption. Under this formulation, the dynamics of debt are described by

$$\bar{B}_{t+1} - \bar{B}_t = \left(P^{ref}_{cu,t} - P_{cu,t}\right)\kappa X_{cu,t}$$

$$+ \tau_{cu,t}\left(P^{ref}_{cu,t} - P_{cu,t}\right)\left(1-\kappa\right)X_{cu,t} + \left(P^{ref}_{mo,t} - P_{mo,t}\right)X_{m,t}$$

$$+ \tau_{w,t}\left[\mathcal{S}_{WR}\int_{\lambda}^{1} W^{R}\left(h\right)L^{R}\left(h\right)dh + \mathcal{S}_{WR}\int_{0}^{\lambda} W^{N}\left(h\right)L^{N}\left(h\right)dh\right]$$

$$- \tau_{w,t}\left[\mathcal{S}_{WR}\int_{\lambda}^{1} W^{R}_{t}\left(h\right)L^{R}_{t}\left(h\right)dh + \mathcal{S}_{WR}\int_{0}^{\lambda} W^{N}_{t}\left(h\right)L^{N}_{t}\left(h\right)dh\right]$$

$$+ \tau_{\mathrm{Pr},t}\left[\int_{\lambda}^{1}\mathrm{Pr}^{R}\left(h\right)dh - \int_{\lambda}^{1}\mathrm{Pr}^{R}_{t}\left(h\right)dh\right] - \mathrm{SURPLUS}_t .$$

Clearly, if the current price of copper is above its long-term value, we have a fiscal surplus (a reduction in government debt). The same is true for the other determinants of government revenues.

From this particular specification of the Chilean fiscal rule, we can derive a more traditional fiscal policy representation for the Bayesian estimation of the structural model, along the lines of our empirical strategy. We assume a specification for government consumption and transfers consistent with the representation of the Chilean fiscal rule just described. In particular, we represent government consumption by the next process:

$$g_t = \left(1 - \rho_G\right)g + \rho_G g_{t-1} + \varepsilon_{G,t}, \tag{19}$$

where ρ_G measures the persistence of the process, g is the long-run government share, $P_G G / PY$, and $\varepsilon_{G,t}$ is an exogenous shock with mean zero and constant variance $\sigma^2_{\varepsilon_G}$. Under this specification, shocks to government consumption imply an increase in government debt in the current period and an adjustment in the structural surplus target (SURPLUS) for the next period. Given our specification, the adjustment in the surplus target translates into an adjustment in government transfers. Shocks to the surplus target (s) consistently translate into one-to-one movements in transfers. In particular, a negative shock to the surplus target increases government transfers. The evolution of transfers mimics the evolution of the surplus target (SURPLUS) determined by equations (17) and (18).

2.4 Monetary Policy

We assume that the Central Bank sets the (gross) nominal interest rate, $R_{rule,t}$ according to a variant of the Taylor rule with partial adjustment, given by

$$R_t = R_{t-1}^{\psi_R} R_{rule,t}^{1-\psi_R} \exp\left(\varepsilon_{m,t}\right) \tag{20}$$

and

$$R_{rule,t} = \left(\frac{\Pi_{A,t}}{\bar{\Pi}_A}\right)^{\psi_\pi} \left(\frac{Y_{r,t}}{\bar{Y}_r}\right)^{\psi_y}, \tag{21}$$

where Ψ_R determines the degree of smoothing and $\varepsilon_{m,t}$ is an exogenous i.i.d. monetary policy shock. The target values are steady-state GDP without the copper sector, $\bar{Y}_r$, and inflation, $\bar{\Pi}_A$, is assumed to be one for simplicity.[18] According to the Taylor principle, the reaction parameter to annualized inflation deviations, Ψ_π, should be larger than one, where $\Pi_{A,t} \equiv \Pi_t^4$, while Ψ_y for quarterly data should be around 0.5/4.

We have also studied an extension of the above rule that allows for a systematic interest rate response to nominal exchange rate variations. That extension could be useful for accommodating the policy regime from 1986:1 to 2001:2, as documented by Medina and Soto (2007). In the analysis that follows we ignore this term since this paper focuses on the sample period from 2001:3 to 2010:1.

18. This is without loss of generality, since in the 2000s the inflation rate in Chile fluctuated quite closely around the three percent inflation target. In the empirical implementation, we subtract this target.

2.5 Equilibrium and Aggregation

We first state clearing conditions in the markets for domestic inputs. For the labor services of household h, the market clearing condition is given by

$$L_t(h) = \int_0^1 L_t(h,i)di,$$

where $L_t(h,i)$ is firm i's demand for labor services from household h. A similar condition must hold for all $h \in (0, 1)$.

Given that only Ricardian households engage in capital accumulation, the market clearing condition in the market for that input is given by

$$K_t = (1-\lambda)K_t^R,$$

where $(1-\lambda)K_t^R = \int_\lambda^1 K_t^R(h)dh$. Similarly, for other asset holdings, we have

$$B_t = (1-\lambda)B_t^R$$

and

$$B_t^* = (1-\lambda)B_t^{R,*} - B_t^{G,*}.$$

Since $B_t^{G,*}$ is the amount of liabilities, a negative sign implies net holdings. In the same manner, aggregate real variables such as consumption and investment are

$$C_t = \lambda C_t^N + (1-\lambda)C_t^R$$

and

$$I_t = (1-\lambda)I_t^R,$$

where C_t^R and C_t^N come from aggregators similar to equation (2) and

$$(1-\lambda)I_t^R = \int_\lambda^1 I_t^R(h)dh.$$

Market clearing in home-produced goods implies that supply, given by the aggregated version of equation (8), equals demand:

$$Y_{H,t} = \Delta_{H,t}\left[T_{H,t}^{-\eta}(1-\alpha)(C_t + I_t) + T_{GH,t}^{-\eta}(1-\alpha_G)G_t\right] + \left(\alpha_C^* + \alpha_I^*\right)\left(\frac{T_{H,t}}{\text{RER}_t}\right)^{-\eta} Y_t^*, \quad (22)$$

where Δ_H is the price dispersion implied by the Calvo pricing scheme for home goods. This number is typically above one for approximations of higher order than one. After some algebra, we can derive the following expression for aggregate output, Y_t, and aggregate output without copper, $Y_{r,t}$:[19]

$$Y_t = \frac{(C_t + I_t)\left[1 - \Delta_{F,t}\alpha\left(T_t T_{H,t}\right)^{1-\eta}\right] + \Phi\left(u_t^R\right)K_{t-1}}{1 - \text{RER}_t\left(p_{cu,t}^* X_{cu,t}^{share} + p_{mo,t}^* X_{mo,t}^{share}\right) - \left[1 - \Delta_{F,t}\alpha_G\left(T_t T_{GH,t}\right)^{1-\eta}\right]g_t}, \quad (23)$$

where Δ_F is the price dispersion implied by the Calvo pricing scheme for foreign goods (again, this number is typically above one for approximations of higher order than one); and

$$Y_{r,t} = \frac{(C_t + I_t)\left[1 - \Delta_{F,t}\alpha\left(T_t T_{H,t}\right)^{1-\eta}\right] + \Phi\left(u_t^R\right)K_{t-1}}{1 - \left[1 - \Delta_{F,t}\alpha_G\left(T_t T_{GH,t}\right)^{1-\eta}\right]g_t}. \quad (24)$$

The Central Bank targets $Y_{r,t}$ instead of Y_t. From equation (23), we can find out the domestic private demand (consumption and investment) as follows:

$$C_t + I_t = \frac{Y_t\left\{\begin{array}{l}1 - \text{RER}_t\left(p_{cu,t}^* X_{cu,t}^{share} + p_{mo,t}^* X_{mo,t}^{share}\right)\\ -\left[1 - \Delta_{F,t}\alpha_G\left(T_t T_{GH,t}\right)^{1-\eta}\right]g_t\end{array}\right\} - \Phi\left(u_t^R\right)K_{t-1}}{\left[1 - \Delta_{F,t}\alpha\left(T_t T_{H,t}\right)^{1-\eta}\right]}. \quad (25)$$

19. For details, see the derivation in section 8.2 of the appendix in the working paper version (Céspedes, Fornero, and Galí, 2012).

The evolution of net foreign assets under incomplete international asset markets is[20]

$$\frac{S_{t-1}B_t^*}{P_{t-1}}\frac{S_t}{S_{t-1}}\frac{1}{\Pi_t}+NX_t=\frac{1}{R_t^*\mathrm{RP}_t(\cdot,\cdot,\cdot)}\frac{S_tB_{t+1}^*}{P_t}, \tag{26}$$

where we employed the following net exports definition:

$$\begin{aligned} NX_t \equiv\ & \mathrm{RER}_t\left(p_{cu,t}^*\kappa X_{cu,t}^{share}+p_{mo,t}^*X_{mo,t}^{share}\right)Y_t \\ & +\Delta_{H,t}\left[\frac{T_{H,t}^{1-\eta}}{MC_{H,t}}(1-\alpha)(C_t+I_t)+\frac{T_{GH,t}^{1-\eta}}{MC_{H,t}}(1-\alpha_G)g_tY_t\right] \\ & +\frac{T_{H,t}}{MC_{H,t}}\left(\alpha_C^*+\alpha_I^*\right)\frac{T_{H,t}^{-\eta}}{\mathrm{RER}_t^{-\eta}}Y_t^*-T_HFC_H \\ & -\Delta_{H,t}(C_t+I_t)-g_tY_t-\Phi\left(u_t^R\right)K_{t-1}. \end{aligned} \tag{27}$$

Here we take into account that $C_t + I_t$ come from equation (25).

The model has seventeen exogenous driving forces, which are collected in the following vector:

$$\mathbf{v}_t=\begin{pmatrix} \upsilon_{m,t},\zeta_t,\mathrm{RER}_{F,t},\Pi_t^*,Y_t^*,A_{H,t},x_{cu,t}^{share},x_{mo,t}^{share}, \\ R_t^*,\phi_{,t},\varepsilon_{I,t},g_t,\tau_{w,t},\tau_{\mathrm{Pr},t},\tau_{cu,t},p_{cu,t}^*,p_{mo,t}^* \end{pmatrix}.$$

Strictly, the exógenous variable s_t (equation 18) should be included, but since we think that fiscal credibility in the rule is incompatible with variability of the surplus target, we omitted it (in other words, we think that s_t has a small variance).

The vector is assumed to follow the process

$$\underset{(17\times1)}{\mathbf{v}_t}=\underset{(17\times17)}{\mathbf{r}}\underset{(17\times1)}{\mathbf{v}_{t-1}}+\underset{(17\times1)}{\mathbf{e}_t},$$

where $\mathbf{r}$ is a diagonal matrix containing the corresponding autoregressive coefficients and $\{\mathbf{e}_t\}$ is the vector of exogenous serially uncorrelated shocks with zero mean and diagonal variance-covariance matrix $\mathbf{S}_\mathbf{e}$.

20. For further details on the derivation, see section 8.3 of the appendix in the working paper version (Céspedes, Fornero, and Galí, 2012).

3. Calibration and Estimation

We estimate the above model using Bayesian methods. First, we define the measurement equation that links the observed variables with the model's solution or law of motion.[21] We then use the Kalman filter to evaluate the posterior density (which is proportional to the product of the likelihood and the assumed prior densities).[22]

To be consistent with the assumptions involving technology in the model, we get rid of the trend of nonstationary variables by filtering the data with a (deterministic) quadratic trend (in accordance with our VAR estimation). We also lower the observed inflation rate by the inflation target, namely, 3 percent annually. For the interest rate, we subtract a neutral interest rate of 5 percent (the inflation target plus an assumed steady-state real rate of 2 percent). We restrict estimation to the sample period 2001:3–2010:1, which was characterized by a well-defined monetary policy based on an inflation target and a flexible exchange rate.

We calibrate a subset of parameters. These are $\beta = 0.9878$, which is consistent with a neutral annual interest rate of 5 percent. Import shares, $\alpha = \alpha_G = 0.3$, approximate the import/GDP ratio. The settings $\alpha_C^* = \alpha_I^* = 0.0004$ are consistent with the share of Chilean GDP in world GDP (0.35 percent). The elasticities of substitution among varieties of intermediate and final imported goods are $\varepsilon_H = \varepsilon_F = 11$, consistent with markups $\mu_H = \mu_F = S_F = 1.1$. The elasticities of substitution among varieties of labor types are $\varepsilon_{LR} = \varepsilon_{LN} = 9$, which imply markups $\mu_{WR} = S_{WR} = \mu_{WN} = S_{WN} = 1.125$. In addition, $\bar{\zeta} = 7.5$ as in Adolfson and others (2007), the annual depreciation rate is assumed to be 10 percent ($\delta = 0.025$), and some steady-state ratios and relative prices are $X_{cu}^{share} = 0.044$, $X_{mo}^{share} = 0.01$, $g = 0.094$, $A_H = 1$, $\tau_w = 0.2$, $\tau_{\mathrm{Pr}} = 0.17$, and $T = T_H = T_{GH} = 1$. We also left calibrated the Calvo price and wage probabilities because of lack of identification under usual priors. Furthermore, the habit formation parameter affects the steady state due to the assumption of internal habit formation; we therefore calibrate it to 0.8. For the exogenous processes of copper and molybdenum shares that are not identified, ρ_{xcu} and ρ_{xmo}, we assume an autoregressive coefficient of 0.1.[23] Finally, the elasticity η is calibrated to 2.

21. Calculations are performed with the set of routines included in DYNARE (Adjemian and others, 2011).

22. For details on these aspects, see Fornero (2010).

23. We also tried a VAR(1) for foreign variables, as is usually done in the literature; however, off-diagonal elements of the persistency matrix turned out to be not statistically different from zero. Thus, we specify AR(1) processes for R^*, Π^*, and Y^*.

The crucial parameter λ is left calibrated to 0.50 due to lack of identification. Data from the Household Financial Survey implemented by the Central Bank of Chile in 2007 suggest a λ value of 0.29. This value is computed by adding the fraction of households that requested a financial credit and were rejected one or more times, the fraction that did not apply for any financial credit because they expected to be rejected, and the fraction that considered themselves unable to afford the credit payments. However, we calibrate λ to a conservative 0.50 since the data from the Household Financial Survey correspond to a period in which credit expanded rapidly toward first time credit holders.[24]

The prior densities are quite standard (see table 5). We choose a gamma density for the friction parameter of investment, Ψ, with prior mean 50 and a standard deviation of 20. The prior mean for the elasticity of the risk premium (RP) function respect to the asset position is 0.04 with prior standard deviation of one-tenth of the mean with beta distribution. A similar density type is chosen for persistence parameters (such as Ψ_R and ρ) with mean 0.5 and variance 0.2. The priors for Taylor rule parameters are quite standard (see Smets and Wouters, 2003). For variances of standard errors and measurement errors, we assume inverted gamma distributions with 20 and 1 degrees of freedom, depending on whether the errors refer to variables or shares (which vary less), respectively (see table 6).

The set of observed variables includes 11 time series, which are gathered in the vector $\mathbf{oZ}_t = (oY_{r,t}, oY_t^*, oC_t, oI_t, o\Pi_t, o\Pi_t^*, oR_t, oR_t^*, ow_t, o\mathrm{RER}_t, og_t)'$. Since the current model version does not have a balanced growth path, the data have been filtered using a linear quadratic trend or, if the resulting detrended time series is not stationary, the Hodrick-Prescott filter. We then scaled variables with the SS values. In addition, we allow for measurement errors, which are included in the vector $\mathbf{meZ}_t = (\mathrm{me}Y_{r,t}, \mathrm{me}Y_t^*, \mathrm{me}C_t, \mathrm{me}I_t, \mathrm{me}\Pi_t, \mathrm{me}\Pi_t^*, \mathrm{me}R_t, \mathrm{me}R_t^*, \mathrm{me}w_t, \mathrm{meRER}_t, \mathrm{me}g_t)'$. In the case of interest rates and inflation, which are not filtered, we subtract the neutral interest rates and inflation targets (foreign inflation is demeaned). Measurement errors are assumed to be i.i.d.

24. Ruiz-Tagle (2009) definescredit-constrained households as those who do not have access to low-cost credit and hence end up using high-cost credit (credit cards). He finds that at least 41 percent of Chilean households were credit constrained in 2004.

Table 5. Estimation Results for Chilean Fiscal Rule

Parameter	*Prior density*	*Prior mean*	*Prior std. dev.*	*Posterior mean*	*Confidence level*	
					0.05	*0.95*
Ψ	Γ	50.000	20.000	64.3307	37.3497	91.4607
ϕ_a	β	0.040	0.004	0.0393	0.0326	0.0465
θ	N	1.000	0.250	0.9359	0.5269	1.4169
ψ_R	β	0.500	0.150	0.8441	0.6771	0.9445
ψ_{ϖ}	N	1.500	0.150	1.2490	0.9751	1.5452
ψ_{yr}	β	0.125	0.050	0.1729	0.0670	0.2745
ρ_{ς}	β	0.500	0.200	0.7033	0.3380	0.9501
ρ_{RERF}	β	0.500	0.200	0.9338	0.8781	0.9740
ρ_{ς}	β	0.500	0.200	0.5098	0.1845	0.8135
ρ_{ς}	β	0.500	0.200	0.4853	0.3284	0.6360
ρ_{y*}	β	0.500	0.200	0.4913	0.1717	0.8071
ρ_{AH}	β	0.500	0.200	0.7555	0.4927	0.9325
ρ_G	β	0.500	0.200	0.7138	0.5341	0.8921
ρ_{R*}	β	0.500	0.200	0.4861	0.2121	0.7808
$\rho_{\varepsilon I}$	β	0.500	0.200	0.5875	0.2482	0.8941
$\rho_{\upsilon tr}$	β	0.500	0.200	0.5565	0.2293	0.8551

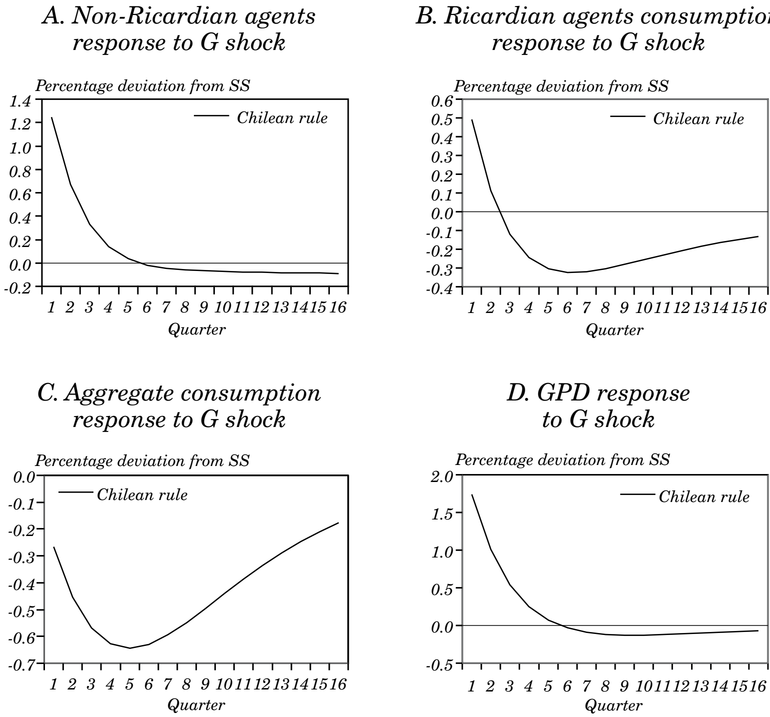
Source: Authors' computations.

Table 6. Estimation Results for Chilean Fiscal Rule: Errors and Measurement Errors

Error	Prior density	Prior mean	Degrees of freedom	Posterior mean	Confidence level	
					0.05	0.95
Standard errors						
υ_m	Γ^{-1}	0.010	20	0.0038	0.0020	0.0052
ε_ς	Γ^{-1}	0.010	20	0.0424	0.0029	0.0689
ε_{RERF}	Γ^{-1}	0.010	20	0.0032	0.0020	0.0043
$\varepsilon_{\varpi*}$	Γ^{-1}	0.037	20	0.0140	0.0111	0.0169
ε_{AH}	Γ^{-1}	0.010	20	0.0054	0.0036	0.0074
$\varepsilon_{\phi a}$	Γ^{-1}	0.010	20	0.0044	0.0023	0.0064
ε_I	Γ^{-1}	0.010	20	0.0122	0.0027	0.0260
ε_G	Γ^{-1}	0.001	1	0.0038	0.0026	0.0052
ε_{tr}	Γ^{-1}	0.010	20	0.0061	0.0025	0.0098
ε_s	Γ^{-1}	0.010	1	0.0085	0.0026	0.0150
Measurement errors						
me_{YR}	Γ^{-1}	0.001	1	0.0010	0.0003	0.0016
me_C	Γ^{-1}	0.001	1	0.0007	0.0003	0.0011
me_I	Γ^{-1}	0.001	1	0.0711	0.0558	0.0847
me_ϖ	Γ^{-1}	0.001	1	0.0037	0.0002	0.0193
me_R	Γ^{-1}	0.001	1	0.0006	0.0002	0.0009
me_W	Γ^{-1}	0.001	1	0.0256	0.0182	0.0330
me_{RER}	Γ^{-1}	0.001	1	0.0468	0.0352	0.0592
me_{Y*}	Γ^{-1}	0.001	1	0.0007	0.0003	0.0012
$me_{\varpi*}$	Γ^{-1}	0.001	1	0.0006	0.0002	0.0011
me_{R*}	Γ^{-1}	0.001	1	0.0007	0.0003	0.0012
me_g	Γ^{-1}	0.001	1	0.0021	0.0009	0.0037

Source: Authors' computations.

Figure 5. A Positive Shock to g_t of One Percent



Source: Authors' computations.

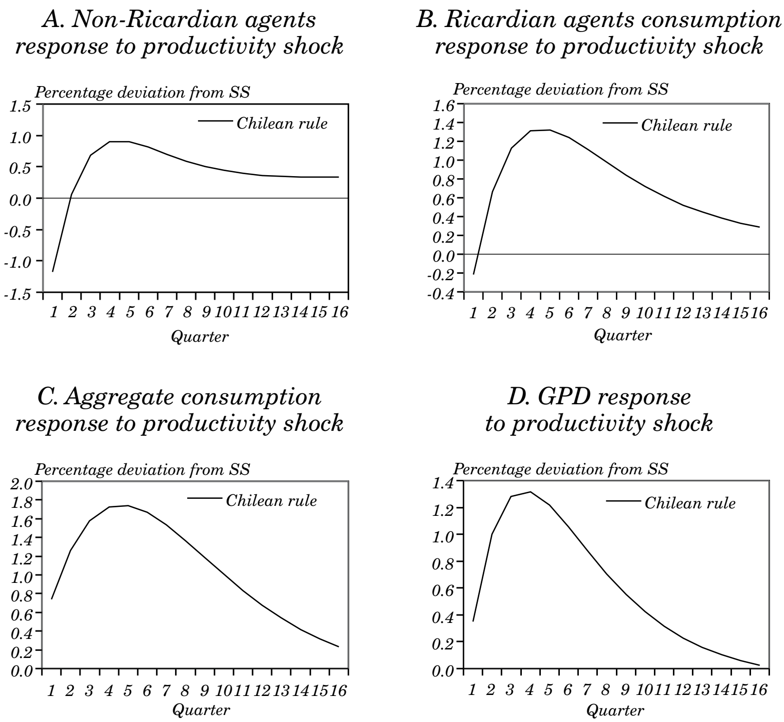
4. Simulations

In this section we present impulse response functions to various shocks under the structural balance fiscal rule introduced above. We then calculate the estimated model's fiscal multipliers.

4.1 Impulse Response Functions

Our analysis of the impulse response functions focuses on the implied size of the consumption and output fiscal multipliers. Figure 5 presents the dynamic response of the economy for a government spending (consumption) shock, ε_G, equal to 1 percent of GDP. The impact on output and consumption is positive.

Figure 6. A Positive Productivity Shock of One Percent

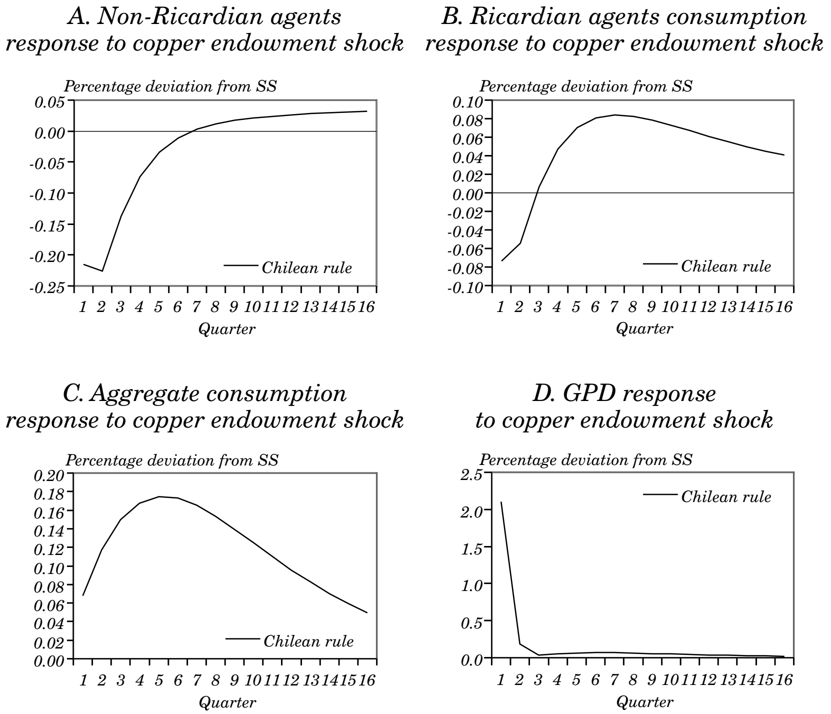


Source: Authors' computations.

Government expenditure increases following equation (19). Since transfers only respond gradually to offset the increase in spending, through changes in the surplus target, the shock is more expansionary and stimulates consumption and output. This is a critical difference with the case in which the government follows a structural balance rule. Under this formulation, the transfers will have to adjust to fully offset the increase in government consumption. This impulse response is consistent with the VAR evidence reported in a previous section.

Figure 6 displays the impulse response functions to a positive shock to total factor productivity. As a result of that shock, marginal costs decrease; nominal wages tend to increase, but since they are sticky they cannot react immediately; and real wages rise due to

Figure 7. A Positive Shock to the Copper-to-GDP Share of One Percent

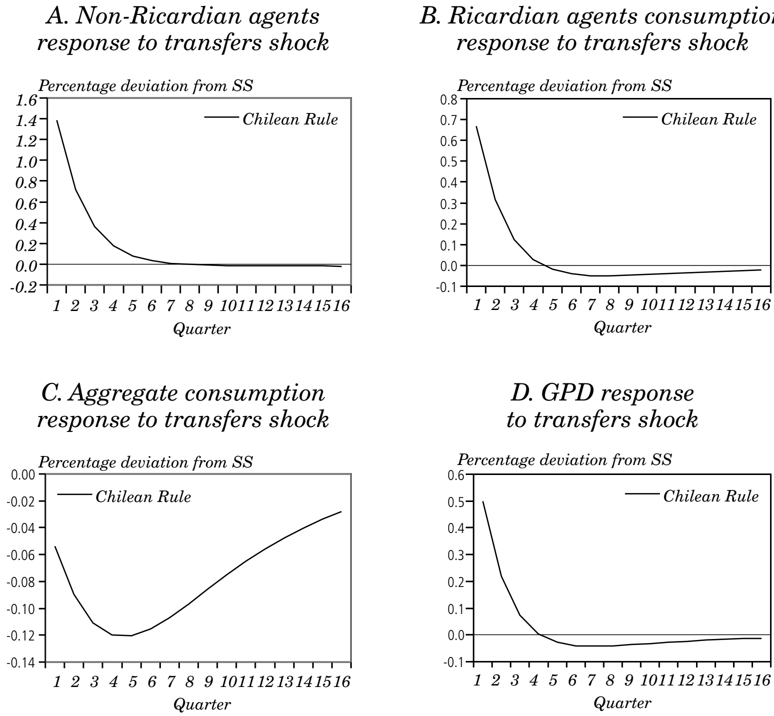


Source: Authors' computations.

deflationary pressures caused by the shock. The real exchange rate appreciates, which mitigates the expansion of exports. Consumption by Ricardian agents reacts positively, whereas non-Ricardian agents' consumption remains negative for two quarters. The higher consumption by Ricardian agents under the Chilean fiscal rule can be associated with the fact that under this specification of fiscal policy, agents understand that the government is going to save, so they consume more.

Figure 7 illustrates a shock in the copper-to-GDP share of 1 percentage point. The GDP multiplier is positive. Consumption by Ricardian agents increases. A fraction of this increase is explained by the fact that under the Chilean fiscal rule, the government is saving the temporary increase in revenues, which is compatible with

Figure 8. A Positive Transfers Shock of One Percent

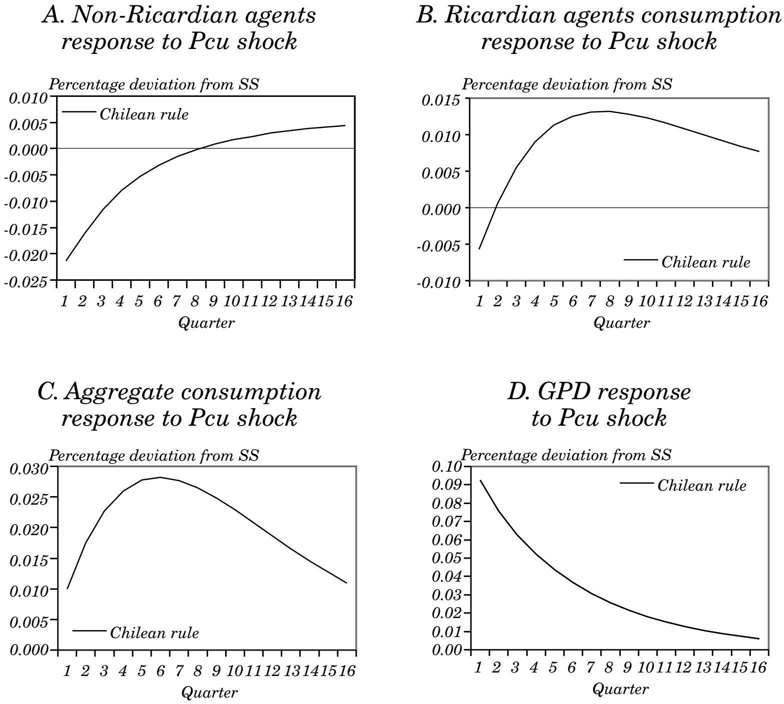


Source: Authors' computations.

larger consumption levels for Ricardian agents. The response of non-Ricardian agents' consumption is interesting to analyze. Under a balanced budget rule, all the temporary increase in revenues would be transferred to the public, leading to a large increase in consumption by non-Ricardian households in the short run (as opposed to Ricardian agents, who smooth consumption and hence save much of the transfer). By contrast, the Chilean rule would fix the expenditure to a constant, such that government savings would increase.

Figure 8 considers a shock to transfers of 1 percent. Note that the estimated persistence of the AR(1) process for transfers is 0.56. Ricardian consumers save the temporary increase in transfers, whereas non-Ricardian agents consume all of it. The positive response of consumption by non-Ricardian agents leads to an aggregate

Figure 9. A Positive Shock to the Copper Price of One Percent



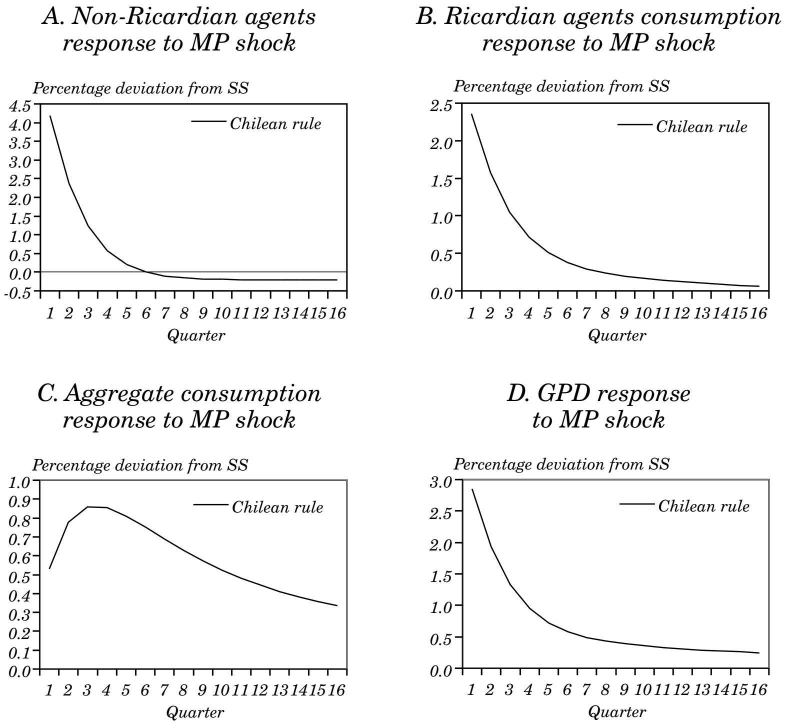
Source: Authors' computations.

consumption multiplier that is positive for about one year. GDP increases as well, and the response path suggests a larger multiplier than consumption.

Figure 9 reports a positive shock of 1 percent in the price of copper relative to the foreign price index. The results are qualitatively similar to those observed in figure 5. The GDP multiplier is positive, as is Ricardian consumption. Non-Ricardian consumption decreases under the Chilean rule, because the government saves for a while by buying public debt.[25]

25. The GDP multiplier also remains positive in the case of a zero-deficit rule (results not shown). Non-Ricardian consumption increases under a zero deficit rule because the government distributes higher transfers.

Figure 10. An Expansive Monetary Policy: A Shock to the Interest Rate Instrument of One Percent



Source: Authors' computations.

Figure 10 reports the responses to an expansive monetary policy under estimated parameters. The drop of interest rates causes a hump-shaped consumption pattern for Ricardian agents, while the responses of non-Ricardian households are monotonic. Overall aggregate consumption and GDP expand, as expected in any New Keynesian model like ours. Non-Ricardian consumption expands due to increases in wages and tax revenues (which are distributed through transfers, which in turn are mitigated by the Chilean fiscal rule). The drop in interest rates makes it less attractive to invest in domestic fixed-income assets in comparison with foreign assets, leading to a depreciation of the domestic currency.

4.2 Model's Fiscal Multipliers

Consistent with the impulse response functions just described, this section calculates fiscal multipliers for an expansionary fiscal policy with the estimated model. Table 7 illustrates both dynamic and dynamic cumulative multipliers, so these figures are comparable with those reported in tables 1 and 2.

Our earlier implementation of a variety of structural VARs showed that the fiscal multipliers were over one. Overall, we confirm these findings with our estimated model: the results resemble those of the open economy or large VAR. In particular, table 7 points to important non-Ricardian effects in aggregate output and consumption of an expansionary fiscal policy (hours worked also increase).

What do the consumption multipliers look like for each of the two agent types? To address this, we further calculate dC^R / dG and dC^N / dG (and their cumulative versions). Aggregate consumption increases for a while because consumption by constrained agents rises and offsets the drop in consumption by Ricardian agents. Cumulative multipliers suggest that aggregate consumption is 0.24 of the initial fiscal impulse by the end of the year. At the same horizon, this is explained by a positive effect in consumption by non-Ricardian agents (2.39) that outweighs the negative effect of the Ricardian consumers (–1.92).

5. Conclusions

This paper presents VAR evidence on fiscal multipliers that are large and robust for Chile. The evidence we present indicates that aggregate real consumption and real GDP expand significantly when transfers or government expenditure (or both) rise. Results from small VARs (four variables) suggest that basic consumption multipliers peak in the second quarter with values larger than one, while output multipliers peak slightly later and are larger in magnitude. Cumulative multipliers grow steadily and peak between four and six quarters, and then the expansionary effect comes to a halt and starts to fall. Values range from 2.4 to 3.5 for consumption and 3.2 to 3.5 for output. Large VARs that explicitly take into account the fact that Chile is a small open economy by including three additional variables (namely, copper price as exogenous, total private investment, and the real exchange rate) produce consumption

Table 7. Model's Fiscal Multipliers: Increase in Public Spending

Time / multipliers	*Multipliers*				*Cumulative multipliers*			
	dY/dG	dC/dG	dCR/dG	dCN/dG	dY/dG	dC/dG	dCR/dG	dCN/dG
$t = 1$	1.74	0.49	–0.27	1.25	1.74	0.49	–0.27	1.25
$t = 2$	1.01	0.11	–0.45	0.67	2.75	0.60	–0.72	1.92
$t = 4$	0.25	–0.25	–0.63	0.14	3.54	0.24	–1.92	2.39
$t = 6$	–0.03	–0.32	–0.63	–0.02	3.58	–0.39	–3.19	2.41
$t = 8$	–0.12	–0.30	–0.55	–0.06	3.37	–1.02	–4.33	2.30

Source: Authors' computations.

and output responses that are stronger in the face of a shock to government purchases. The large VAR with transfers shocks exhibits fiscal multipliers similar to the ones obtained from the smalWe confront this evidence with the prediction of a DSGE model for the Chilean economy. The model features two household types: Ricardian and non-Ricardian. The former solve a typical dynamic programming problem, whereas non-Ricardian households consume labor income and transfers within the period. We assume a standard specification for monetary policy, but allow for a fiscal policy that approximates the Chilean fiscal policy rule, characterized by expenditure flows responding to structural or long-run revenues. The results indicate that when a balanced budget rule is instrumented by transfers (leaving public expenditure exogenous), a public transfer shock yields positive fiscal multipliers of consumption and output. On the other hand, if government purchases are shocked instead, the balanced budget rule causes a negative fiscal multiplier for consumption, but a positive one for GDP. Interestingly, the implementation of a fiscal policy rule that approximates the Chilean fiscal rule in the model leads to the finding that both the consumption and output fiscal multipliers are positive in the short run.

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A Solution to Fiscal Procyclicality: The Structural Budget Institutions Pioneered by Chile

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In June 2008, the President of Chile, Michelle Bachelet, had a low approval rating, for management of the economy in particular. There were undoubtedly multiple reasons for this, but a major reason was popular resentment that the government had resisted intense pressure to spend soaring receipts from copper exports. Copper is Chile's biggest export, and Chile is the world's biggest copper exporter. The world price of copper was at $800 per metric ton in 2008, a historical high in nominal terms and more than quadruple the level of 2001. Yet the government insisted on saving most of the proceeds.

One year later, in mid-2009, Bachelet attained the highest approval rating of any president since democracy had been reinstated in Chile, and she kept it through the remainder of her term (see figure 1).[1] Her finance minister, Andrés Velasco, also had the highest approval rating of any finance minister since the restoration of democracy. Why the change? It was certainly not an improvement in overall economic circumstances, given that the global recession had hit, causing copper prices to fall, growth to decline, and unemployment to rise. Rather, the government had

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1. The figure shows the approval ratings for four Chilean presidents from 1991 to 2009. For a chart that also includes the finance ministers, see Frankel (2011a, figure 2; also included in the NBER version).

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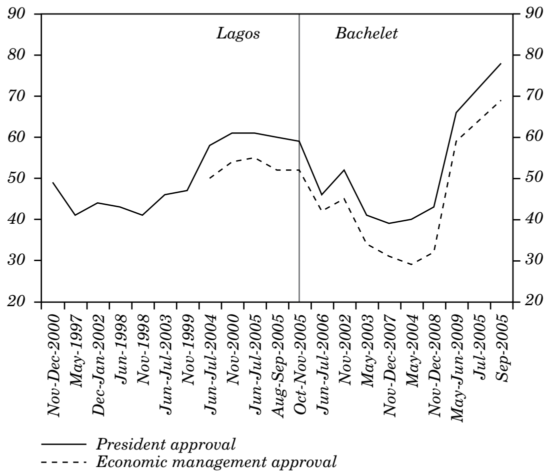
increased spending sharply, using the assets that it had acquired during the copper boom, and had thereby moderated the downturn. Saving for a rainy day made the officials heroes, now that the rainy day had come.

Figure 1: Approval of president and economic management under two Chilean adminstrations[a]



Source: Centro de Estudios Públicos, National Survey of Public opinion, october of 2009, www.cepchile.cl
a. Statistical significative difference between measurements of Aug-2009 and Oct-2009.

Thus, Chile has over the last decade achieved what few commodity-producing developing countries had managed previously: a truly countercyclical fiscal policy. It is not the only country to have made progress in this direction in recent years[2], Chile is a particularly striking case, however. It has beaten the curse of procyclicality via the innovation of a set of fiscal institutions that are designed to have a good chance of working even in a world where politicians and voters are fallible human beings rather than angels.

The proposition that institutions make a big difference, that a country is less likely to establish good policies in the absence of

2. Frankel, Végh, and Vuletin (2011) show that during the decade 2000–09, roughly one-third of developing countries escaped from the pattern of fiscal procyclicality.

good institutions, has popped up everywhere in economics of late.[3] What is sometimes missing, however, is examples of very specific institutions that countries might wisely adopt. These should be institutions that are neither so loose that their constraints do not bind nor so rigid that they have to be abandoned subsequently in light of circumstances.

Although specifics differ from country to country, there is no reason why a version of Chile's institutions cannot be emulated by other commodity-producing developing countries.[4] Even advanced countries and noncommodity producers, for that matter, could take a page from the Chilean book. Proper budget discipline is never easy, and commodity cycles are but one kind of cyclicality that such institutions could address.

1. Chile's Fiscal Institutions

Looking at the budget balance in structural or cyclically adjusted terms is an old idea.[5] Chile's structural budget regime is somewhat more complex. Chile's fiscal policy is governed by a set of rules. The first rule is that the government must set a budget target. The target was originally set at a surplus of 1 percent of GDP, for three reasons: to recapitalize the central bank, which inherited a negative net worth from bailing out the private banking system in the 1980s and sterilizing inflows in the 1990s; to fund some pension-related and other liabilities; and to service net external dollar debt.[6] The target was subsequently lowered to 0.5 percent of GDP in 2007 and again to 0 percent in 2009, as it was determined that the debt had

3. In the case of fiscal policy, the importance of institutions is emphasized by Buchanan (1967), von Hagen and Harden (1995), Alesina and Perotti (1995, 1996), Poterba (1997), Poterba and von Hagen (1999), Persson and Tabellini (2004), Wyplosz (2005), Calderón and Schmidt-Hebbel (2008), and Calderón, Duncan, and Schmidt-Hebbel (2010). For commodity producers more specifically, see Davis and others (2001, 2003) and Ossowski and others (2008), among others. For Latin America, see Alesina and others (1999), Stein, Talvi, and Grisanti (1999), and Perry (2003), among others.

4. The structural budget regime is one of many innovative reforms that Chile has adopted over the last few decades, many of which have been successful and are potentially worthy of emulation. See Corbo and Fischer (1994), Edwards and Cox-Edwards (1991, 2000), Ffrench-Davis (2010), and Velasco (1994) for details.

5. The swing in Chile's budget from surplus in the boom year of 1989 to deficit in the recession year of 1999, for example, was determined to be all cyclical rather than structural (Marcel and others, 2001, p. 18).

6. Rodríguez, Tokman, and Vega (2007, p.5, 21).

been essentially paid off and that a structurally balanced budget was economically appropriate.[7]

A budget target of zero may sound like the budget deficit ceilings that supposedly constrain members of the euro area (which agreed to deficits of 3 percent of GDP under the Stability and Growth Pact, or SGP) or like U.S. proposals for a balanced budget amendment (zero deficit). But those attempts have failed, in part because they are too rigid to allow for deficits in recessions, counterbalanced by surpluses in good times.

Tougher constraints on fiscal policy do not always increase effective budget discipline. Countries often violate their constraints. In an extreme setup, a rule that is too rigid—so rigid that official claims that it will be sustained are not credible—might even lead to looser fiscal outcomes than if a more moderate and flexible rule had been specified at the outset.[8]

Euro countries large and small have repeatedly violated the fiscal rules of the SGP, which was originally envisioned as a simple ceiling on the budget deficit of 3 percent of GDP. The main idea for enforcing the SGP is that a government that is unable to reduce its budget deficit to the target has to pay a substantial fine. This, of course, just adds to the budget deficit. Thus, the enforcement mechanism does not much help the credibility of the rule.[9]

Credibility can be a problem for budget institutions either with or without uncertainty regarding the future path of the economy. Consider first the nonstochastic case. Even if the future unfolds as expected when the rule was formulated, the target may be up against predictably irresistible political pressures. Common examples are provisions for special fiscal institutions that may have been formulated to please the World Bank or the International Monetary Institute (IMF), but without local elites "taking ownership" of the reforms, let alone winning public support for them. Such institutions,

7. A team of three economists appointed by Velasco in 2007 recommended reducing the structural budget target: Engel, Marcel, and Meller (2007). See Velasco and others (2007), Velasco and others (2010), and Eduardo Olivares C., "Las opciones que Hacienda tuvo para flexibilizar la regla," El Mercurio, 24 May 2007.

8. Neut and Velasco (2003).

9. An analogous example outside the realm of macroeconomic policy is the idea that the Kyoto Protocol on Global Climate Change would be enforced by a provision requiring countries that exceeded their allocation of greenhouse gas emissions in one period to cut emissions even further below target in the subsequent period—a penalty with interest. One might as well tell people on a diet plan that if they fail to lose five pounds in the first week, then they have to lose ten pounds in the second week.

which include fiscal rules and fiscal responsibility legislation, are often abandoned before long.[10]

The case of rules that are too onerous to last arises particularly in the stochastic context. A target that might have been reasonable ex ante, such as an unconditionally balanced budget, becomes unreasonable after an unexpected shock, such as a severe fall in export prices or national output. Common examples are rigid balanced budget rules that do not allow the possibility of fiscal deficits in bad times.

A sensible alternative is to specify rules that mandate changes in response to changed circumstances. In particular, instead of targeting an actual budget balance of zero or some other numerical surplus, the rule can target a number for the structural budget.

This alternative may not work, however, if the political process determines whether a deficit is or is not structural. Politicians can always attribute a budget deficit to unexpectedly and temporarily poor economic growth. Since there is no way of proving what an unbiased forecast of growth is, there is no way of disproving the politicians' claim that the shortfall is not their responsibility.

Copper accounts for approximately 16 percent of Chile's fiscal income: about 10 percent from the revenues of CODELCO, which is owned by the government, and the rest in tax revenue from private mining companies.[11] That the figure is only 16 percent illustrates that Chile's use of copper exports has not prevented it from achieving a diversified economy. Nevertheless, the number understates the sensitivity of the budget to copper prices. Copper profits are highly volatile, much more volatile even than copper prices. Furthermore, the mining industry tends to have a multiplier effect on the rest of GDP. Madrid-Aris and Villena (2005) argue that copper prices drive the Chilean economy.[12] Other mineral and agricultural commodities

10. In their econometric analysis of these special financial institutions for oil-producers, Ossowski and others (2008, pp. 19, 23, 24, 38–43) find no statistically significant effect on the actual fiscal stance. This may be partly due to econometric limitations, but it is evidently also due to governments that, after having adopted these institutions, subsequently find them too rigid in practice and so weaken or abandon them. Recent examples include Ecuador, Equatorial Guinea, and Venezuela (Ossowski and others, 2008, pp. 12–13, 19, 24). See also Villafuerte, López-Murphy, and Ossowski (in this volume).

11. Rodríguez, Tokman, and Vega (2007, p. 8).

12. Their econometrics consists in cointegration tests, and their theory is essentially classic Dutch disease: an increase in copper prices is transmitted to the nontradables sector via appreciation of the currency.

are also important, but their prices on world markets are to some extent correlated with copper.[13]

The central rule that makes up Chile's structural balance regime is that the government can run a deficit larger than the target to the extent that output falls short of its long-run trend, in a recession, or that the price of copper is below its medium-term (ten-year) equilibrium. The key institutional innovation is that there are two panels of experts whose job it is each mid-year to make the judgments, respectively, on what is the medium-term trend of output and what is the medium-term equilibrium price of copper. The experts on the copper panel are drawn from mining companies, the financial sector, research centers, and local universities. The government then follows a set of procedures that translates these numbers, combined with any given set of tax and spending parameters, into the estimated structural budget balance. If the resulting estimated structural budget balance differs from the target, then the government adjusts spending plans until the desired balance is achieved.

The structural budget policy showed clear benefits by 2006. Between 2000 and 2005, public savings rose from 2.5 to 7.9 percent of GDP (allowing national saving to rise from 20.6 to 23.6 percent).[14] As a result, central government debt fell sharply as a share of GDP, and the sovereign spread gradually declined.[15] By December 2006, Chile had achieved a sovereign debt rating of A, several notches ahead of Mexico, Brazil, and other Latin American peers.[16] Chile had become a net creditor by 2007. By June 2010, its sovereign rating had climbed to A+, ahead of some advanced countries, such as Israel and Korea (A), Iceland (BBB–), and Greece (BB+).

The announcement of the structural surplus rule in itself appears to have improved Chile's creditworthiness in 2000, even before it had had time to operate.[17] Even this early, better access

13. Nitrates were the important export before World War I. Fruit and wine have gained importance in recent years. Larraín, Sachs, and Warner (2000) discuss the reasons for Chile's heavy structural dependence on commodity exports, which they view as negative for long-term growth. The reasons include not just natural endowments, but also a small internal market and geographic remoteness, which necessitate exports that have a high ratio of value added to transport cost.

14. Rodríguez, Tokman, and Vega (2007, p. 27).

15. Rodríguez, Tokman, and Vega (2007, p. 29–30).

16. Standard and Poor's ratings, obtained from Bloomberg.

17. Lefort (2006) empirically substantiates that the structural balance rule made a significant contribution in reducing the country risk margin beyond the effect of lower public indebtedness. Rodríguez, Tokman, and Vega (2007, p. 30) report a turnaround in Chile's sovereign spread from the date of the announcement in early 2000. Perry (2003, pp. 13–14) also sees an immediate credibility effect.

to foreign capital may have helped the country to weather the 2001–02 crisis more easily than the crisis of 1982–83.[18] Public spending fluctuated much less than in past decades and less than income, helping to stabilize the business cycle.[19] According to one estimate, the structural balance policy allowed a reduction in GDP volatility of one-third in 2001–05.[20] Another study goes so far as to claim that the policy can all but eliminate the effects of copper price fluctuations on the real economy.[21]

The real test of the policy came during the latter years of the copper boom of 2003–08 when, as usual, there was political pressure to declare the increase in the copper price permanent and to thereby justify spending on a par with export earnings. The expert panel ruled that most of the price increase was temporary, so that most of the earnings had to be saved. This turned out to be right, as the 2008 spike was partly reversed the next year. As a result, the fiscal surplus reached almost 9 percent when copper prices were high. The country paid down its debt to a mere 4 percent of GDP, and it saved about 12 percent of GDP in the sovereign wealth fund. This allowed a substantial fiscal easing in the recession of 2008–09, when the stimulus was most sorely needed.

Part of the credit for Chile's structural budget rule should go to the government of President Ricardo Lagos (2000–06) and Finance Minister Nicolás Eyzaguirre, who initiated the structural budget criterion and the panels of experts.[22] In this first phase, however, the budget rule was a policy initiated and followed voluntarily by the government, rather than a matter of legal or other constraint.[23] The structural budget rule became a true institution under the Bachelet government (2006–10), which enshrined the general framework in law. It introduced a Fiscal Responsibility Bill in 2006, which gave

18. Rodríguez, Tokman, and Vega (2007, p. 32) shows that the external shocks in 1982 were a recession in advanced countries and the international debt crisis. The external shocks in 2001 were another (admittedly milder) U.S. recession and a debt crisis next door in Argentina.

19. Rodríguez, Tokman, and Vega (2007, pp. 33–34).

20. Larraín and Parro (2008).

21. Medina and Soto (2007) find in a dynamic stochastic general equilibrium (DSGE) model that the fiscal regime is capable of reducing the effect on Chile's GDP of a 10 percent exogenous increase in the copper price from 0.70 percent to 0.05 percent.

22. IMF (2005, p. 11). Some credit should also go to earlier governments for establishing the Copper Stabilization Fund in the 1980s, which stipulated that copper revenue above a certain price was to be saved, and for sticking with the rule when the price rose later.

23. Aninat and others (2006, pp. 8, 54); Rodríguez, Tokman, and Vega (2007, p. 5).

legal force to the role of the structural budget.[24] Moreover, it abided by the law—and in fact took extra steps to make sure the copper bonanza was saved—when it was most difficult to do so politically. The public approbation received by the Bachelet government in the polls by the end of its term in office was in this sense well-earned.

The advice to save in a boom is standard, and there are other examples of governments that have had the courage to take away the fiscal punch bowl. What makes Chile's institutions particularly worthy of study is that they may constitute a template that other countries can adopt, a model that can help even in times and places where the political forces to follow procyclical fiscal policy would otherwise be too strong to resist.

Section 2 highlights economic volatility among countries that are dependent on exports of mineral and agricultural products. Section 3 focuses on procyclical fiscal policy among commodity producers. I then turn to the role played by systematic bias in official budget forecasts in other countries and how Chile has avoided it.

2. Volatility Among Commodity Exporters

Developing economies generally tend to be more volatile than advanced economies. The volatility arises, in part, from foreign shocks, such as fluctuations in the prices of exports on world markets. The mineral and agricultural commodities produced by Latin American countries tend to be characterized by particularly large price fluctuations, as shown in table 1.[25] Volatility also arises from domestic macroeconomic and political instability.[26] Although most developing countries brought their chronic runaway budget deficits, money creation, and inflation under control in the 1990s, a majority are still subject to monetary and fiscal policy that is procyclical rather than countercyclical: they tend to be expansionary

24. The bill, Law No. 20,128, was proposed by the government in September 2005 and approved by Congress to enter into effect in August 2006. Among other things, it also created a Pension Reserve Fund and a Economic and Social Stabilization Fund, the latter a replacement for the existing Copper Stabilization Funds that dated from 1981, and specified norms for how the funds should be invested.

25. Some authors suggest that the volatility of natural resource prices is, in itself, bad for economic growth, that it is the source of the so-called natural resource curse. See Blattman, Hwang, and Williamson (2007), Hausmann and Rigobon (2003), and Poelhekke and van der Ploeg (2007).

26. Perry (2009) decomposes the extra growth volatility of commodity producers.

in booms and contractionary in recessions, thereby exacerbating the magnitudes of the swings. The aim should be to moderate the cyclical fluctuations—that is, to achieve the countercyclical pattern that the models and textbooks of the decades following the Great Depression originally hoped discretionary policy would take.

Table 1. Price Volatility of Leading Commodity Exports in Latin American and Caribbean Countries, 1970–2008

Country	*Leading commodity export*[a]	*Std. dev. of log of dollar price*
Argentina	Soybeans	0.2781
Bolivia	Natural Gas	1.8163
Brazil	Steel	0.5900
Chile	Copper	0.4077
Colombia	Oil	0.7594
Costa Rica	Bananas	0.4416
Ecuador	Oil	0.7594
El Salvador	Coffee	0.4792
Guatemala	Coffee	0.4792
Guyana	Sugar	0.4749
Honduras	Coffee	0.4792
Jamaica	Aluminum	0.4176
Mexico	Oil	0.7594
Nicaragua	Coffee	0.4792
Panama	Bananas	0.4416
Peru	Copper	0.4077
Paraguay	Beef	0.2298
Trinidad and Tobago	Natural Gas	1.8163
Uruguay	Beef	0.2298
Venezuela	Oil	0.7594

Source: Global Financial Data.
a. According to World Bank analysis, as of 2007.

That developing countries tend to experience larger cyclical fluctuations than industrialized countries is only partly attributable to commodities. It is also due to the role of factors that should moderate the cycle, but in practice seldom operate that way: procyclical capital flows, procyclical monetary and fiscal policy, and the related Dutch disease. If anything, these factors tend to exacerbate booms and busts instead of moderating them. The hope that improved policies or institutions might reduce this procyclicality makes this one of the most potentially fruitful avenues of research in emerging market macroeconomics.

2.1 The Procyclicality of Capital Flows to Developing Countries

According to the theory of intertemporal optimization, countries should borrow during temporary downturns to sustain consumption and investment, and they should repay that debt or accumulate net foreign assets during temporary upturns. In practice, it does not always work this way. Capital flows are more often procyclical than countercyclical.[27] Most theories to explain this involve imperfections in capital markets, such as asymmetric information or the need for collateral. In the commodity and emerging market boom of 2003–08, net capital flows typically went to countries with trade surpluses, especially Asian economies and commodity producers in the Middle East and Latin America, where they showed up in record accumulation of foreign exchange reserves. This was in contrast to the two previous cycles, 1975–81 and 1990–97, when the capital flows to developing countries largely went to finance current account deficits.

One interpretation of procyclical capital flows is that they result from procyclical fiscal policy: when governments increase spending during booms, some of the deficit is financed by borrowing from abroad; when they are forced to cut spending in downturns, it is to repay some of the excessive debt that they incurred during the upturn. Another interpretation of procyclical capital flows to developing countries is that they pertain especially to exporters of agricultural and mineral commodities, particularly oil. The next subsection consider procyclical fiscal policy.

2.2 The Procyclicality of Fiscal Policy

Many authors document the tendency for fiscal policy to be procyclical in developing countries, especially in comparison with

27. Kaminsky, Reinhart, and Végh (2005); Reinhart and Reinhart (2009); Gavin and others (1996); and Mendoza and Terrones (2008). Caballero (2002) and Gallego, Hernández, and Schmidt-Hebbel (2002) examine procyclical capital flows in Chile, in particular.

industrialized countries.[28] Most studies look at the procyclicality of government spending. An important reason for procyclical spending is precisely that government receipts from taxes or royalties rise in booms, and the government cannot resist the temptation or political pressure to increase spending proportionately or more than proportionately.

Procyclicality is especially pronounced in countries that possess natural resources and where income from those resources tends to dominate the business cycle. Among those focusing on the correlation between commodity booms and spending booms is Cuddington (1989). Sinnott (2009) finds that Latin American countries are sufficiently commodity dependent that government revenue responds significantly to commodity prices. Arezki and Brückner (2010a) find that commodity price booms lead to increased government spending, external debt, and default risk in autocracies, but do not have those effects in democracies.[29]

Two large budget items that account for much of the increased spending from commodity booms are investment projects and the government wage bill. Regarding the first budget item, investment in infrastructure can have a large long-term payoff if it is well designed; too often in practice, however, it takes the form of white elephant projects, which are stranded without funds for completion or maintenance when the commodity price goes back down (Gelb, 1986). Regarding the second budget item, Medas and Zakharova (2009) point out that oil windfalls have often been spent on higher public sector wages. The revenue can also go to increasing the number of workers employed by the government. Either way, it raises the total public sector wage bill, which is hard to reverse when oil prices go back down.[30]

Cross-country evidence is harder to come by on the tax side than on the spending side, because tax receipts are particularly endogenous with respect to the business cycle. But one can find a procylical pattern there, as well, by focusing on tax rates rather than revenues.[31]

28. For example, Cuddington (1989), Tornell and Lane (1999), Kaminsky, Reinhart, and Végh (2005), Talvi and Végh (2005), Alesina, Campante and Tabellini (2008), Mendoza and Oviedo (2006), Ilzetzki and Végh (2008), and Medas and Zakharova (2009). For Latin America in particular, see Gavin and Perotti (1997), Calderón and Schmidt-Hebbel (2003), and Perry (2003).

29. Arezki and Brückner (2010b) find that the dichotomy extends to the effects on sovereign bond spreads paid by autocratic versus democratic commodity producers.

30. Arezki and Ismail (2010) find that current government spending increases in boom times, but is downward sticky.

31. Végh and Vuletin (2011) find evidence that tax rate policy has been mostly procyclical in developing countries, and acyclical in industrialized countries.

3. The Problem of Procyclical Fiscal Policy among Mineral Exporters

The Hartwick rule says that rents from a depletable resource should be saved, on average, against the day when deposits run out.[32] At the same time, traditional textbook macroeconomics says that government budgets should be countercyclical, running surpluses in booms and spending in recessions. Mineral producers tend to fail in both these principles: they save too little on average and all the more so in booms. Thus one of the most important ways to cope with the commodity cycle is to create institutions to ensure that export earnings are put aside in a commodity saving fund during the boom time, perhaps with the aid of rules governing the cyclically adjusted budget surplus.[33]

In general, one would expect that the commitment to fiscal constraints would produce more transparent and disciplined budgets. Alesina and others (1999), Stein, Talvi, and Grisanti (1999), and Marcel and others (2001) find that Latin American countries attained better fiscal discipline in the 1980s and early 1990s if their institutions were more hierarchical and transparent, judged by the existence of constraints and voting rules.

3.1 Mineral Cycles and the Budget

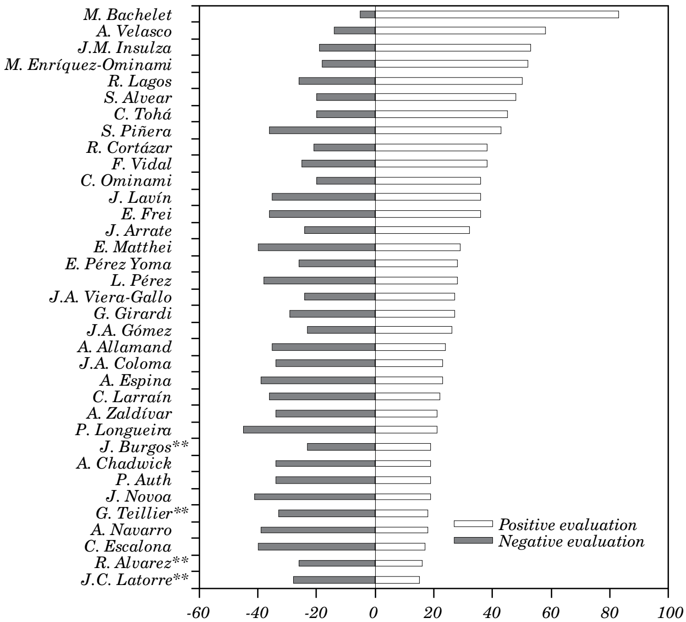
The tendency to undersave mineral wealth is particularly pronounced during booms.[34] The temptation to spend the windfall from high world prices is sometimes irresistible. When the price of the mineral eventually goes back down, countries are often left with high debt, a swollen government sector and nontradable goods sector, and a hollowed out nonmineral tradable goods sector. They may then be forced to cut back on government spending, completing the perverse cycle of countercyclical saving. This may occur if the political process overrides sober judgments, so that spending responds to booms more than intertemporal optimization would dictate. It could also reflect an error in perceptions: forecasters extrapolate a high world price

32. More precisely, the Hartwick rule says that all rents from exhaustible natural resources should be invested in reproducible capital, so that future generations do not suffer a diminution in total wealth (natural resource plus reproducible capital) and therefore in the flow of consumption (Hartwick, 1977; Solow, 1986).

33. Davis and others (2001, 2003).

34. They may also undersave on average, of course. Few countries follow the Hartwick rule, in practice.

Figure 2. Evaluation of Political Figures in 2009, including the President of Republic and his Cabinet



Source: Centro de Estudios Públicos, National Survey of Public opinion, october of 2009, www.cepchile.cl
Note. To surveyed people is readed a closed list of individuals to be evaluated. A positive or negative evaluation is measured for those who have an opinion ('not answered' or 'unknown individual' categories are eliminated).

today, during the boom, far into the future, whereas in reality the real price will eventually return to some long-run equilibrium.

The example of copper prices in Chile illustrates how important commodity price movements can be to the task of forecasting the budget. There are several ways to measure the benchmark relative to which the ex post spot price of copper is observed. One is the forward or futures price of copper observed the preceding year. Figure 2 plots the official budget forecast error (one year ahead) against the copper price relative to the previous August's forward price. There is clearly a strong relationship.[35] Table 2 reports the corresponding regression.

35. An appendix in Frankel (2011a) explains the data sources. Figure 7a in that paper uses the ten-year average of the spot price of copper, rather than the future rate used in figure 5 in this work, as the benchmark for measuring short-term movements. The data then go back to 1977. Again, copper price movements are correlated with fluctuations in the budget balance.

The copper price is statistically significant and dominates movement in the budget to such an extent that GDP is not significant alongside it. Presumably this reflects not just the important role of copper royalties in Chile's budget revenues, but also the big influence of copper prices on the rest of the economy.

The bottom line is that anyone who wishes to make unbiased forecasts of next year's budget in Chile needs to be able to make unbiased forecasts of next year's copper price. The next sections therefore addresses the question of the copper price's time series behavior.

Table 2. Short-Term Determinants of Chile's Budget Deficit[a]

Explanatory variable	*(1)*	*(2)*
Copper price movement	0.060**	0.056**
	(0.021)	(0.021)
GDP movement	0.239	
	(0.187)	
Constant	0.023	0.163
	(0.754)	(0.683)
Summary statistic		
No. observations	20	20
R^2	0.299	0.251
Root mean square error	2.655	2.666

Source: Author's calculations.
** Statistically significant at the 5 percent level.
a. The dependent variable is the budget balance (ex post budget relative to forecast); the explanatory variables are also ex post relative to forecast. The copper price movement is here measured as 100 [log(average of end of month price, Jan.–Dec., of the next year) – log(August 15 – month forward price)]. The sample period is 1990–2009. Robust standard errors are in parentheses.

3.2 Reasons for Overshooting in Mineral Prices

Conceptually, there are three different reasons why mineral prices may follow a cyclical or mean-reverting process. They are based, respectively, in mineral microeconomics, in monetary economics, and in speculative bubbles. The relative importance of the three makes no difference for the purposes of this paper.

First, it is not hard for a microeconomist to understand why the market price of minerals overshoots in the short run or even the medium run. Because elasticities of supply and demand with respect to price are low, relatively small fluctuations in demand (due, for example, to weather) or in supply (due, for example, to disruptions) require a large change in price to re-equilibrate supply and demand. Demand elasticities are low in the short run largely because the capital stock at any point in time is designed physically to operate with a particular ratio of mineral inputs to output, with little scope for substitution. Supply elasticities are also often low in the short run because it takes time to open new mines or otherwise adjust output. Inventories can cushion the short run impact of fluctuations, but they are limited in size. Scope to substitute across materials is also limited. As time passes, elasticities become far higher on both the demand side and the supply side, so prices come back down in the aftermath of a spike. In the medium term, mineral prices may be subject to a cobweb cycle, due to the lags in response: the initial market equilibrium is a high price; the high price cuts demand after some years, which in turn leads to a new low price, which raises demand with a lag, and so on.

The second possible explanation for a cycle in mineral prices is monetary overshooting.[36] The Hotelling (1931) theory of nonrenewable resources says that the decision of whether to leave deposits in the ground or to extract and sell them at today's price should be governed by an arbitrage condition between the interest rate, on the one hand, and the expected future rate of increase in the mineral price, on the other. The expected future rate of price increase, in turn, should be related to any perceptions that today's price is below its long-run equilibrium price. A similar arbitrage condition holds with respect to the decision of whether to hold inventories or sell them, but storage costs are added to the interest rate on the carrying-cost side of the ledger, while convenience yield is added to expected future appreciation on the benefits side. The key implication is an inverse relationship between real interest rates and real commodity prices. If the real interest rate is high, it undercuts the incentive to hold minerals underground or in inventories. The result is a fall in demand or rise in supply, which drives down the spot price of the mineral. The market is in short-run equilibrium when the mineral is sufficiently undervalued (relative to its long-run equilibrium) that a general perception of future price increases is sufficient to offset the higher real interest rate, thereby restoring the arbitrage condition.

36. Frankel (1986, 2008b).

That much is Hotelling. Monetary cycles can be inserted into the process. A currently high real interest rate can be the result of transitorily tight monetary policy. In the medium run, the real interest rate tends to return to its medium-run equilibrium; as a result, the real commodity price also returns to its equilibrium. According to this view, low real interest rates in the 1970s and 2000s led to high global real prices for oil and minerals, while high real interest rates in the 1980s and 1990s led to low real prices for oil and minerals.

The third possible explanation for mean reversion is speculative bubbles, defined as a self-confirming or bandwagon process that carries the commodity price away from its fundamentals. Speculators know that the bubble might pop and the price return to its fundamental value. But they weigh the probability, in each given month that the bubble will end (so that they will have lost money if they stay in the market) against the probability that it will continue another month (so that they will have lost money if they got out of the market). Theory does not have much to say about when or under what conditions bubbles get started or stop, but they usually start on the back of a trend that originated in fundamentals, whether microeconomic (as in the first theory above) or monetary (as in the second).

3.3 Evidence of Reversion to Long-Run Equilibrium in Real Copper Prices

Is a high mineral price statistically likely to be followed eventually by a reversion to the long-run mean? Cuddington and Jerrett (2008) find three “super cycles” in the prices of copper and four other metals over the 150 years from 1850 to 2000, followed by the beginnings of a fourth super cycle. The tendency for commodity prices to revert from historic highs back to their long-run equilibrium is too weak to show up statistically in a few decades of data. This is true even though the tendency to revert may be strong enough to wreck national economies, implausible as that juxtaposition may sound. Statistically, one needs a lot of data to reject a random walk (or to establish a permanent trend). There is not enough power in tests on time series of prices that are only a few decades long.

This proposition can be illustrated with either empirical evidence or a priori theory. Assume an AR(1) process. Table 3 regresses the change in the real copper price against its lagged value, both with and without a trend. In a deliberate attempt to mimic many other studies, the data in table 3 cover only 30 years, starting in 1980. The real price of copper

Table 3. Test for Mean Reversion in the Copper Price, 1980–2009[a]

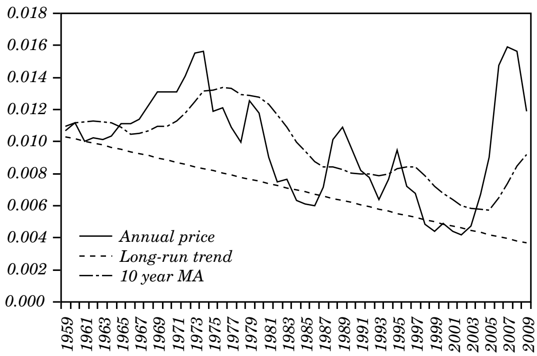
A. With trend	*Test statistic*	*1% C.V.*	*5% C.V.*	*10% C.V.*
$Z(t)$	−1.512	−4.334	−3.580	−3.228
MacKinnon approximate p value for $Z(t) = 0.017$				
Change in log of real copper price	*Coefficient*	*Std. error*	*t statistic*	$p > \|t\|$
Lagged real copper price	−0.1484	0.0981	−1.51	0.142
Trend	0.0058	0.0042	1.38	0.179
Constant	−0.8077	0.4790	−1.69	0.103

B. Without trend	*Test statistic*	*1% C.V.*	*5% C.V.*	*10% C.V.*
$Z(t)$	−1.576	−3.716	−2.986	−2.624
MacKinnon approximate p value for $Z(t) = 0.287$				
Change in log of real copper price	*Coefficient*	*Std. error*	*t statistic*	$p > \|t\|$
Lagged log of real copper price	−0.1569	0.0995	−1.58	0.126
Constant	−0.7651	0.4857	−1.58	0.126

Source: Author's calculations.
a. All the regressions in this table are based on 30 observations.

for this period is illustrated in figure 3. The estimated trend is positive, but not significant, when the sample ends in 2009.[37] More importantly for present purposes, the coefficient on the lagged real price of copper is negative but not significant. (Dickey-Fuller critical levels require a test statistic of 3.6 to give significance at the 5 percent level, or about 3.0 to give significance at the 10 percent level.) Putting the significance question aside momentarily, the point estimate is about –0.1 when the process is estimated without a trend, suggesting that about 10 percent of the gap between the real price of copper and its long-run average is closed each year in the absence of new disturbances.

Figure 3. Real Copper Price
(M US$ per metric ton)



Sources: , Historical Statistics of the United States, US Bureau of Labor Statistics y Bloomberg.

Why is the reversion parameter not significant? Economists often observe such a failure to reject the null hypothesis of a random walk and then jump to language implying that the variable in question actually follows a random walk. The two propositions are different, however, as any introductory statistics student is taught.

37. Some authors find a small upward trend in mineral prices, some a small downward trend. The answer seems to depend, more than anything else, on the date for the end of the sample. Studies written after the commodity price increases of the 1970s find an upward trend, but those written after the 1980s find a downward trend, even when both kinds of studies went back to the early twentieth century. No doubt, when studies using data through 2008 are completed, some will again find a positive long-run trend. References include Cuddington (1992), Cuddington, Ludema, and Jayasuriya (2007), Cuddington and Urzúa (1989), Grilli and Yang (1988), Pindyck (1999), Hadass and Williamson (2003), Reinhart and Wickham (1994), Kellard and Wohar (2005), Balagtas and Holt (2009), and Harvey and others (2010).

Imagine that the true speed of adjustment is indeed 0.1. In other words, the autoregressive coefficient for the real copper price is 0.9. A simple calculation can illustrate why one would not expect 30 or 40 years of data to give enough statistical power to reject a unit root (random walk) even if none were there. The asymptotic standard error of an estimate of an autoregressive coefficient ρ is approximately the square root of $(1 - \rho^2) / N$. So the t statistic to test the null hypothesis that $\rho = 1$ is

$$t = \frac{1-\rho}{\left(\frac{1-\rho^2}{N}\right)^{\frac{1}{2}}}.$$

If the true speed of adjustment is on the order of 10 per cent per year ($\rho = 0.9$), the number of years of data needed to have enough power to reject the null hypothesis ($t > 3$) can be computed as

$$t = \frac{1-\rho}{\left(\frac{1-\rho^2}{N}\right)^{\frac{1}{2}}} > 3;$$

$$N > \left(\frac{3}{1-0.9}\right)^2 (1-0.9^2) = 171.$$

In other words, one should expect to require something like 171 years of data in order to be able to reject the null hypothesis of a unit root.[38] If one only has 30 years of data, it would be surprising if one succeeded in rejecting $\rho = 1$. It would be analogous to Gregor Mendel's famous experiments with peas, where the results matched the theoretical predictions of gene theory so perfectly that Fisher (1936) later argued on probabilistic grounds that he must have cheated.

38. Because the formula for the standard error is asymptotic, one should perhaps not take this calculation too literally. However, the implication that one needs something like 200 years of data to reject a random walk can be further supported in several ways, including more elaborate a priori calculations, trying the test out on varying time samples of actual data, and Monte Carlo studies. These points regarding random walk test power were made some years ago in the context of real exchange rates.

Table 4. Test for Mean Reversion in Copper Price, 1784–2009[a]

A. With trend	*Test statistic*	*1% C.V.*	*5% C.V.*	*10% C.V.*
$Z(t)$	−3.799	−4.001	−3.434	−3.134
MacKinnon approximate *p value* for $Z(t)$ = 0.017.				
Change in log of real copper price	*Coefficient*	*Std. error*	*t statistic*	$p > \|t\|$
Lagged real copper price	−0.1284	0.0338	−3.80	0.000
Trend	−0.0010	0.0003	−3.20	0.002
Constant	−0.4228	0.1117	−3.78	0.000
B. Without trend	*Test statistic*	*1% C.V.*	*5% C.V.*	*10% C.V.*
$Z(t)$	−2.000	−3.471	−2.882	−2.572
MacKinnon approximate *p* value for $Z(t)$ = 0.287.				
Change in log of real copper price	*Coefficient*	*Std. error*	*t statistic*	$p > \|t\|$
Lagged log of real copper price	−0.0357	0.0178	−2.00	0.047
Constant	−0.1523	0.0748	−2.04	0.043

Source: Author's calculations.

a. All the regressions in this table are based on 217 observations.

Fortunately, for a commodity such as copper, it is easy to get data going back two centuries and more. Table 4 repeats the same statistical tests with over 200 years of data, starting in 1784.[39] The coefficient on the lagged real copper price is now statistically significant, showing an estimated tendency to revert to equilibrium at a speed of 0.13 per year. The autoregressive coefficient is less than one, not just at the 10 percent level of statistical significance, but also at the 5 percent level. Just as the a priori calculation suggested, mean reversion is there, but one needs two centuries of data to see it.

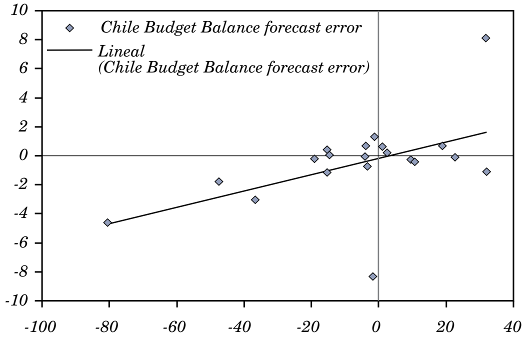
3.4 Private Forecasts of Copper Prices

Do copper price forecasters internalize the long-term data, which imply that a large increase in the current spot price of copper is likely to be partially reversed in the future? Or do they subscribe to the random walk hypothesis, consistent with shorter time samples? I use the futures markets to measure private forecasts, although there is only a decade of data. As illustrated in figure 4, when the spot price of copper rises, the forward price rises less than proportionately, implying a forecast of a possible future reversal. The graph also shows the official Chilean estimate of the long-run copper price produced by the expert panel. It rose even less than the forward price during the spike of 2006–08, behaving much like the ten-year moving average, as it is supposed to do. The panel, like the private markets, does appear to internalize the tendency of the price to revert toward its long-run trend.

Table 5 formally tests the hypothesis that private forecasters—to the extent that their monthly expectations are reflected in the forward market—believe in mean reversion in the real price of copper. The dependent variable is the expected future rate of change in the real copper price, with expectations measured by the forward rate at a monthly frequency. At all three horizons (15 months, 27 months, and 63 months) the results strongly support the hypothesis.

39. The time series constructed from *Historical Statistics of the United States* obtains the price of copper from different locations in different periods: Philadelphia: 1784–1824; Sheathing: 1825–59; Copper Lake: 1860–1906; New York: 1907–26; Connecticut: 1927–77; U.S. Bureau of Labor Statistics: 1978–98. The real price is the current dollar price divided by the BLS-based consumer price index. The 225-year history of the real price of copper is graphed in Frankel (2011a, appendix, figure 2). The trend is statistically significant, but negative.

Figure 4. Chile Budget Balance Forecast Error



Source: Bloomberg.

Table 5. Private Market Recognition of Mean Reversion in Copper Prices[a]

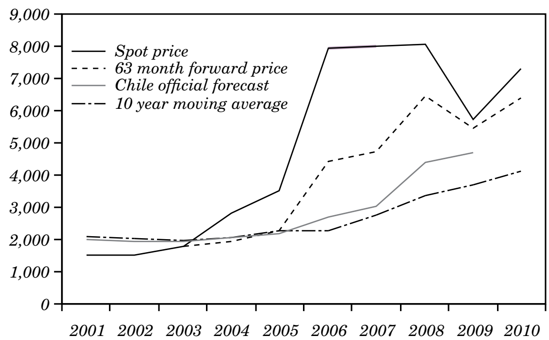
	Horizon		
	15 months	*27 months*	*63 months*
Explanatory variable	*(1)*	*(2)*	*(3)*
Spot price real	–0.0016***	–0.0029***	–0.0047***
	(0.0002)	(0.0003)	(0.0009)
Constant	0.0232***	0.0405***	–0.0119
	(0.0070)	(0.0116)	(0.0466)
Summary statistic			
No. observations	258	204	93
R^2	0.147	0.232	0.186
Root mean square error	0.0631	0.0980	0.201

Source: Author's calculations.
*** Statistically significant at the 1 percent level.
a. The dependent variable is log(real forward price / real spot price). Robust standard errors are in parentheses.

Even though real copper prices have a tendency to revert to a long-run trend and the forward market seems to internalize this tendency, the temptation to believe that changes in the price are permanent is very strong, particularly with big increases. The temptation would be especially understandable if uncertainty were genuinely higher after big increases in the price; it would be harder for naysayers to object.

The next hypothesis to be tested is that uncertainty is indeed higher at the top of the cycle. Uncertainty is here measured by the volatility that is implicit in options prices. The middle of the cycle is estimated as the long-run trend value of the real price, over the entire sample period 1784–2009. Unfortunately, options data are only available from 2004 to 2009, and the copper price during all of this period was above the measure of the long-run trend price. Thus, the only hypothesis that can be tested is that uncertainty becomes unusually high as the price moves toward the upper range of the price cycle; the symmetric hypothesis that uncertainty is also unusually high toward the lower part of the cycle cannot be tested with these data. Table 6 confirms the hypothesis, at high significance levels for options prices of five of the six horizons tested. Evidently, uncertainty does indeed rise as the copper price moves far above its long-run trend value. Figure 5 graphs the positive relationship between option-implied volatility and the level of the spot price. This finding is consistent with the hypothesis that forecasting is especially difficult in a boom.

Figure 5. Copper Price - Spot, Forward and Forecasted
(US$ per metric ton)



Sources: International Financial Statistics (IMF) and Bloomberg.

Table 6. Uncertainty When the Copper Price Is above Its Long-Run Trend?[a]

	Horizon					
	12 months	*15 months*	*24 months*	*27 months*	*39 months*	*63 months*
Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Real copper price	7.339**	8.377***	9.903***	10.040***	9.506***	−2.143
(diff. vs. long-run trend)	(3.190)	(3.017)	(2.822)	(2.775)	(2.677)	(1.522)
Constant	29.19***	27.74***	24.88***	24.32***	23.42***	31.95***
	(2.624)	(2.489)	(2.381)	(2.353)	(2.276)	(1.228)
Summary statistic						
No. observations	60	60	60	60	59	47
R^2	0.109	0.150	0.226	0.238	0.242	0.027
Root mean square error	7.108	6.750	6.206	6.082	5.675	3.688

Source: Author's calculations.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The table reports the regression of option-implied copper price volatility on log(real spot price) – linear trend [log(real spot price)], using data for 230 years. Robust standard errors are in parentheses.

4. Statistical Evidence of Overoptimism in Government Forecasts

Of the various ways that governments can fail to save enough, especially in boom times, the one of central interest in this paper is the possibility that official forecasts of revenue are overly optimistic. If the official forecast is optimistic, there is no reason to take painful steps such as cutting spending or raising taxes. The syndrome is not confined to commodity producers. A prominent example is the overly optimistic U.S. budget forecasts made by the White House in 2001 and subsequent years. Its unrealistic forecasts were a major reason for the striking failure of the United States to take advantage of the opportunity of the 2002–07 expansion to save.[40] However, the pattern, and the hope for an institutional solution, comes into sharper focus in the case of commodity producers.

4.1 Are Official Budget Forecasts Overly Optimistic on Average?

There is some evidence that government budget forecasts are overly optimistic on average, often because official estimates of economic growth are overly optimistic. Studies of growth forecasts by U.S. government agencies in the 1960s and 1970s used to find them generally unbiased and as accurate as private sector forecasts. Subsequent analyses, however, found biases. For example, McNees (1995) updated the time sample to 1994 and found an optimistic bias in some official forecasts of long-term growth. Auerbach (1994) found overly optimistic forecasts in the decade preceding 1993. In a later work, Auerbach (1999) again found that the semi-annual forecast of the U.S. Office of Management and Budget (OMB) tended to overestimate revenues during the period 1986–93, but tended to *underestimate* revenues in 1993–99 (during the Clinton Administration). McNab, Rider, and Wall (2007) find that the OMB's one-year-ahead forecasts of U.S. tax receipts were biased over the period 1963–2003. They

40. The White House claim that budget surpluses over the subsequent ten years would approach $5 trillion was a major factor in the new administration's ability to persuade the Congress to approve long-term tax cuts and spending increases. The result was that the ten-year fiscal outlook soon swung to roughly a cumulative $5 trillion *deficit*. (For details and further references, see Frankel, 2003, 2008a.)

suggest that the slant may be strategic on the part of various administrations seeking to achieve particular goals, such as overstating budget balance when the administration is seeking to increase spending or cut taxes. Frendreis and Tatalovich (2000) find that U.S. administrations (through the OMB) are less accurate in estimating growth, inflation, and unemployment than are the Congressional Budget Office and the Federal Reserve Board. They find partisan bias, which they interpret as Republican administrations overforecasting inflation and Democratic administrations overforecasting unemployment.

Forni and Momigliano (2004) find optimism bias among member countries of the Organization for Economic Cooperation and Development (OECD) more generally. Ashiya (2007) finds that official Japanese growth forecasts at a 16-month horizon are skewed upward by 0.7 percentage points, and they are significantly less accurate than private sector forecasts. Canada evidently underestimated its budget deficits in the late 1980s and early 1990s, but subsequently overestimated them (1994–2004), perhaps to reduce the risk of missing its target of a balanced budget under its strengthened institutional framework (O'Neill, 2005; Mühleisen and others, 2005).

Jonung and Larch (2006) find a clear tendency for E.U. governments to overestimate the economic growth rate when making budget plans. Several European countries display a statistically significant optimistic bias, including France, Italy, and Portugal over the period 1991–2002 (Hallerberg, Strauch, and von Hagen, 2009) and Germany, Italy, Greece, Luxembourg, and Portugal when the data set is updated to 2004 (Schuknecht, von Hagen, and Walswijk, 2009). The United Kingdom, Finland, and Sweden, on the other hand, tend to overestimate their deficits. Brück and Stephan (2006) explicitly conclude that euro area governments have manipulated deficit forecasts before elections since the introduction of the Stability and Growth Pact (SGP). Most of these authors argue that the systematic overoptimism in ex ante forecasts translates directly into larger ex post deficits, in particular deficits larger than targeted under the SGP.

Similarly, Beetsma, Guiliodori, and Wierts (2009) find that ex post budget balances among SGP countries systematically fall short of official ex ante plans. Marinheiro (2010) adds another complete business cycle to the data under the SGP and again finds that the forecasts of European fiscal authorities are overly optimistic, on average. This evidence is not consistently strong across the set of 15 E.U. countries, but the error is again systematically high for France, Italy, and Portugal at all forecast horizons.[41]

There is far less research into the forecasting records of fiscal authorities in low-income or medium-income countries than in advanced countries.[42] One reason is the very limited availability of data. However, some major emerging market countries became more transparent about their budgets after the crises of the 1990s. Mexico, for example, now makes available data on its ex ante planned budget balance, which can be compared with the ex post realized budget balance. If the numbers are interpreted as a forecasting exercise, then the accuracy during the period 1995–2009 is impressively high. At the same time, there is evidence of a small bias in the direction of overoptimism: the budget deficit as a share of GDP is underforecast by an average of one-tenth of a percent of GDP. The mean is greater than zero and statistically significant, but only at the 10 percent level.[43]

Table A1 in the appendix reports the mean errors made by government forecasts of the budget balance for 33 countries.[44] A majority of the countries are European (25, of which 16 are euro members, not counting Estonia which was approved for membership in 2010). European countries are heavily represented in the sample because they report official budget forecast data as a side effect of the Stability and Growth Pact, whereas most countries do not. The European data allow testing for the effect on forecast bias of the political forces from a budget rule such as the SGP, as shown below. Of the additional eight countries, three are advanced commodity-exporting countries (Australia, Canada, and New Zealand), two are major advanced countries that are not primarily associated with their commodity exports (the United States and the United Kingdom), and three are middle-sized emerging market countries that export commodities (Chile, Mexico, and South Africa). The last category is perhaps the most important for this study, but national sources must be consulted one by one, and for most countries the answer is that such data are not available.

41. He proposes delegating the macroeconomic forecasting to supranational authorities, such as the E.U. Commission or the IMF.

42. Chang, Franses, and McAleer (2010) analyze official forecast errors for Taiwan, a newly industrialized economy, but without clear findings.

43. Frankel (2011a, table 5 and figure 6) reports the results.

44. An appendix in Frankel (2011a) identifies the data sources for the 33 countries.

The third column of the table reports the official ex ante forecast minus actual ex post outcome one year ahead: mean forecast error, minimum, and maximum. Some countries report forecasts two or three years ahead; these forecast errors are shown in the fourth and fifth columns, respectively. The general pattern, as suspected, is overoptimism. In most cases, the positive bias emerges more strongly at the three-year horizon than at the two-year horizon and more sharply at the two-year horizon than at the one-year horizon. The average across all countries is an upward bias of 0.2 percent of GDP at the one-year horizon, 0.8 percent two years ahead, and a hefty 1.5 percent three years ahead. The absolute magnitude of forecast errors increases with the length of the horizon. This would be true even if forecasts were optimal. The upward trend in the bias suggests, however, that the longer the horizon and the greater the genuine uncertainty, the more the scope for wishful thinking.

The bias is not greater for commodity producers or developing countries than it is for other economies, though the sample is far too small to allow a reliable test of the difference. The U.S. and U.K. forecasts have substantial positive biases around 3 percent of GDP at the three-year horizon. This is approximately equal to their actual deficit, on average; in other words, they repeatedly forecast a disappearance of their deficits that never materialized. The forecast biases in the European countries have already been noted from the literature. Official budget forecasts in South Africa were overly *pessimistic*, on average, as were those for Canada and New Zealand. Chile had no optimism bias (the hypothesis of this study is that this was the result of its institutions), and Mexico has already been discussed. Neither offers forecasts beyond the one-year horizon.

4.2 Are Official Growth Forecasts Overly Optimistic on Average?

One likely reason for upward bias in official budget forecasts, in advanced and developing countries alike, is upward bias in economic assumptions such as economic growth and commodity prices. This is the hypothesis of central interest in this paper. There are other possible reasons, as well, why official budget forecasts could be overly optimistic on average. The official forecast may represent the desired target in the plan of the executive, but there could be slippage by the time the final expenditures are made, due to the usual political pressures.[45] Those who write the initial budget plan may even be fully aware of this tendency toward slippage and may place a lower priority on statistically unbiased forecasts than on setting an ambitious goal so as to achieve as strong a final outcome as possible.

Table A2 in the appendix reports the mean errors made by government forecasts of the GDP growth rate, for 33 countries. Again the overall pattern is an upward bias, on average, which rises with the length of the horizon: 0.4 percent when looking one year ahead, 1.1 percent at the two-year horizon, and 1.8 percent at three years. The bias appears in the United States and many other advanced countries, but it is not generally among the commodity producers in this sample.[46] Chile on average underforecast its growth rate, by 0.8 per cent at the one-year horizon. South Africa was just slightly too optimistic, on average (0.2 per cent at the one-year horizon), and Mexico more so (1.7 per cent).

I next turn to cyclical patterns in the forecast errors. Fewer authors have looked for cyclical patterns in the systematic forecast errors made by national authorities than unconditional average errors.

4.3 The Influence of Macroeconomic Fluctuations on Budget Balances

As previously illustrated in table 2, the price of copper is key to the ex post determination of the budget in Chile. Before any attempt to detect systematic ex ante determinants of errors made in officials forecast of budget deficits in the full sample of 33 countries, it would be useful to confirm that a few macroeconomic variables such as the real growth rate are, in fact, key to the ex post determination of the actual budget balance. This would then indicate that overoptimism in forecasts of these macroeconomic variables is a possible source of any observed overoptimism in the budget forecasts.

Table 7 regresses the ex post budget outcome (expressed relative to the ex ante attempt to predict it) against the ex post real growth rate (again expressed relative to the forecast), for the full set of

45. Cárdenas, Mejía, and Olivera (2009) show how this process works for Colombia. There may also be slippage that is not captured in the final budget numbers, because it takes place in off-budget agencies or categories.

46. The commodity exporters in this data set almost certainly represent some sample selection bias, in that only governments that are transparent enough to publish their budget forecasts are included, for obvious reasons. I therefore do not emphasize tests of whether official forecasts behave differently for commodity exporters than for other countries. Such tests appear to show that the special commodity exporters in the sample are actually less optimistic than others.

countries. At all three horizons, the growth rate is highly significant at determining the budget balance. For every 1 percent of growth, relative to what was forecast a year previously, the budget improves by about half that amount, relative to what was forecast a year previously. The same is true at the two-year and three-year horizons. Thus, overoptimism in forecasting the budget is likely to coincide with overoptimism in predicting real growth.

In some countries, inflation pushes taxpayers into a higher tax bracket.[47] Accordingly, table 8 adds the inflation rate as another possible determinant of the budget balance. (Both are again expressed relative to the official ex ante forecasts.) The finding is that inflation does indeed translate into a strong budget surplus, to a statistically significant degree at the two- and three-year horizon.[48]

Table 7. GDP as a Determinant of Budget Balance as a Percent of GDP[a]

Explanatory variable	*One year ahead (1)*	*Two years ahead (2)*	*Three years ahead (3)*
GDP forecast error	0.479***	0.525***	0.489***
	(0.060)	(0.068)	(0.077)
Constant	0.155	0.198	0.556*
	(0.174)	(0.249)	(0.314)
Summary statistic			
No. observations	367	277	175
No. countries	33	31	28
R^2	0.280	0.369	0.322
Root mean square error	1.695	2.053	2.327

Source: Author's calculations.
*** Statistically significant at the 1 percent level.
a. The dependent variable is the ex post budget outcome (expressed relative to the ex ante attempt to predict it). The estimations include random effects by country. Robust standard errors are in parentheses.

47. The Tanzi effect can go the other direction at high levels of inflation: due to lags in tax collection, inflation erodes the real value of tax receipts and can worsen the budget deficit.

48. These tables allow random effects by country (which facilitates comparison across the three columns even though the sample of countries diminishes). Results without random effects are reported in Frankel (2011a). There, the effect of inflation was a bit stronger statistically.

Table 8. GDP and Inflation as Determinants of Budget Balance as a Percent of GDP[a]

Explanatory variable	*One year ahead (1)*	*Two years ahead (2)*	*Three years ahead (3)*
GDP forecast error	0.498***	0.466***	0.460***
	(0.055)	(0.064	(0.075)
Inflation forecast error	0.158	0.196*	0.254***
	(0.109)	(0.116)	(0.093)
Constant	0.331	0.593*	0.913**
	(0.212)	(0.306)	(0.356)
Summary statistic			
No. observations	214	185	159
No. countries	28	27	27
R^2	0.351	0.402	0.351
Root mean square error	1.634	2.127	2.313

Source: Author's calculations.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is the ex post budget outcome (expressed relative to the ex ante attempt to predict it). The estimations include random effects by country. All variables are lagged so that they line up with the year in which the forecast was made, not the year being forecast. Robust standard errors are in parentheses.

4.4 Are Budget Forecasts More Prone to Overoptimism in Booms?

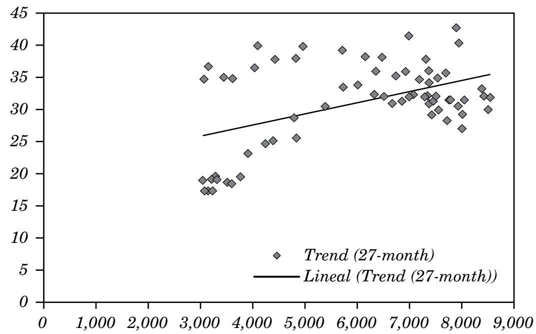
I now return to the examination of bias in government forecasts. Table 9 goes beyond testing for unconditional overoptimism in official budget forecasts to see if the bias is greater in a boom, here measured as the deviation of output from a quadratic trend. The cyclical term is indeed positive and highly significant: overoptimism tends to be greater in booms. Its estimated magnitude rises as the horizon moves from one year to two years and then again to three years. This makes sense: there is more scope for wishful thinking at longer horizons because the uncertainty is genuinely higher. Nevertheless, there is still also evidence of a bias toward optimism even when GDP is at its trend value.

Table 9. Budget Balance Forecast Error as a Percent of GDP: Full Sample[a]

Explanatory variable	*One year ahead (1)*	*Two years ahead (2)*	*Three years ahead (3)*
GDP deviation from trend	0.093***	0.258***	0.289***
	(0.019)	(0.040)	(0.063)
Constant	0.201	0.649***	1.364***
	(0.197)	(0.231)	(0.348)
Summary statistic			
No. observations	398	300	179
R^2	0.033	0.113	0.092
Root mean square error	2.248	2.732	3.095

Source: Author's calculations.
*** Statistically significant at the 1 percent level.
a. The dependent variable is lagged so that it lines up with the year in which the forecast was made and not the year being forecast. The regressions include random effects by country. The GDP deviation is the deviation from the quadratic trend. Robust standard errors are in parentheses, clustered by country.

Figure 6. Trend (27-month)

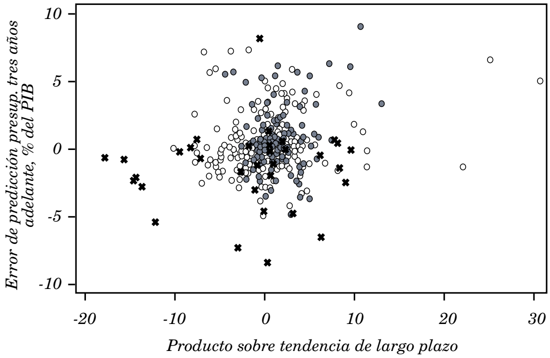


Source: Bloomberg.

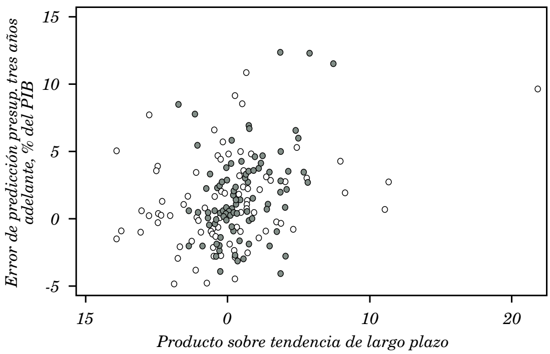
The findings are visible in figures 6 and 7. First, budget forecasts in most countries are biased upward (that is, most points appear above the zero level of budget prediction error). Second, Chile is an exception, in that the *x* values in figure 6 mostly lie below the zero level. Third, a comparison of the two figures reveals that the bias is greater at longer horizons. Fourth, the bias is greater in booms (that is, a regression line slopes upward.) [49]

Figure 7. Budget Balance Forecast Error and Business Cycle State

A. One year horizon



B. Three years horizon



Source: World Development Indicators (World Bank).
Lighter colors corresponds to APEC countries. Crosses indicates Chile.

49. The country with the longest sample period at the one-year horizon is Chile (1977–2009); see figure 6. At the two-year horizon, the United States has the longest sample period (1987–2009), as shown in Frankel (2011a, figure 7B). At the three-year horizon, numerous European countries have a sample period of 2001–2009: see figure 7. For the individual country sample periods, see Frankel (2011a, table A1).

4.5 Are Official Budget Forecasts More Prone to Overoptimism When the Country is Subject to a Budget Rule?

The E.U. countries that had to work the hardest to meet the Maastricht fiscal criteria—such as Italy—are also the ones found by several studies to have had the greatest bias in their forecasts. The fact that the United Kingdom does not show significant overoptimism (Jonung and Larch, 2006) is consistent with the possibility that the bias is related to the common currency, given that the country has not sought entrance into the euro area. Thus the literature supports the hypothesis that formal adoption of a budget deficit ceiling may, by itself, induce a tendency toward overoptimism in official forecasts, but that overoptimism can be counteracted by the right sort of fiscal regime or institution.

To test this hypothesis, I performed a regression of my own tests of the "planning to cheat" hypothesis, on a bigger data set than the earlier studies. The examples of rule-bound countries are the euro members, as in the literature.[50] Rather than comparing them only to other European countries, however, I also include economies from other regions, including a number of commodity producers. The data confirm the finding that the European countries, in general, and the SGP countries, in particular, are prone to overly optimistic budget forecasts in the data set. The bias is stronger at longer forecast horizons. I also tested for a cyclical pattern in the overoptimism by including a term for the interaction of the dummy for countries subject to the SGP and their GDP expressed as a deviation from its long-run trend.[51] The coefficient is statistically significant. The positive sign confirms the extrapolative nature of the forecasters' optimism: when the business cycle is at its peak, the government forecasters are more prone to give free reign to wishful thinking. The results are very similar regardless of whether the data set includes just western European countries, all European countries, or the complete set of countries.

50. New Zealand and Switzerland are other examples of countries with rules that put ceilings on the deficit and debt (Marcel and others, 2001).

51. Frankel (2011a, tables 9A, 9B, and 9C) or Frankel (2011b, table 3). The coefficient's estimated magnitude and statistical significance rise with the horizon of the forecast.

4.6 Is Overoptimism in Growth Forecasts Worse in Booms?

As discussed above, for most countries, the evolution of the actual budget deficit at a one-year horizon is heavily influenced by the evolution of the economy, particularly GDP. In this section, I test whether the cyclical component to errors in budget forecasting derives from an analogous cyclical component to errors in economic forecasting. Table 10 tests if growth forecasts tend to be more overly optimistic when the economy is at a cyclical peak, here measured as the deviation of GDP from a quadratic trend. The answer is a resounding yes, especially as the horizon of the forecast lengthens, just as with forecasts of the budget deficit.

Table 10. GDP Growth Rate Forecast Error[a]

Explanatory variable	*One year ahead (1)*	*Two years ahead (2)*	*Three years ahead (3)*
GDP deviation from trend	0.204***	0.497***	0.668***
	(0.033)	(0.078)	(0.159)
Constant	0.265***	0.799***	1.600***
	(0.091)	(0.130)	(0.247)
Summary statistic			
No. observations	368	282	175
No. countries	33	31	28
R^2	0.138	0.298	0.303
Root mean square error	2.234	2.945	3.306

Source: Author's calculations.
*** Statistically significant at the 1 percent level.
a. The dependent variable is lagged so that it lines up with the year the forecast was made in and not the year being forecast. The regressions include random effects by country. The GDP deviation is the deviation from the quadratic trend. Robust standard errors are in parentheses, clustered by country.

The next step is to see if the pattern is worse among rule-bound countries. In every case, the term that interacts the SGP dummy with GDP has a significantly positive effect on the error made in forecasting output, very much like the positive effect in forecasting the budget.[52] In other words, when the economy is at a cyclical high

52. Frankel (2011a, tables 11A, 11B, and 11C) or Frankel (2011b, table 5).

in rule-bound countries, forecasters tend to extrapolate, as if the boom would last forever.

4.7 Are Official Forecasts Overly Optimistic at Cyclical Lows as Well as Highs?

I have noted some evidence consistent with the idea that overoptimism thrives when genuine uncertainty is high—namely, it increases with the horizon of the forecast. Uncertainty is probably greater at cyclical highs and lows, because it is difficult to tell whether the recent movement is temporary or permanent. These considerations suggest a further hypothesis worth testing: that forecasts are overly optimistic not just at the top of the business cycle, but at the bottom as well. The simplest way to test this hypothesis is to transform the cyclical independent variable, which has been expressed as the deviation of GDP from trend, to the absolute value of that deviation. The exercise offers strong support for the hypothesis, as a characterization of both bias in official forecasts of the budget balance and bias in official forecasts of economic growth.[53] Evidently, official forecasters are overly optimistic both in booms and busts, more so than when GDP is at its long-run trend. They overestimate the permanence of the booms and the transitoriness of the busts.[54]

5. Summary of Statistical Findings

This section restates the paper's 15 econometric results.

—The real price of copper tends to revert toward its long-run trend, but the tendency can only be statistically detected when the time series history runs for as long as a century or two. For studies that only encompass a few decades of data, statistical power is lacking. In such cases, a departure of the price of copper from its long–run trend, as in the 2003–08 boom, can easily but erroneously appear to be permanent.

—Further illustrating the difficulty of forecasting in the midst of a boom, the option-implied volatility is higher when the real price of copper lies far above its long-run trend value.

53. Reported in Frankel (2011a, tables 12A and 13A) or Frankel (2011b, tables 6a and 7a).

54. The patterns are worse for European forecasters than for others (Frankel, 2011a, tables 12B and 13B) or Frankel (2011b, tables 6b and 7b).

—Official forecasts of future budgets in a sample of 33 countries are, on average, overly optimistic.

—The bias toward overoptimism in budget forecasts is stronger the longer the horizon (from one to two to three years). At the three-year horizon, the average is an upward bias of 1.5 percent of GDP.

—Official forecasts of the budget in the United States and Europe are overly optimistic, on average.

—Chile's official forecasts are not overly optimistic, on average.

—The same patterns show up in official forecasts of real GDP growth rates among 33 countries: overly optimistic on average, especially at longer horizons (1.8 percent at the three-year horizon), but not overly optimistic for Chile.

—Forecasting GDP is a major component of forecasting the budget: prediction errors in the former are highly significant determinants of prediction errors in the latter.

—In Chile, errors in predicting the price of copper are highly significant determinants of errors in predicting the budget; indeed, GDP is not a statistically significant determinant of the budget when controlling for the copper price.

—The bias in official budget forecasts among 33 countries is statistically correlated with the business cycle: overoptimism is higher in booms.

—The tendency for overoptimism in government budget forecasts and growth forecasts to rise in booms is particularly strong in European countries that are formally subject to the Stability and Growth Pact, especially at the two- and three-year horizons.

—There is also statistical evidence for the proposition that budget forecast bias is related to the absolute value of the deviation of GDP from its long-run trend. In other words, overoptimism occurs at the bottom of the business cycle as well as at the top, although the R^2 is not as high as in the earlier formulation.

—The same pattern holds for bias in GDP forecasts: there is some support for the hypothesis that overoptimism increases at both ends of the cycle, but the fit is not quite as good as for the hypothesis that it increases at the top of the cycle.

—There is no consistent relationship between budget forecast errors and the copper price in Chile, suggesting that the country has avoided the problem common in other countries.

—Taken together, these results tell a coherent story. Among many countries, there is a tendency toward wishful thinking in official forecasts of growth and the budget. Governments unrealistically extrapolate booms three years into the future. The bias is worse among the European countries that are supposedly subject to the budget rules of the SGP, presumably because those in the government who make the forecasts feel pressured to be able to announce that they are on track to meet the budget targets even if they are not. Chile has a budget rule, but is not subject to the same bias toward overoptimism in forecasts of the budget, growth, or the all-important copper price. This evidence is consistent with the idea that the key innovation that has allowed Chile to achieve countercyclical fiscal policy and to run surpluses in booms is not just a structural budget rule in itself, but rather the regime that entrusts to two panels of independent experts the responsibility for estimating the extent to which contemporaneous copper prices and GDP have departed from their long-run averages.

6. Countercyclical Fiscal Institutions Generalized for Other Countries

Any country could usefully apply variants of the Chilean fiscal device. This is especially true for oil and mineral producers.[55] Countries that do not rely on commodities could also usefully adopt versions tailored to their own circumstances. Much like mineral producers, countries prone to natural disasters should put aside savings in good years. In both cases, independent expert panels could estimate the relevant parameters. Even large diversified industrialized countries could set up independent institutions charged by law with estimating the output gap and other budget-relevant macroeconomic variables, such as the inflation rate and the fractions of GDP going to wage versus nonwage income.

Given that many countries, especially in the developing world, are prone to weak institutions, a useful reinforcement of the Chilean idea would be to formalize the details of the procedure into law and give the panels legal independence. There could be a law protecting panel members from being fired, as there for governors of independent central banks. The principle of a separation of decisionmaking powers should be retained: the rules as interpreted by the panels

55. Ecuador at one point had institutions designed to increase national saving during an oil boom, and Colombia had institutions for both coffee and oil. But such countries often miss their targets or change their rules (Perry, 2003, pp. 18–19; Villafuerte, López-Murphy, and Ossowski, in this volume).

help determine the total amount of spending and budget deficits, while the elected political leaders determine how that spending is allocated and how tax revenue is raised.

Two technical questions remain: of the extent to which the structural budget calculations are to be delegated to the independent panels of experts and whether the budget rules are interpreted as ex ante or ex post. With regard to the former, the computation of the structural balance in Chile involves a number of calculations that are made inside the Ministry of Finance, rather than by the panels of experts. These calculation apparently include the estimation of trend GDP from an aggregate production function (the macroeconomic panel provides the estimates of trend levels of inputs), the estimation of the long-term price of molybdenum,[56] the estimation of mining and nonmining tax revenues, and so on.[57] If the locus of these calculations were to be moved from the Ministry to the independent panels, it might require establishing a standing bureaucracy, in the manner of the U.S. Congressional Budget Office (CBO). The CBO has managed to maintain its independence and integrity, despite the politicization of most of the rest of Washington.[58] If the new independent agency were given more comprehensive control over fiscal policy, it would then draw closer to symmetry with the delegation of monetary policy to independent central banks.[59] At the opposite end of the spectrum, the panels might be charged with nothing more than computing the ten-year moving-average trend of the copper price and real GDP.

The second, related, question is whether the targeting is to be ex ante or ex post. An ex post rule for the budget deficits would have to be phrased as a target range or as an upper bound, because unanticipated economic developments make it impossible for anyone to hit a budget

56. As of 2005, the government can run a larger deficit to the extent that the price of molybdenum is below its medium-term average, so it is now targeting more than just the price of copper.

57. Marcel and others (2001, pp. 6–17); Rodríguez, Tokman, and Vega (2007, pp. 10–21).

58. Chile's congress established a version of the CBO in 2003, with a staff of three analysts (Santiso, 2005, p. 29). The legislative branch in Chile does not have the power to determine fiscal policy as it does in the United States.

59. Wyplosz (2005) and Jonung and Larch (2006) propose setting up an independent fiscal policy committee that would reproduce what independent monetary policy committees do. Others also note the analogy with monetary policy (for example, Alesina and Perotti, 1996), but the analogy has its limits. Few reformers suggest that the details of tax and spending policy could or should be delegated to an agency that is not directly accountable in a democratic way, even though the details of interest rate setting and asset purchases are delegated to independent central banks.

target precisely. The alternative is for an ex ante rule: tax rates, spending parameters, and so forth are set so as to produce the desired target if all goes precisely as expected, while recognizing that there will be unanticipated deviations during the course of the year.

The analogous issue is familiar in the context of monetary policy. If the target variable is the money supply or inflation rate, the authorities cannot be expected to hit it exactly, as opposed to a target of the gold price or the exchange rate. The usual approach is that the monetary authorities announce a target range for M1 or the inflation rate. Conceptually, a sincere central bank will set the range so it they can achieve an outcome within the specified range, say 95 percent of the time. The public can then monitor the ability of the central bank to deliver on its commitment. An alternative proposal is that the monetary authorities set the parameters so as to hit a desired ex ante inflation target. If the one true model of how the economy operates were known to the central bank, which in turn announced it to the public, the two procedures would be equivalent. In reality, however, the model is highly uncertain, everyone knows that it is uncertain, and different elements among the staff and different members of the monetary policy committee vary as to their preferred models. Thus, it is less practical to announce an ex ante target. The members of the monetary policy committee would have to negotiate with each other over an ever-changing common model and set of forecasts, a cumbersome way to go about negotiating a decision on monetary policy.

In the case of the fiscal expert panels, however, setting an ex ante target may be more feasible. More precisely, the panel could be charged with evaluating whether the government's budget proposal would hit the desired structural budget target, not only if output were at potential and the copper price were at its long-run equilibrium, which they already have to do under the Chilean system, but also, more comprehensively, if growth and other economic variables were at the levels *expected over the coming year.*

Another important modification to consider is to recast the fiscal policy rule as more aggressively countercyclical. The Bachelet government appears to have steps to make the budget even more countercyclical than required by the rule, saving more in 2007–08 and spending more in 2009–10. One could argue that this degree of countercyclicality should now be formalized into the rule. A further possibility would be an escape clause for earthquakes as severe as the one that hit central Chile in February 2010. The design of rules is always subject to a tradeoff between the advantages of simplicity and the disadvantages of leaving to much to the discretion of uncommitted politicians.

7. Concluding Thoughts

Although Chile's fiscal institutions have been well studied inside Chile, they have not yet received the attention from the wider world that they merit. They should and could provide a useful model worthy of emulation by other countries.

Chile's fiscal institutions are a relatively pure example of several much broader trends. The first is the increased emphasis on institutions in development economics and other branches of economics over the past decade or two. It is recognized that it is not enough to recommend good fiscal policy to a country—or for the IMF to make loans to a country conditional on good fiscal policy—if the deeper political support and institutions are not there to sustain the policy. Sometimes, however, economists are not specific enough about what they mean by good institutions. Exhortations on the importance of rule of law need to be backed up by concrete recommendations.[60]

The second trend is the increased importance over the last decade of primary commodities: namely, fossil fuels, minerals, and agricultural products. After two decades of lower real prices, almost all minerals and other commodities experienced a major boom in 2003–08. With the commodity boom, issues of how to manage volatility, Dutch disease, and the natural resource curse returned. The need, then, is for institutions to help manage the commodity cycle, in line with trend number one. It is good news that there are now examples of regimes that are designed to guard against the human nature to overspend when commodity prices go up.

The third trend is a historic reversal of roles between some countries traditionally classified as advanced or industrialized and some countries traditionally classified as emerging or developing. The

60. No set of rules or institutions is foolproof against determined efforts to circumvent them. In the United States, for example, politicians who wish to appear fiscally responsible have found legislative tricks for manipulating CBO estimates so that future budget deficits falsely appear to diminish and disappear. The Bush Administration routinely left the cost of foreign wars off the budget, treating their continuation as a surprise every year. It also pretended for legal purposes that its extensive tax cuts would expire in the future even though its policy was to renew them when the time came.

latter group, especially in Latin America, has been characterized by unfortunately procyclical fiscal policy and poor creditworthiness. In the post-2000 boom, however, many developing countries achieved stronger budget balances, national saving rates, current account balances, and foreign exchange reserve holdings than in past cycles. Consequently, some have been able to reap the rewards of better creditworthiness, as reflected in credit ratings and sovereign spreads, and they were better able to respond to the global financial crisis and recession of 2008–09 by easing rather than tightening. Some of these countries have now achieved a fiscal policy that is not only less procyclical than the pattern of their own past histories, but also more countercyclical than that of the advanced countries.

The fiscal regime that has been explored in this paper is among the most well-focused examples that lie at the intersection of these three trends. For the many countries that need to make their budgets stronger and less procyclical, Chile's fiscal institutions may offer a useful model.

APPENDIX
Data Sources and Supplemental Tables

The countries classified as commodity exporters are Australia, Canada, Chile, Mexico, New Zealand, and South Africa.

The countries classified as European are Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland, and the United Kingdom.

The countries classified as western European are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

The countries included in the Stability and Growth Pact convergence program are Austria, Belgium, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Ireland, Latvia, Lithuania, Luxemburg, Malta, Poland, Portugal, Slovakia, Slovenia, and Spain. (These countries are all in the SGP, but were not in the Mühleisen and others, 2005, data set.) All forecast data are from the European Union SGP convergence programs. The years 1999–2007 are from the convergence programs as reported in Beetsma, Giuliodori, and Wierta (2009). The data for 2008–10 were updated directly from the convergence programs. Through 2006, the realized values for these countries are from the European Commission AMECO database (via Beetsma, Giuliodori, and Wierta, 2009). The data for 2007–09 were updated using the realizations reported in the SGP convergence programs. European Union SGP convergence programs are available online at ec.europa.eu/economy_finance/sgp/convergence/programmes/index_en.htm.

Table A1. Errors in Forecasting Budget Surplus: Official Budget Forecast Minus Actual Fiscal Balance
(Percent of GDP)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Australia: 1985–2009				
Mean	–0.2	–0.2	–0.2	1.2
Minimum	–2.7	–1.6	–1.4	–0.9
Maximum	1.7	4.0	3.3	3.2
No. observations	26	25	14	2
Austria: 1999–2009				
Mean	–1.8	0.3	0.7	0.9
Minimum	–3.9	–0.6	–1.3	–1.3
Maximum	–0.2	3.2	3.3	4.1
No. observations	13	11	10	9
Belgium: 1999–2009				
Mean	–1.0	0.2	1.0	1.3
Minimum	–5.9	–1.1	–1.1	–1.0
Maximum	0.3	2.4	6.2	6.6
No. observations	13	11	10	9
Canada: 1985–2008				
Mean	–2.1	–0.9	–0.7	n.a.
Minimum	–8.6	–2.6	–2.5	n.a.
Maximum	1.3	0.5	1.7	n.a.
No. observations	26	23	20	0

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Chile: 1977–2009				
Mean	2.2	–1.4	n.a.	n.a.
Minimum	–5.5	–8.3	n.a.	n.a.
Maximum	8.9	8.1	n.a.	n.a.
No. observations	33	33	0	0
Cyprus: 2005–2009				
Mean	–2.8	–0.2	–0.4	–0.4
Minimum	–6.5	–4.9	–5.1	–4.8
Maximum	3.3	5.3	6.6	5.7
No. observations	12	5	4	3
Czech Republic: 2005–2009				
Mean	–4.2	–0.1	–0.3	0.4
Minimum	–6.8	–2.4	–1.9	–1.7
Maximum	–1.6	5.0	3.6	3.6
No. observations	13	5	4	3
Denmark: 1999–2008				
Mean	1.6	0.1	0.2	0.1
Minimum	–3.0	–2.8	–3.1	–2.8
Maximum	4.8	3.0	5.0	4.8
No. observations	13	11	10	9

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Estonia: 2005–2009				
Mean	0.3	–0.3	0.4	1.4
Minimum	–3.5	–3.3	–3.4	–2.8
Maximum	3.4	4.1	4.1	4.2
No. observations	13	5	4	3
Finland: 1999–2009				
Mean	2.8	–0.5	–0.8	–0.3
Minimum	–2.2	–2.5	–4.7	–3.1
Maximum	6.9	4.3	5.8	4.9
No. observations	13	11	10	9
France: 1996–2009				
Mean	–3.5	0.6	1.5	2.2
Minimum	–7.9	–0.5	–0.4	0.1
Maximum	–1.5	4.0	6.2	7.0
No. observations	16	14	10	9
Germany: 1991–2009				
Mean	–3.0	1.0	1.4	1.3
Minimum	–4.8	–1.7	–2.5	–2.0
Maximum	0.0	3.5	3.4	3.8
No. observations	19	19	18	9

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Greece: 2000–2009				
Mean	–5.5	4.3	5.4	6.0
Minimum	–12.7	0.3	0.1	0.9
Maximum	–2.9	9.0	11.9	11.5
No. observations	13	10	9	8
Hungary: 2005–2009				
Mean	–6.1	1.7	2.2	1.9
Minimum	–9.3	–1.3	–0.5	0.7
Maximum	–3.0	4.6	6.2	3.1
No. observations	13	5	4	3
Ireland: 1999–2009				
Mean	0.0	0.4	1.0	1.9
Minimum	–11.7	–3.6	–3.6	–4.1
Maximum	4.7	6.3	10.6	12.3
No. observations	13	11	10	9
Italy: 1990–2009				
Mean	–7.9	1.1	1.6	2.6
Minimum	–18.1	–3.8	–3.5	0.5
Maximum	–1.8	5.8	5.2	4.2
No. observations	25	20	19	9

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Latvia: 2005–2009				
Mean	–2.1	1.5	2.9	3.7
Minimum	–10.0	–1.3	–1.4	–1.4
Maximum	1.4	6.5	11.0	9.6
No. observations	13	5	4	3
Lithuania: 2005–2009				
Mean	–3.4	1.4	2.7	3.7
Minimum	–11.9	–2.0	–1.3	–0.3
Maximum	–0.5	7.0	9.3	9.1
No. observations	13	5	4	3
Luxembourg: 1999–2009				
Mean	2.3	–1.7	–1.4	–0.7
Minimum	–1.2	–4.8	–4.8	–4.8
Maximum	6.1	2.2	2.6	4.6
No. observations	13	11	10	9
Malta: 2005–2009				
Mean	–5.7	0.9	1.8	2.6
Minimum	–9.9	–0.7	–0.5	0.4
Maximum	–1.8	3.5	3.8	3.9
No. observations	13	5	4	3

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Mexico: 1995–2009				
Mean	–0.6	0.1	n.a.	n.a.
Minimum	–2.3	–0.1	n.a.	n.a.
Maximum	0.1	0.6	n.a.	n.a.
No. observations	15	15	0	0
Netherlands: 1995–2009				
Mean	–2.7	0.6	0.4	0.7
Minimum	–11.0	–2.3	–2.6	–2.3
Maximum	1.3	7.1	5.5	5.8
No. observations	17	15	10	9
New Zealand: 1995–2008				
Mean	1.9	–0.1	–0.4	–0.8
Minimum	–0.9	–4.2	–3.9	–0.8
Maximum	7.3	2.9	3.9	–0.8
No. observations	18	13	12	1
Poland: 2005–2009				
Mean	–4.4	1.6	2.1	2.7
Minimum	–7.2	0.4	–0.2	–0.2
Maximum	–2.0	4.7	5.2	6.6
No. observations	13	5	4	3

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Portugal: 1999–2009				
Mean	−3.9	1.4	2.3	3.1
Minimum	−9.3	−1.0	−1.0	0.1
Maximum	−2.7	5.4	7.8	7.8
No. observations	13	11	10	9
Slovakia: 2005–2009				
Mean	−5.2	0.5	1.4	1.9
Minimum	−12.2	−0.7	−0.1	0.3
Maximum	−2.2	3.3	4.5	4.4
No. observations	13	5	4	3
Slovenia: 2005–2009				
Mean	−2.6	−0.2	0.9	1.5
Minimum	−5.7	−1.4	−1.3	−1.0
Maximum	−0.1	0.9	5.1	4.7
No. observations	13	5	4	3
South Africa: 1998–2008				
Mean	−1.6	−0.3	−1.3	−1.5
Minimum	−5.2	−2.8	−4.0	−4.4
Maximum	1.7	5.6	0.9	0.2
No. observations	13	11	10	9

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Spain: 1999–2009				
Mean	–1.6	0.9	1.5	1.6
Minimum	–11.4	–1.2	–1.6	–1.8
Maximum	2.2	5.6	12.6	12.3
No. observations	13	11	10	9
Sweden: 1998–2009				
Mean	0.8	0.4	0.7	1.4
Minimum	–2.2	–1.7	–2.3	–2.5
Maximum	3.8	3.5	5.3	5.3
No. observations	14	12	11	9
Switzerland: 1990–2003				
Mean	–0.4	–0.2	–0.2	n.a.
Minimum	–2.2	–2.9	–2.3	n.a.
Maximum	0.8	1.4	1.0	n.a.
No. observations	16	14	13	0
United Kingdom: 1997–2009				
Mean	–3.0	0.8	1.8	2.8
Minimum	–12.6	–1.4	–1.9	–0.7
Maximum	2.7	4.5	10.2	10.9
No. observations	25	13	11	9

Table A1. (continued)

Country, sample period, and statistic	*Actual fiscal balance*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
United States: 1986–2009				
Mean	–2.7	0.4	1.0	3.1
Minimum	–9.9	–2.2	–3.1	–0.6
Maximum	2.6	7.2	8.7	8.5
No. observations	26	24	23	3
Total				
Mean	–1.9	0.2	0.8	1.5
Minimum	–18.1	–8.3	–5.1	–4.8
Maximum	8.9	9.0	12.6	12.3
No. observations	535	399	300	179

Source: See Frankel (2011a, data appendix).
a. Years are those for which there are data for the one-year-ahead budget forecast error.

Table A2. Errors in Forecasting Growth: Official GDP Forecast Minus Actual GDP

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Australia: 1987–2009				
Mean	3.1	0.2	0.8	n.a.
Minimum	–0.8	–2.0	0.4	n.a.
Maximum	4.6	2.8	1.1	n.a.
No. observations	24	23	2	0
Austria: 1999–2009				
Mean	1.9	0.1	0.9	1.0
Minimum	–3.4	–1.5	–1.0	–1.2
Maximum	3.6	2.0	5.9	5.9
No. observations	13	11	10	9
Belgium: 1999–2009				
Mean	1.8	0.0	0.9	1.1
Minimum	–3.1	–1.2	–1.4	–0.6
Maximum	3.7	1.7	5.1	5.3
No. observations	13	11	10	9
Canada: 1985–2003				
Mean	2.9	–0.3	0.4	n.a.
Minimum	–1.7	–3.3	–2.6	n.a.
Maximum	5.1	2.0	4.7	n.a.
No. observations	21	18	17	0

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Chile: 1981, 1985–2008				
Mean	4.9	–0.8	n.a.	n.a.
Minimum	–10.3	–7.3	n.a.	n.a.
Maximum	12.3	4.6	n.a.	n.a.
No. observations	28	25	0	0
Cyprus: 2005–2009				
Mean	3.3	0.7	1.6	2.3
Minimum	–1.7	–0.5	0.1	0.4
Maximum	5.9	3.8	5.7	5.8
No. observations	13	5	4	3
Czech Republic: 2005–2009				
Mean	2.6	0.8	1.7	2.6
Minimum	–4.0	–2.8	–2.5	–2.7
Maximum	6.5	7.7	9.0	8.8
No. observations	13	5	4	3
Denmark: 1999–2009				
Mean	1.4	0.5	0.6	1.0
Minimum	–4.3	–1.9	–2.6	–2.0
Maximum	3.9	4.1	5.4	5.0
No. observations	13	11	10	9

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Estonia: 2005–2009				
Mean	5.2	2.4	6.5	10.3
Minimum	–14.5	–4.6	–5.2	–1.1
Maximum	11.2	11.0	20.6	22.1
No. observations	13	5	4	3
Finland: 1999–2009				
Mean	2.7	0.7	0.7	0.9
Minimum	–7.6	–1.7	–2.5	–2.5
Maximum	6.1	8.2	10.6	10.2
No. observations	13	11	10	9
France: 1998–2009				
Mean	1.7	0.6	1.0	1.3
Minimum	–2.3	–0.9	–1.4	0.0
Maximum	3.9	2.7	4.8	4.6
No. observations	14	12	10	9
Germany: 1992–2009				
Mean	1.4	0.9	1.2	1.7
Minimum	–5.0	–1.5	–1.5	–0.7
Maximum	3.9	5.2	6.5	6.8
No. observations	20	18	18	9

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Greece: 2000–2009				
Mean	3.5	0.2	0.7	0.9
Minimum	–1.2	–1.2	–1.0	–0.6
Maximum	5.0	2.3	5.2	5.3
No. observations	13	10	9	8
Hungary: 2005–2009				
Mean	3.0	1.8	4.0	5.8
Minimum	–6.7	–0.1	0.3	3.0
Maximum	5.2	5.8	10.7	10.9
No. observations	13	5	4	3
Ireland: 1999–2009				
Mean	5.4	0.0	1.2	1.7
Minimum	–7.5	–3.7	–2.9	–1.0
Maximum	11.4	6.7	11.0	11.5
No. observations	13	11	10	9
Italy: 1991–2009				
Mean	1.7	0.7	1.3	2.3
Minimum	–4.8	–1.4	–0.9	0.7
Maximum	4.8	2.8	6.4	6.4
No. observations	25	18	17	9

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Latvia: 2005–2009				
Mean	4.9	3.2	6.9	11.2
Minimum	–18.0	–5.4	–6.4	–3.6
Maximum	12.9	13.0	25.0	25.5
No. observations	13	5	4	3
Lithuania: 2005–2009				
Mean	4.8	1.5	4.3	7.0
Minimum	–15.0	–2.3	–3.3	–2.6
Maximum	10.4	10.2	19.5	19.5
No. observations	13	5	4	3
Luxemburg: 1999–2009				
Mean	4.3	–0.1	0.9	1.6
Minimum	–3.9	–5.2	–4.7	–2.3
Maximum	8.6	6.9	8.9	7.9
No. observations	13	11	10	9
Malta: 2005–2009				
Mean	2.5	–0.3	–0.1	0.8
Minimum	–2.5	–3.8	–3.5	–2.5
Maximum	8.1	4.2	5.2	5.1
No. observations	13	5	4	3

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Mexico: 2003–2009				
Mean	1.5	1.7	n.a.	n.a.
Minimum	–6.5	–1.2	n.a.	n.a.
Maximum	4.8	9.5	n.a.	n.a.
No. observations	8	7	0	0
Netherlands: 1995–2009				
Mean	2.1	0.2	0.8	1.1
Minimum	–4.0	–2.5	–1.8	–1.0
Maximum	4.7	5.3	5.8	5.8
No. observations	17	15	10	9
New Zealand: 1998–2008				
Mean	2.8	–0.3	0.3	0.4
Minimum	0.0	–1.7	–1.1	0.4
Maximum	4.6	2.7	4.2	0.4
No. observations	13	11	10	1
Poland: 2005–2009				
Mean	4.3	0.1	0.0	1.0
Minimum	1.2	–1.9	–1.9	–0.9
Maximum	7.1	2.0	3.3	3.9
No. observations	13	5	4	3

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Portugal: 1999–2009				
Mean	1.7	0.7	1.9	2.5
Minimum	–2.7	–0.6	–0.7	0.9
Maximum	4.8	2.2	5.5	5.7
No. observations	13	11	10	9
Slovakia: 2005–2009				
Mean	4.2	0.0	0.7	1.7
Minimum	–5.7	–3.3	–4.3	–5.0
Maximum	10.4	8.1	11.5	10.8
No. observations	13	5	4	3
Slovenia: 2005–2009				
Mean	3.4	0.1	2.1	3.2
Minimum	–7.3	–1.8	–2.1	–2.1
Maximum	6.1	3.3	11.4	11.4
No. observations	13	5	4	3
South Africa: 1998–2008				
Mean	3.2	0.2	0.1	0.1
Minimum	0.4	–1.5	–1.7	–1.6
Maximum	5.6	2.6	2.7	2.8
No. observations	13	11	10	8

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
Spain: 1999–2009				
Mean	3.0	0.0	0.5	0.8
Minimum	–3.6	–1.4	–1.8	–0.9
Maximum	5.1	2.2	6.6	6.9
No. observations	13	11	10	9
Sweden: 1998–2009				
Mean	2.2	0.4	0.4	0.7
Minimum	–5.2	–2.4	–2.2	–1.8
Maximum	4.6	6.5	7.7	7.9
No. observations	14	12	11	9
Switzerland: 1990–2003				
Mean	1.1	0.9	1.1	n.a.
Minimum	–0.7	–1.6	–1.4	n.a.
Maximum	3.4	2.7	2.7	n.a.
No. observations	16	14	13	0
United Kingdom: 1998–2009				
Mean	2.1	0.0	0.7	0.9
Minimum	–4.8	–2.0	–1.5	–1.0
Maximum	3.8	3.8	7.6	7.3
No. observations	13	12	11	9

Table A2. (continued)

Country, sample period, and statistic	*Actual GDP growth rate*	*One-year-ahead forecast error*	*Two-year-ahead forecast error*	*Three-year-ahead forecast error*
United States: 1985–2009				
Mean	2.7	0.5	0.6	3.8
Minimum	–2.5	–3.1	–3.1	1.9
Maximum	7.0	5.5	5.6	5.6
No. observations	27	25	24	2
Total				
Mean	2.9	0.4	1.1	1.8
Minimum	–18.0	–7.3	–6.4	–5.0
Maximum	12.9	13.0	25.0	25.5
No. observations	500	369	282	175

Source: See Frankel (2011a, data appendix).
a. Years are those for which there are data for the one-year-ahead GDP growth forecast error.

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Chile's Fiscal Rule as Social Insurance

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Well before the Great Recession of 2009 put fiscal policy debates in the front burner, commodity-exporting countries had to deal with important fiscal policy dilemmas stemming from revenue volatility and eventual depletion. Chilean policymakers have been at the forefront in this area since adopting a fiscal rule to guide government spending decisions a decade ago. This so-called structural balance rule (SBR) incorporates fluctuations in copper prices—the main source of volatility in fiscal revenues—and was instrumental in saving a large part of the windfall during the commodity boom of 2005–08. When the country went into recession in 2009, however, the rule was essentially abandoned as authorities implemented a fiscal expansion beyond that suggested by the SBR.

While having a fiscal rule has served Chile well, there are pending questions about the appropriateness of its design. How much would welfare improve if the rule were modified to respond more to accumulated assets? Or to promote more countercyclical spending? Furthermore, since the rule is well understood and has gained legitimacy across society, it is desirable to consider improvements that do not entail major departures from its current structure. This raises the question of whether the gains from moving toward a spending policy with a higher propensity to spend out of assets when private income is low can be achieved with a rule

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similar to the SBR, for example, by adding an escape clause whereby spending is expanded beyond what is prescribed for normal times in predetermined extreme circumstances.

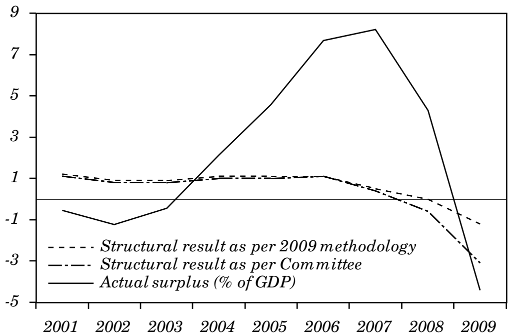
In this paper, we explore from a normative perspective the contours of an optimal spending rule for a government that has volatile revenues from an exogenous source such as a flow from a natural resource, very much like Chile. Specifically, we analyze policies for a government with a precautionary saving motive that decides how much to transfer from volatile copper revenues to impatient agents that differ in their private incomes, which in turn are volatile and correlated with fiscal revenues. Much as in reality, the government can save abroad, has limited space for borrowing against future revenue, and has access to an imperfect technology for targeting transfers (that is, a portion of transfers leaks to richer households). Households' behavior is simple: they consume all available income.

Output is exogenous in our model, that is, fiscal multipliers are zero, so any countercyclical action reflects the desire of increasing transfers at times when household consumption is low and government spending has a higher marginal utility, rather than a Keynesian mechanism. Fiscal policy is ultimately the implementation of social insurance.

We analyze the welfare gains of an optimal rule vis-à-vis a balanced-budget rule whereby the government transfers all its revenues to households in each period. We also study the behavior of government assets and the extent to which government spending is countercyclical. We compare the optimal rule prescribed by our model with simpler rules, including the Chilean SBR, a rule that spends the permanent income from copper (à la Friedman), and linear rules similar to the SBR except that propensities to consume out of assets and structural revenues are chosen optimally. We also analyze the gains from having an escape clause.

The last global cycle made it apparent once again that government revenues in Chile are heavily influenced by copper prices. After representing less than 1 percent of GDP (or about 5 percent of total government revenues) in 1998–2003, government mining revenues increased to more than 8 percent of GDP following the rise of copper prices in 2004–08. With the subsequent decrease in commodity prices, copper revenues declined to 3 percent of GDP. Nonmining revenues, which are higher on average, have also fluctuated, but their volatility has been considerably lower. Spending decisions, on the other hand, have been guided by a predetermined central government structural surplus target (1.0 percent of GDP until 2006, 0.5 percent of GDP in 2007, and 0.0 percent in 2008). To this end, spending has been based on what is considered to be permanent revenues, stripping out cyclical revenues that include both tax revenues (influenced by the GDP cycle) and the volatile mining revenues affected by the price of copper. In principle, the rule aims to establish an acyclical fiscal behavior and the full operation of automatic stabilizers on the tax revenue side. Real government spending growth would be relatively stable and change only with innovations in trend GDP growth, changes in tax policy, and updates of what is considered the normal or reference copper price. Consequently, the overall fiscal result has varied considerably in a few years, with large savings when copper prices were high and large spending when the country went into recession (see figure 1). Government net assets increased to more than 20 percent of GDP in 2008.

Figure 1. Structural Balance Rule (SBR) and Actual Fiscal Funds



Source: Chilean Budget Office.

Fiscal policy was decisively countercyclical in 2009, when the economy entered a recession following the Lehman collapse. Real government spending increased by 18 percent (year on year), providing a fiscal impulse of 3 percent of GDP—one of the highest one-year fiscal impulses in emerging market economies during the Great Recession. Part of the fiscal reaction was in the form of targeted transfers to poor families. Unemployment increased to more than 10 percent in 2009, only slightly less than in the previous recession of 1998–99, which also followed large external shocks. Output contracted by 1.5 percent in 2009, more than the 0.8 percent drop in the previous recession. Interestingly, however, the government approval rating followed very distinct patterns: it increased significantly in 2009, largely due to perceptions of economic policies, whereas it tanked in 1998–99. This suggests that households welcome targeted fiscal policies in times of hardship.

In our model, the gains from moving from a balanced-budget rule to an optimal rule are sizeable, which indicates that the profile of fiscal spending can be quite relevant. With the baseline parameters calibrated to the Chilean economy, welfare gains from an optimal rule are equivalent to a proportional increase of copper revenues by 100 percent under a balanced-budget rule. Optimal spending displays significant countercyclicality: a fall of one standard deviation in private income leads, on average, to a rise in government transfers of 50 percent of the government's median income. The optimal rule is more countercyclical when government expenditures are less targeted, as the relative value of government transfers during recession increases in this case. Put somewhat differently, the inefficiencies of poor targeting are less costly during recessions.

Simpler rules also provide significant welfare gains. The SBR rule attains 18 percent of the gains obtained under the optimal rule; a Friedman-type rule does somewhat better, achieving 20 percent of possible gains. Gains increase substantially with linear rules where, in contrast to the Chilean SBR and Friedman-type rules, the marginal propensities to spend out of assets and wealth are chosen optimally to reflect heterogeneous households, imperfect targeting, and borrowing constraints. The results suggest a considerably lower propensity to consume out of structural copper revenues and a higher one with respect to assets, relative to the SBR. These parameters narrow the distribution of assets. The best linear rule attains 74 percent of the gains obtained under the optimal rule. Furthermore, allowing for rules that switch between two linear regimes depending on the GDP cycle further increases welfare to 83 percent of the gain under the optimal rule. As expected, the propensity to spend out of assets and structural revenue is higher in the low GDP regime. In fact, the main difference between rules with one and two linear regimes is that the former are pretty much acyclical while the latter capture the degree of countercyclical expenditure present in the optimal rule. We interpret the quasi-optimality of a regime-switching rule as the gains from having escape clauses for extreme events, which simple rules are not able to handle adequately.

The paper is organized as follows. Section 1 provides a brief literature review. Section 2 describes the model. Section 3 implements the model with Chilean data. This section describes the optimal fiscal rule, evaluates welfare gains, and analyzes the rule's behavior under different environments and shocks. Section 4 investigates whether alternative simpler rules provide useful approximations to the optimal solution, with a special focus on Chile's structural rule and variations that could help improve it. Finally, section 5 presents some concluding remarks.

1. Relation to the Literature

This paper is related to two literatures. First, it draws from works on optimal consumption with self-insurance. The starting point is the income-fluctuation problem, where a risk averse consumer receives an exogenous, stochastic income stream and maximizes the expected discounted utility, subject to an exogenous credit constraint that assumes all debts are repaid.[1] The agent has a precautionary saving motive and is impatient, as in Zeldes (1989), Deaton (1990), and Carroll (1992, 1997).[2] The model in this paper may be viewed as an income-fluctuation problem in which a planner with volatile income saves and spends to maximize the sum of expected discounted utilities of heterogeneous, impatient households with their own volatile income sources.

This paper also relates to debate on the cost of business cycles triggered by Lucas (1987).[3] We consider a government with a highly volatile source of income and compare the welfare implications of spending incomes on receipt (balanced-budget rule) with those of using a fiscal rule. Our results show that a fiscal rule aimed at stabilizing the incomes of the poor during downturns leads to considerably larger welfare gains than those obtained by Lucas.

A second type of work connected to this paper is the study of fiscal policy rules. For the most part, the applied literature focuses

1. See Schechtman (1976) for the seminal paper and Chamberlain and Wilson (2000) for a good overview.

2. As noted by Schechtman (1976), in this setting an agent with infinite marginal utility at zero consumption optimally acts as if there were liquidity constraints even if there are none.

3. See Barlevy (2004), Lucas (2003), and Yellen and Akerlof (2006) for surveys of this literature with diverging conclusions on where it stands. Also see Krusell and others (2009) for a recent contribution.

on issues of fiscal sustainability and whether having fiscal rules is, from a positive perspective, useful to that end. IMF (2009) and Kopits (2004) are good examples of this type of analysis. The former documents that fiscal rules have become more common in recent years, with almost 80 countries having rules in place in early 2009 (versus fewer than ten in 1990), and that, on average, they have been associated with improved fiscal performance and more prudent fiscal policies. The latter work compiles several case studies to analyze conditions under which rules have succeeded and concludes that political support and transparency are critical, while the extent to which a rule is legally enshrined is largely irrelevant.

One particular strand of the fiscal policy rules literature studies the challenges arising from revenues tied to nonrenewable commodities with volatile prices (for example, oil and copper). Villafuerte, López-Murphy, and Ossowski (in this volume) analyze the recent experience with fiscal policy of commodity-rich Latin American countries; they conclude that, on average, policies have been somewhat procyclical, countries that pursued more conservative fiscal policies during the boom were able to implement more aggressive countercyclical fiscal policies during the downturn, and these dimensions of fiscal policy were not linked to fiscal rules or resource funds.

Closely related work on fiscal rules from a normative perspective focuses on commodity-related revenues. A standard approach has been to apply Friedman's permanent-income hypothesis and prescribe rules that spend the annuity value of the commodity-related wealth. Segura (2006) is one of several papers based on this approach, which is attractive because of its simplicity but has several shortcomings precisely for the same reason. Among the shortcomings is that it neglects both that households have other sources of income beyond transfers and that precautionary savings can be particularly important given commodity price volatility. Engel and Valdés (2000) analyze the intergenerational distribution of an exhaustible commodity (oil, in their case) when household income is increasing over time, as well as appropriate precautionary saving given volatile prices and imperfect insurance markets. Maliszewski (2009) applies the framework to oil-producing countries and concludes that ad hoc rules perform relatively poorly. Drexler, Engel, and Valdés (2002) apply the framework to Chile and copper, noting that actual fiscal policy has been closer to the prescriptions of a model with precautionary saving than to those of a model based solely on smoothing government expenditures. The focus in their paper is the distribution of natural resource wealth across generations, not across households over the cycle as in this paper.

Finally, a number of papers study the implications of different fiscal rules for macroeconomic volatility, including the effects of the Chilean fiscal rule, through new Keynesian dynamic stochastic general equilibrium (DSGE) models. In general, these papers assume some form of non-Ricardian behavior (so that fiscal policy has nontrivial effects) through the existence of liquidity-constrained consumers (in the form of rule-of-thumb or hand-to-mouth decisions, very much like in our model). Andrés and Domenech (2006) analyze whether there is a trade-off between the sustainability of public finances and their countercyclical power, concluding that this is not the case. Kumhof and Laxton (2009) compare a balanced-budget rule with rules that embed a more active countercyclicality, including one with a structural balance. They conclude that there are high potential welfare gains from using more active rules and that in the case of commodity-driven revenues, automatic stabilizers should be allowed to operate fully (keeping spending stable). In the specific case of the Chilean fiscal rule, both Kumhof and Laxton (2010) and Batini, Levine, and Pearlman (2009) conclude that a balanced-budget rule is inferior to a structural budget rule. The first paper also concludes that a rule with more activism than the structural balance rule lowers output volatility with a minor cost in inflation volatility but considerable movements in the fiscal instrument. None of these papers deals with imperfect targeting of fiscal policy or heterogeneous agents and the income distribution, as we do in this paper.

2. Model

We analyze the optimal program of a planner that can save and spend incomes from a natural resource to maximize the sum of discounted utilities of agents representing the economy's income quintiles. An important departure from previous work is that the planner cannot target households at will, but rather is constrained by an exogenous transfer technology.

2.1 Households

Time is discrete. Total private income follows an exogenous stochastic process, Y_t^p. Income quintiles are indexed, from the poorest to the richest, by $i = 1, 2, \ldots, 5$. Each quintile is represented by one household, all of which have a subjective discount rate of $\delta > 0$. The income share of quintile i, which remains constant over time, is denoted by s_i, with $0 \leq s_1 \leq s_2 \leq \ldots \leq s_5$ and $\sum_{i=1}^{5} s_i = 1$. Households consume all their income.[4]

2.2 Planner

The planner receives an exogenous, stochastic income stream, Y_t^g, derived from a natural resource (we could extend the model to incorporate tax revenues). The planner can save at an exogenous riskless real rate, r, with $r < \delta$, so that households (and therefore the planner representing them) are impatient.

The planner faces an exogenous debt limit, B, that allows paying back the debt with probability one, which he does.[5] That is, if the planner spends $G_t \geq 0$ in period t, beginning-of-period assets evolve according to

$$A_{t+1} = (1 + r)(A_t + Y_t^g - G_t),$$

and the borrowing constraint takes the form

$$A_{t+1} \geq -B.$$

The planner's expenditures are distributed across quintiles according to an exogenous, time-invariant, targeting function, α, so that quintile i receives $\alpha_i G$ when the planner spends G, with $\alpha_i \geq 0$ and $\sum_{i=1}^{5} \alpha_i = 1$.

2.3 Dynamic Formulations

The sequential formulation for the planner's problem at time 0 is as follows:

$$\max_{G_0, G_1, \ldots} \mathrm{E}_0 \sum_{t \geq 0} \left(1+\delta\right)^{-t} \sum_{i=1}^{5} u\left(s_i Y_t^p + \alpha_i G_t\right),$$

4. This admittedly strong assumption allows us to avoid modelling the strategic interaction between the planner and households and provides a role for fiscal rules. We relax this assumption in Engel, Neilson, and Valdés (2011).

5. That is, B is less than or equal to the planner's natural debt limit, defined as the minimum present value of income.

subject to (Y_0^p, Y_0^g) given

(Y_t^p, Y_t^g) exogenous process, $t = 1, 2, 3,\ldots$

$A_t = (1 + r)(A_{t-1} + Y_{t-1}^g - G_{t-1}), t = 1, 2, 3,\ldots$

$A_t + B \geq 0, t = 1, 2, 3,\ldots$

$G_t \geq 0, t = 0, 1, 2,\ldots.$

The problem's recursive formulation is

$$V\left(A_t, Y_t^g, Y_t^p\right) = \max_{0 \leq G_t \leq A_t + Y_t^g + (1+r)^{-1} B} \sum_{i=1}^{5} u\left(s_i Y_t^p + \alpha_i G_t\right)$$
$$+ \left(1+\delta\right)^{-1} \mathrm{E}_t V\left[\left(1+r\right)\left(A_t + Y_t^g - G_t\right), Y_{t+1}^g, Y_{t+1}^p\right].$$

In periods in which the solution is interior, a straightforward calculation starting from the sequential formulation yields the Euler equation:

$$\sum_i \alpha_i u'\left(s_i Y_t^p + \alpha_i G_t\right) = \frac{1+r}{1+\delta} \mathrm{E}_t \sum_i \alpha_i u'\left(s_i Y_{t+1}^p + \alpha_i G_{t+1}\right). \qquad (1)$$

The planner spends resources to equalize a weighted sum of current marginal utilities with the corresponding discounted expected weighted sum of the next period's marginal utilities. The weights are given by the targeting function, in which quintiles that benefit more from government expenditures receive a higher weight. The Euler equation also shows that an increase in expected future private incomes leads to higher current spending by the planner.

In contrast to equation (1), in periods in which the borrowing constraint is binding, we have

$$\sum_i \alpha_i u'\left(s_i Y_t^p + \alpha_i G_t\right) > \frac{1+r}{1+\delta} \mathrm{E}_t \sum_i \alpha_i u'\left(s_i Y_{t+1}^p + \alpha_i G_{t+1}\right). \qquad (1)$$

2.4 Perfect Targeting

One of the main departures from the literature in this paper is to allow for imperfect targeting. This motivates considering first the case with perfect targeting, which requires allowing the α_i to vary over time and will serve as a useful benchmark.

When the planner can target expenditures at will, there is a simple characterization of the distribution of government expenditures across households, conditional on the choice of G_t.[6] Expenditures are distributed across quintiles so as to equalize marginal utilities among the poorer quintiles until G_t is exhausted. Richer quintiles do not receive any transfers while the remaining households achieve a common consumption level, so that poorer quintiles receive higher transfers.

More precisely, using $\tilde{G}_k$ to denote total transfers needed to equalize total incomes of quintiles 1 through k with private income of quintile $k + 1$, a straightforward calculation shows that

$$\tilde{G}_k = \sum_{i=1}^{k} i\left(s_{i+1} - s_i\right)Y_t^p,$$

where $k = 1, 2,\ldots, 4$ and where we adopt the convention that $s_0 = 0$, $\tilde{G}_0 = 0$, and $\tilde{G}_5 = \infty$.

Since the sequence $\tilde{G}_k$ is increasing, given a level $G \geq 0$ of government expenditure there is a unique nonnegative integer k such that $\tilde{G}_k \leq G < \tilde{G}_{k+1}$. The optimal allocation of G_t across quintiles transfers resources only to quintiles 1 through $k + 1$, and it does so in a way that equalizes their total incomes. Using G_i to denote the transfer to quintile i, this means that

$$G_i = \left(s_{k+1} - s_i\right)Y_t^p + \frac{G_t - \tilde{G}_k}{k+1}.$$

It follows that finding G_t is equivalent to solving a standard incomes fluctuation problem, in which the planner's instantaneous marginal utility from government expenditures is equal to

6. Engel and Valdés (2000) derive a similar result in a model that distributes natural resource wealth across generations.

$$u'\left(s_{k+1}Y_t^p + \frac{G_t - \tilde{G}_k}{k+1}\right),$$

with k given by the piecewise constant, increasing function of G_t described above.

3. Implementation and Results

In this section, we implement the model described in section 2 using data from Chile. The trusting (or impatient) reader can skip section 3.1, which describes our parameter and functional choices, and move directly to section 3.2 on the optimal policy.

3.1 Parameter Choices

To determine the joint process of private and government revenues, we considered annual data for the 1990–2009 period. We proxied Y^p by the difference between GDP and government expenditures per capita (based on data from the Central Bank of Chile), and detrended log Y^p using a quadratic trend. The resulting stationary variable is denoted by y^p in what follows. We work with detrended Y^p to highlight the relation between cyclical fluctuations and optimal fiscal policy.

We proxied Y^g by per capita fiscal revenues derived from copper, both directly from state-owned CODELCO and indirectly via taxes on privately held copper companies, using data from the Chilean Budget Office. We denote log Y^g as y^g.

We fitted a first-order vector autoregression (VAR) to (y^p, y^g). Under the identifying assumption that current innovations to y^p have no effect on current y^g, we found no statistically significant effect of past innovations of y^p on y^g (see figure 2 for the resulting impulse response functions). For our benchmark income process, we therefore chose a specification of the form

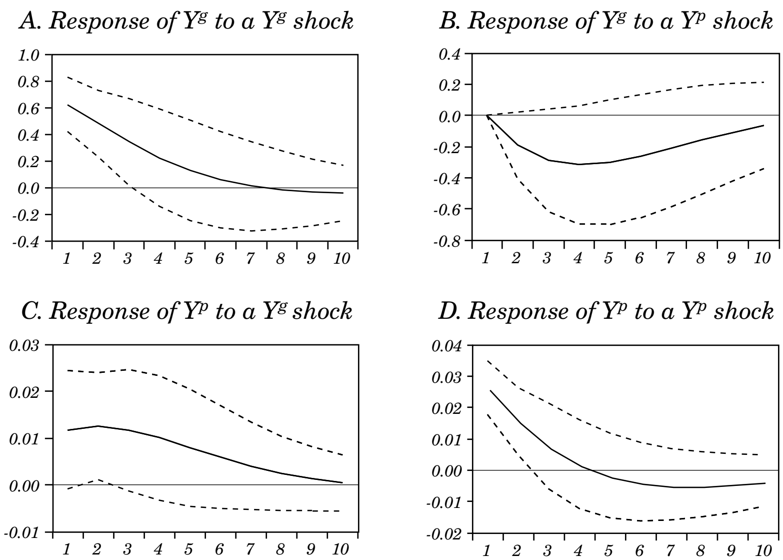
$$y_t^p = F_0^p + F_{pp} y_{t-1}^p + F_{pg} y_{t-1}^g + \varepsilon_t^p$$

and

$$y_t^g = F_0^g + F_{gg} y_{t-1}^g + \varepsilon_t^g,$$

where only contemporaneous innovations are allowed to be correlated. Section 3.3 considers two alternative specifications, one in which past values of y^g have no effect on current y^p ($F_{pg} = 0$) and the other in which past values of y^p influence y^g.[7]

Figure 2. Impulse Responses of Government Copper Revenues and Private Income[a]



Source: Authors' computations.

a. Cholesky decomposition with Y^g the most exogenous. Dashed lines are +/– two standard deviations.

Since we are interested in fiscal rules that are relevant in coming years, we set the average value of Y_g at 2.1 percent of the average value of Y_p (which is somewhat lower than the 3 percent observed in the data) to account for the fact that Y^p was much higher toward the end of the period than at the beginning.

7. The latter could reflect, for example, a negative shock to private income that leads to a depreciation of the peso, thereby increasing revenues from copper measured in pesos. Alternatively, a negative GDP shock might cause the government to ask CODELCO to lower its investment and increase transfers to the government. As mentioned above, our VAR analysis found no statistically significant effect of past GDP shocks on current copper revenues, but the estimated coefficients are economically significant, which, given the relatively short series at hand, suggests this case may be relevant as well.

The planner's problem is solved using a Tauchen discretization for the joint distribution of (y^p, y^g). This discretization has 25 states: y^p takes five values, and there are five possible values of y^g associated with every value of y^p. Table 1 shows the probabilities of the five values of y^p and the magnitudes of the corresponding deviations from trend.

Table 1. Private Income States in the Discretization of the State Space
(in percent)

State	*Probability*	*Deviation from trend*
1	2.12	–11.9
2	22.83	–6.2
3	50.10	0.0
4	22.83	6.2
5	2.12	11.9

Source: Authors' computations.

We set the annual risk-free interest rate, r, at 5 percent and the subjective discount factor, δ, at 8 percent. A useful way to capture the notion that poor households value having smoother consumption across periods and states of nature relatively more than wealthier households is to consider an instantaneous utility function, u, that is a Stone-Geary extension of a constant-elasticity-of-intertemporal-substitution felicity function:[8]

$$u(c) = \begin{cases} \dfrac{1}{1-\theta}\left(c - c^*\right)^{1-\theta}, & \theta \neq 1, \\ \log\left(c - c^*\right), & \theta = 1, \end{cases} \tag{2}$$

where c^* denotes the subsistence level. We consider a coefficient of relative risk aversion, θ, of 3 in the benchmark model and set c^* at 98

8. See, for example, Deaton and Muellbauer (1980, chap. 3). An alternative route is to allow for a marginal utility of consumption that is decreasing in wealth, as in Blundell, Browning, and Meghir (1991), Attanasio and Browning (1995), Atkeson and Ogaki (1996), and Guvenen (2006). We are exploring this route in ongoing work.

percent of the income of the poorest quintile in the worst aggregate income scenario, which corresponds to an annual per capita income of approximately US$800 (the poverty line varied around US$1,200 in the period considered).

To solve the model we impose an upper bound on accumulated assets equal to average private income; this restriction is rarely binding, and our results do not change when we loosen it. We also impose a lower bound of zero on assets ($B = 0$).

Table 2 shows the values for the income share and expenditure share parameters, s_i and α_i, for each quintile. They correspond to values reported by MIDEPLAN in 2009, which are calculated using the CASEN 2009 household survey. Social expenditure targeting in Chile is considerably better than in most developing countries: Rey de Marulanda, Ugaz, and Guzmán (2006, figure 1) suggest that the typical targeting function in Latin America is close to uniform targeting, that is, to having $\alpha_i = 1/5$ for all quintiles.

Table 2. Income and Expenditure Shares: Chile, 1990–2009
(in percent)

Quintile	*Income share* ($100 \times s_i$)	*Expenditure share* ($100 \times \alpha_i$)
1	3.6	44.2
2	8.3	24.6
3	12.7	16.6
4	19.6	10.3
5	55.8	4.3

Source: MIDEPLAN and CASEN (2009).

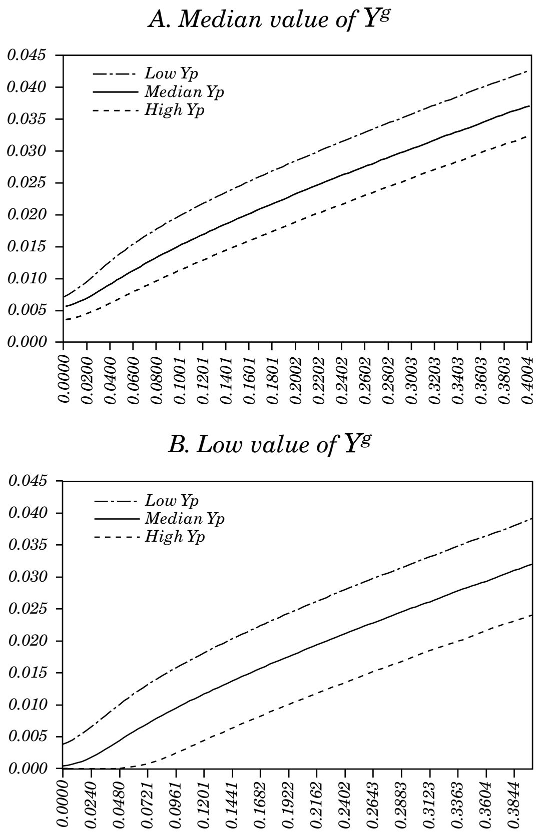
3.2 Optimal Policy

Panel A in figure 3 shows optimal government expenditure as a function of government assets, for three values of private income. Government income is held (approximately) constant at its median value.[9] The figure plots curves for high private income (highest value

9. As described above, the discretization we consider leads to small differences in y^g across the three states considered.

in the discretization), intermediate private income (median value), and low private income (lowest value in the discretization). Both G and A are normalized by average private income (referred to as average GDP in what follows). Panel B is similar except that Y^g is held (approximately) constant at its lowest value.

Figure 3. Optimal Fiscal Spending



Source: Authors' computations.

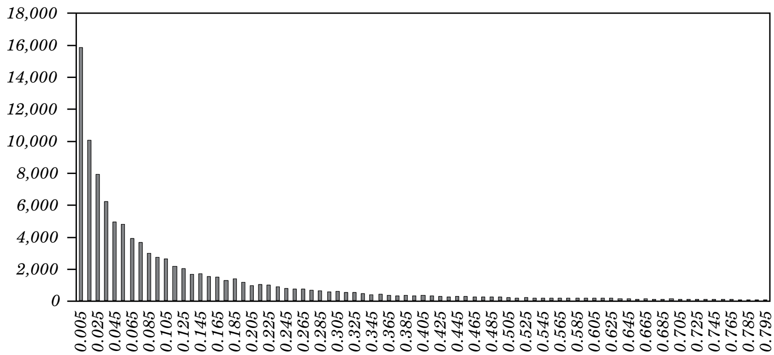
Other things equal, expenditures are higher when private sector output is lower, that is, when the marginal utility of private consumption is higher. The government saves during good times to be able to spend in bad times. The expenditure functions are concave (in the regions with positive expenditure), implying a marginal propensity to spend out of assets that decreases with assets. Concavity of the expenditure function for low asset values is more pronounced during recessions (low values of Y^p), which reflects the interplay between the precautionary motive and impatience.

Comparing the two panels in figure 3 shows that government expenditures are lower when current fiscal income is lower. In fact, when fiscal revenues are low and private income is sufficiently high, there is a range of asset values in which the government finds it optimal not to spend at all.

3.2.1 Asset accumulation

Mean and median assets in steady state are equal to 38.9 and 32.9 percent of average GDP, even though assets accumulate slowly. Starting from zero, mean and median assets during the first 25 years of the rule are 13.2 and 6.1 percent of GDP, respectively. Figure 4 depicts the corresponding histogram, based on 4,000 simulations in 25 periods each (that is, 100,000 observations).

Figure 4. Distribution of Assets under Optimal Rule: First 25 Years



Source: Authors' computations.

3.2.2. Welfare gains

To gauge the welfare gains under the optimal rule, we quantify the associated welfare improvement with that obtained under a balanced-budget rule where the government does not incur debt or save from current income. To do this, we solve for γ in:

$$E_0\left\{\left[\sum_{t\geq 0}(1+\delta)^{-t}\sum_i u\left[s_i Y_t^p+\alpha_i(1+\gamma)Y_t^g+\alpha_i\frac{r}{1+r}A_0\right]\right]\right\}$$
$$=E_0\left[\sum_{t\geq 0}(1+\delta)^{-t}\sum_i u\left(s_i Y_t^p+\alpha_i G_t\right)\right].$$

Thus γ measures the fraction by which fiscal revenue must increase when the government spends all its income on receipt, to achieve the same level of expected welfare as under the optimal rule.[10] We obtain a value for γ of 1.001 starting from $A_0 = 0$. The welfare gain under the optimal fiscal rule is considerable.

An alternative welfare measure compares gains under the optimal rule with a scenario with no natural resource income. Using Q to denote the ratio of average government and private incomes, we solve for γ^* in:

$$E_0\left\{\left[\sum_{t\geq 0}(1+\delta)^{-t}\sum_i u\left[s_i\left(1+\gamma^* Q\right)Y_t^p+s_i\frac{r}{1+r}A_0\right]\right]\right\}$$
$$=E_0\left[\sum_{t\geq 0}(1+\delta)^{-t}\sum_i u\left(s_i Y_t^p+\alpha_i G_t\right)\right]. \tag{3}$$

The normalization constant Q is such that $\gamma^* = 1$ when $s_i = \alpha_i$ for all i and the natural resource income is equal to a constant fraction of private income, in all periods and for all quintiles ($Y_t^g = \lambda Y_t^p$). Starting with no assets, the value of γ^* is equal to 3.122 for the optimal program. Thus, even though copper revenue equals only 2.1 percent of GDP, on average, the welfare improvement it fosters

10. When $A_0 > 0$, we assume that in the balanced-budget counterfactual the government spends the annuity value from A_0.

under the optimal fiscal rule is akin to increasing private income by 6.6 percent. This happens because targeting is considerably better than having transfers proportional to quintile income and because the natural resource revenue is far from perfectly correlated with private income (correlation of 0.45). It is also possible to calculate γ^* for the balance-budget rule, by solving equation (3) with

$$G_t = Y_t^g + \frac{r}{1+r} A_0.$$

The solution is denoted by γ^*_{BB} and equal to 1.65 in our baseline, implying that welfare under a balanced-budget rule is the same as under a 3.5 percent increase in private incomes and no natural resource revenue ($3.5 \cong 1.65 \times 2.1$ percent).

3.2.3 Cyclical behavior

The macroeconomic implications of the optimal fiscal rule for the cyclical behavior of government expenditure can be captured in various ways. Obvious options are the correlation between the economic cycle (as measured by detrended Y_t^p) and either government expenditures or government savings. We would expect the latter to be procyclical and the former to be countercyclical.

Denoting government saving by S_t, we have $S_t = Y_t^g - G_t$, and a straightforward calculation shows that

$$\sigma(S_t)\rho(S_t, Y_t^p) + \sigma(G_t)\rho(G_t, Y_t^p) = \sigma(Y_t^g)\, \rho(Y_t^g, Y_t^p), \tag{4}$$

where $\rho(x_t, y_t)$ denotes the time-series correlation between x_t and y_t, while $\sigma(x_t)$ denotes the standard deviation of x_t. Equation (4) shows that procyclical government saving is equivalent to countercyclical government spending only when private and government income are uncorrelated. When the two sources of income are positively correlated—as is the case in most countries with significant revenues from natural resources, including Chile—the possibility of procyclical saving and expenditure arises. This is the case for the optimal policy in our benchmark model: the correlation between government saving and the economic cycle is 0.30, while the correlation between government spending and the cycle is 0.26. By comparison, these correlations are zero and 0.45, respectively, for a balanced-budget rule.

An alternative way to quantify the extent to which optimal spending varies with the business cycle, Y^P, is to use ordinary least squares (OLS) to estimate a linear approximation to the optimal rule of the form

$$G_t = c_0 - c_p Y_t^p + c_g Y_t^g + c_a A_t + \text{error}$$

and measure the degree of countercyclicality by

$$CCG \equiv c_p \times \frac{\sigma\left(Y^p\right)}{\text{med}\left(Y^g\right)}, \tag{5}$$

where med(x_t) denotes the median of x_t. *CCG* captures the response of government expenditures, as a fraction of median government income, associated with a decrease of one standard deviations in private income. For the benchmark model we obtain $CCG = 0.49$, which implies that government expenditure, as a fraction of median government income, increases by 49 percent, on average, when private income drops by a standard deviation.

3.3 Alternative Parametrizations

Column 1 in table 3 shows the main statistics for the benchmark model: welfare gains, compared with both a balanced-budget rule and a scenario with no natural resource income (γ and γ^*); measures of asset accumulation under the optimal rule (median accumulation during the first 25 years and in steady state); two indices for countercyclical behavior (namely, the correlation between savings and the cycle and the *CCG* measure defined in equation 5); and welfare gains under a balanced-budget rule, γ^*_{BB}. The first three and the last statistic assume initial assets equal to zero; the fourth, fifth, and six rows report steady-state values.

Columns 2 through 8 show summary statistics for the optimal rule if we modify parameters from the benchmark model that characterize household preferences, one at a time. The cost of moving to the optimal rule when the initial level of assets is low is front loaded, since the planner must accumulate assets to spend in times when the marginal utility of consumption is high. By contrast and for the same reason, the benefits of adopting a fiscal rule are back loaded. This explains why an increase in households' subjective discount factor lowers welfare gains and asset accumulation (column 2), while a decrease has the opposite effect (column 3).

Table 3. Alternative Preferences

	Benchmark	$\delta = 0.1$	$\delta = 0.06$	$\theta = 5$	$\theta = 1$	$c^* = 0$	$c^* = 50\%$	$c^* = 90\%$
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
γ	1.001	0.806	1.307	1.526	0.131	0.176	0.275	0.557
γ^*	3.244	2.920	3.747	1.199	4.222	6.705	6.793	5.093
Med(A_{25})	0.061	0.054	0.070	0.024	0.015	0.006	0.016	0.044
Med(A_{ss})	0.329	0.225	0.512	0.055	0.047	0.039	0.105	0.264
$\rho(S,Y^P)$	0.299	0.288	0.299	0.196	0.232	0.236	0.266	0.295
CCG	0.491	0.412	0.557	0.809	0.117	0.097	0.262	0.451
γ^*_{BB}	1.647	1.635	1.662	0.594	3.836	5.919	5.672	3.642

Source: Authors' computations.

The elasticity of intertemporal substitution for the instantaneous utility defined in equation (2) is

$$\text{EIS} \equiv -\frac{u'(c)}{cu''(c)} = \frac{c - c^*}{\theta c},$$

which is decreasing in θ and c^*. This explains why columns 4 through 8 show that the benefits of a fiscal rule are larger when households have a stronger preference for a smoother consumption over time (smaller EIS). Also, fiscal policy is more countercyclical when households, particularly those in the poorest quintile, are less able to smooth consumption over time. The countercyclical measures of fiscal policy are significant in all cases, although they are sometimes smaller than for the benchmark model.

Table 4 considers changes in the income processes. Columns 2 and 3 fit separate AR(1) processes to y^p and y^g and assume independent innovations (column 2) and correlated innovations (column 3, where the correlation is 0.40). The value of owning copper, compared with a scenario with no natural resource revenues, is larger when innovations are independent than when they are positively correlated, both under the optimal policy and under a balanced-budget policy (γ^*_{BB} of 3.81 versus 2.45; γ^* of 5.24 versus 4.12). The reason for this is that a revenue stream that is uncorrelated with private income provides more insurance than a positively correlated income source.

Column 4 of table 4 considers a first-order VAR in which past private income shocks are allowed to affect current commodity revenues (see footnote 7). Specifically, revenues from the natural resource can be expected to rise in the period following a negative innovation to private income, which allows the planner to spend more aggressively today, since there is less need to save resources for future periods. This explains why the value of the optimal policy, as measured by both γ and γ^*, is higher than in the benchmark case and the cases with standard AR specifications.

Columns 5 through 8 show that the benefits of a fiscal rule increase with the volatility of both fiscal and private income, compared with a balanced-budget rule, leading to higher values of γ. In the case of a change in the volatility of fiscal revenues, this improvement largely reflects the fact that the value of a balanced-budget rule deteriorates significantly when volatility increases (see the γ^* reported in the last

Table 4. Alternative Income Processes

		Independent	*Correlated*	*Unrestricted*	$\sigma(y^p)$		$\sigma(y^g)$		$\mu(Y^g)$	
	Benchmark	*AR*	*AR*	*VAR*	*↓25%*	*↑25%*	*↓25%*	*↑25%*	*↓50%*	*↑50%*
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
γ	1.001	0.546	0.897	1.170	0.882	1.093	0.458	1.837	1.153	0.906
γ^*	3.244	5.245	4.211	4.409	3.152	3.379	5.416	1.792	3.542	3.039
Med(A_{25})	0.061	0.040	0.051	0.053	0.060	0.061	0.054	0.060	0.038	0.086
Med(A_{ss})	0.329	0.263	0.293	0.270	0.336	0.326	0.253	0.369	0.174	0.446
$\rho(S,Y^P)$	0.299	0.070	0.271	0.296	0.283	0.314	0.338	0.260	0.332	0.283
CCG	0.491	0.304	0.390	0.613	0.437	0.521	0.216	1.133	0.481	0.476
γ^*_{BB}	1.647	3.813	2.451	2.245	1.728	1.617	3.735	0.695	1.671	1.635

Source: Authors' computations.

row of the table): an increase in the volatility of copper revenues, which is positively correlated with private income, decreases the extent to which this income stream provides insurance.

Columns 9 and 10 consider changes in the importance of copper revenues, with a 50 percent decrease and increase, respectively. The value of the optimal program, compared with the balanced-budget rule, is larger when copper revenue is less important. The marginal benefit of additional natural resource income is smaller when overall resources are larger, as these resources are likely to be spent at times when marginal utility of additional government expenditures is lower.

Table 5 summarizes the effects of changes in the targeting technology. Welfare gains increase when Chile's targeting parameters are replaced by less focalized uniform targeting ($\alpha_i = 1/5$ for all i), while countercyclicality increases considerably. The relative social value of targeting during recessions is much higher when targeting is poor. Welfare gains also increases considerably under perfect targeting (γ^*in the second row provides the correct measure in this case).

Table 5. Alternative Targeting Technologies

Variable	*Benchmark* *(1)*	*Uniform targeting* *(2)*	*Perfect targeting* *(3)*
γ	1.001	1.297	2.941
γ^*	3.244	1.713	6.155
Med(A_{25})	0.061	0.077	0.06
Med(A_{ss})	0.329	0.209	0.329
$\rho(S, Y^P)$	0.299	0.367	0.293
CCG	0.491	0.865	0.455
γ^*_{BB}	1.647	0.759	3.634

Source: Authors' computations.

Finally, table 6 provides an alternative comparison of the three targeting technologies. It reports average expenditures for the five private income scenarios (see table 1). The first column considers a balanced-budget policy, where no effort is made to use copper income to smooth household consumption or provide precautionary saving.

The remaining columns consider the same targeting technologies as in table 5. The last row of this table shows that, as expected, total expenditures are higher when the government accumulates assets. Given the extremely high volatility of copper revenues and its positive correlation with private incomes, this results in highly procyclical government transfers, explaining the dramatic difference between columns 2–4 and column 1. Government expenditures when private income is low increase considerably (by a factor between 6 and 20, depending on the policy and low income state considered) when the government moves beyond a balanced-budget policy.

Expenditures are more countercyclical when targeting is less. For example, government transfers are at least 10 percent higher under Chile's relatively good targeting than under uniform targeting. Nonetheless, expenditures are highest, on average, when private income is highest. The reason is that copper revenues are procyclical and highly persistent, so that the wealth effect associated with high copper revenues dominates the precautionary motive.

Table 6. Average G Conditional on y^p for Alternative Targeting Technologies
(in percent)

	Targeting			
Private income level	*BB* *(1)*	*Uniform* *(2)*	*Chile* *(3)*	*Perfect* *(4)*
Low	0.19	3.64	3.05	2.98
Below average	0.55	3.55	3.19	3.16
Average.	1.54	3.65	3.59	3.58
Above average	4.19	4.49	4.74	4.77
High	11.30	8.97	9.36	9.38
Overall average G (%)	2.10	3.93	3.87	3.87

Source: Authors' computations.

4. Simple Rules

In practice, fiscal rules should be simple for a number of reasons. First, it is easier to communicate the constraints imposed on public spending to elected officials and the public in general when the rule is relatively simple. This helps legitimize the rule and makes it less likely that the rule will be abandoned. Second, fiscal rules are often written into laws, and this is not easy with rules that require tabulating values to characterize how much is spent and how much is saved in a given year, as in the example plotted in figure 3. That is, to be useful, rules need to be easily replicable in terms of their calculation. Third, as in the Chilean case, the starting point is often a simple rule that has earned legitimacy among policymakers and the public, so moving to a much more complex rule may come at the cost of losing this social capital.

4.1 Rules Considered

Our starting point is a version of the Chilean structural balance rule (SBR), and the question we address is how much closer we can get to the optimal rule discussed in section 3.2 with a simple variant of the SBR.

Our version of Chile's structural balance rule is written as follows:

$$G_t = \mathcal{S}_t^G + \frac{r}{1+r} A_t, \qquad (6)$$

where S_t^G is the structural government income, defined as[11]

$$\mathcal{S}_t^G = \frac{1}{10}\sum_{k=0}^{9} \mathrm{E}_t Y_{t+k}^G,$$

where E_t denotes expectations based on information available in period t, which in our case is current and past values of both income processes. The SBR prescribes spending the sum of the current structural income,

11. We focus on copper-related revenue and continue ignoring tax revenue. In practice, every year the Finance Minister appoints a committee of experts that provides an estimate for S_t^G. See Frankel (in this volume) for a discussion of the institutional design of the rule.

equal to the best estimate for average income over the next decade, and the (long-term) interest obtained on assets saved.

The SBR is similar to the optimal spending/saving rule implied by Friedman's permanent income theory of consumption, with structural income in place of wealth. For this reason, we also consider the following Friedman-type rule:

$$G_t = \frac{r}{1+r}\left(\mathcal{W}_t^G + A_t\right), \tag{7}$$

where

$$\mathcal{W}_t^G = \sum_{k\geq 0}\left(1+r\right)^{-k} \mathrm{E}_t Y_{t+k}^G$$

denotes government wealth.

We consider the following simple variant of the SBR, which keeps the basic linear structure but frees up the values for the marginal propensities:

$$G_t = c_0 + \theta_s \mathcal{S}_t^G + \theta_a A_t. \tag{8}$$

Equation (8) defines a rule that is linear in structural income and assets, but optimizes over the corresponding coefficients.

As mentioned in the introduction, real government spending increased by 18 percent (year on year) in 2009, going beyond the increase suggested by the SBR and providing a fiscal impulse of 3 percent of GDP. Some analysts argued at the time that this increase could be justified by the fact that the SBR did not allow for a marginal propensity to spend out of assets that increased during recessions.[12] This motivates considering linear spending rules with coefficients that vary with the level of private income, such as

$$G_t = c_0 + \begin{cases} \theta_{sl}\mathcal{S}_t^G + \theta_{al}A_t, & \text{if } Y^p \text{ is low;} \\ \theta_{sh}\mathcal{S}_t^G + \theta_{ah}A_t, & \text{if } Y^p \text{ is normal or high.} \end{cases} \tag{9}$$

12. See, for example, "Eduardo Engel y los vientos económicos," *La Segunda,* 24 July 2009, p. 40.

The marginal propensities are allowed to vary with the economic cycle, as captured by private income, Y^P. We consider the case in which these coefficients can take two (optimally chosen) values, depending on whether private income is low (namely, the lowest two values in table 1) or normal/high (the highest three values in table 1).

Rule (9) is a regime-switching rule with two simple linear regimes, which can be thought of as a rule with an escape clause. A simple linear rule operates most of the time (75 percent in our case), but it is abandoned in extreme circumstances, when private income (in deviation from trend) is below a certain threshold.

As with all the simple rules we study in this section, we impose the same borrowing constraints considered when deriving the optimal rule in section 2, that is, $A_t \geq 0$ and $G_t \geq 0$.[13] To estimate the parameters in models (8) and (9) we first generate 1,000 time-series for private and government income, each with 100 observations: $Y^p_{k,t}$ and $Y^g_{k,t}$, $k = 1,\ldots 1{,}000$; $t = 1,\ldots 100$. Next we use the Nelder-Mead simplex method to find the parameter configuration, θ, within the family of rules being considered, Θ, that maximizes $\gamma(\theta)$, defined via

$$\sum_{k=1}^{1{,}000}\sum_{t=0}^{99}(1+\delta)^{-t}\sum_{i=1}^{5}u\left\{s_i Y^p_{k,t} + \alpha_i\left[1+\gamma(\theta)\right]Y^g_{k,t} + \alpha_i \frac{r}{1+r}A_0\right\}$$

$$= \sum_{k=1}^{10{,}000}\sum_{t=0}^{99}(1+\delta)^{-t}\sum_{i=1}^{5}u\left[s_i Y^p_{k,t} + \alpha_i G\left(A_{k,t}, S^g_t, Y^p_{k,t};\theta\right)\right],$$

where $A_{k,t}$ denotes the value of assets and $G(A_{k,t}, S^g_t, Y^p_{k,t};\theta)$ optimal expenditure, both for the kth time series, under rule $\theta \in \Theta$ at time t. This determines the optimal rule, $\hat{\theta}$. To avoid overfitting, the value of γ we report for $\hat{\theta} \in \Theta$ is obtained by rerunning the above procedure with 4,000 series of newly generated income series of length 100 each.

4.2 Results

Table 7 presents the summary statistics for the simple rules considered in this section. The SBR and the Friedman-type rule attain 18 and 20 percent of the welfare gain obtained under the

13. Thus, for example, the rule in equation (8) actually has $G_t = \max(0, c_0 + \theta_s S_t^G + \theta_a A_t)$.

optimal rule, respectively. These rules tend to underaccumulate assets when compared with the optimal rule, and, not surprisingly, both of them vary very little, if at all, with the economic cycle.[14]

Table 7. Simple Rules

Rule	*Welfare gain* γ ($A_0 = 0$)	*Steady-state* *Median assets*	*CCG*
Benchmark	1.001	0.329	0.491
Chile's SBR	0.180	0.095	–0.159
Friedman	0.205	0.161	–0.001
Linear rule (8)	0.743	0.160	0.092
Rule with exit clause (9)	0.830	0.154	0.454

Source: Authors' computations.

An SBR-type rule, in which the marginal propensities to spend out of current government income and assets are chosen optimally, leads to higher welfare, with approximately 74 percent of the gain under the optimal rule. Table 8 reports the estimated marginal propensities to consume out of assets in this case, showing that the improvement in performance is achieved by more than doubling the propensity to spend out of assets and reducing by more than two-thirds the propensity to spend out of structural income. This suggests that the SBR is too responsive to changes in structural income and responds too little to changes in assets. This insight is robust across specifications: the median value for the marginal propensity to spend out of assets across the 19 models considered in tables 3, 4, and 5 is 0.117, with an interquartile range of 0.025. Similarly, the median value for the propensity to spend out of structural revenue is 0.335, with an interquartile range of 0.293 (the range of values goes from 0.116 to 0.747).

The regime-switching rule achieves a significant welfare gain, attaining 83 percent of the gains obtained under the optimal rule (with a γ of 0.830 versus 1.001). Both rules accumulate considerably

14. In fact, the SBR is somewhat procyclical, reflecting the fact that structural revenue is procyclical and that the linear term in assets is not important enough to undo this effect.

fewer assets than the optimal rule. More important, the rule with an exit clause achieves a degree of countercyclicality similar to that of the optimal rule, while the optimal linear rule does not.

Table 8 also shows that the propensities to spend out of the government's assets under the rule with an exit clause are considerably larger during recessions than under the linear rule, where these propensities are chosen optimally but are not allowed to vary over the cycle. By contrast, the propensities to spend during expansions are similar under both rules where this propensity is chosen optimally. With regard to the propensity to spend out of structural income, rule (9) has a higher propensity during recessions than rule (8), but a lower propensity during normal times or expansions. A linear rule has a hard time capturing the countercyclical behavior of the optimal rule, while a rule with an exit clause can capture this feature with a marginal propensity that is higher when income is low.

Table 8. Simple Rules and Marginal Propensities to Spend

Rule	*A*	S^G	*Constant*
Chile's SBR:	0.048	1.000	—
Linear rule (8)	0.118	0.290	–0.0006
Rule with exit clause (9)			
Y^P low:	0.164	0.467	–0.0023
Y^P normal or high:	0.120	0.261	–0.0023

Source: Authors' computations.

The above insight can be applied to gauge how much government expenditures should have increased when the economy went into recession in 2009. The rule with an escape clause suggests an increase of almost one percentage point of GDP higher than the increase implied by the linear rule when accumulated assets are 20 percent of GDP, which was the level of the Chilean government's net assets going into 2009. Similarly, assuming structural government revenue was at its average value of 2.1 percent, moving to the linear rule with an escape clause leads to additional expenditures of approximately 0.4 percent of GDP. The combined effect is an increase of 1.4 percent of GDP beyond that suggested by the rule in normal times, a meaningful fiscal expansion.

Summing up, a simple linear rule with an exit clause (which leads to a different, equally simple, linear rule) does a remarkably good job at capturing the nonlinearities present in the optimal policy. Furthermore, this rule leads to lower asset accumulation and can be explained as a straightforward generalization of the SBR. Both these factors should enhance its political viability.

5. Conclusion

We have explored the qualitative and quantitative implications of different ways to conduct fiscal policy, that is, the decision of how much to spend out of government income, in a framework in which fiscal expenditure has nontrivial effects because households are hand-to-mouth consumers and both household and government incomes face unpredictable shocks. Government income is particularly volatile, as it depends on the price of a primary commodity.

The basic intuition guiding government expenditures is straightforward: the authorities seek to help the private sector smooth consumption by combining a precautionary motive with the smoothing of transitory income shocks (à la Friedman). However, the government does not only consider its own revenue and assets when deciding how much to spend, but also looks at how the private sector is doing, spending more when the private sector's income is low. Furthermore, because there is income heterogeneity across households, and the government has only a limited ability to transfer income to the poor, the government faces a nontrivial tradeoff when implementing its spending rule: imperfect targeting increases the level of expenditure needed to achieve a given level of consumption for the poorest households, which in turn makes the optimal policy more countercyclical than if targeting were perfect. It follows that better targeting leads to less countercyclical government spending, implying that countries that have less capacity to target transfers should run a more countercyclical rule.

The application of our model to Chile, using plausible parameters for income fluctuations and correlations, the household income distribution, and the targeting technology, allows us to quantify the welfare benefits of different alternatives for conducting fiscal policy, from a (complex) optimal policy function to simple linear rules, including the Chilean structural balance rule (SBR). In comparison with a balanced-budget rule, the optimal rule improves welfare by the equivalent of a 100 percent increase of government copper revenue per year under our baseline calibration, which includes positive effects from copper prices to private sector income. The optimal policy involves significant expected asset accumulation as a buffer stock, equivalent to around 33 percent of GDP in our baseline, although it takes many years to reach large values. More important, the optimal policy implies a considerable degree of countercyclicality: a fall in private income of one standard deviation translates, on average, into a 50 percent rise in government transfers relative to median government income. In certain states (characterized by high private income, low copper revenues, and low assets), the optimal policy is to save all current income and cut transfers to zero.

The SBR used in Chile over the past decade and a Friedman-type rule attain meaningful welfare gains of around 20 percent of those achieved by the optimal rule. On average, both simple rules accumulate fewer assets than the optimal policy and are close to acyclical. Optimizing the marginal propensities to spend out of assets and structural government income for an SBR-type rule results in a propensity to spend out structural or permanent copper revenues that is much lower than one, together with a propensity to spend out of assets that is much higher than the annuity value. This rule yields considerable additional gains, attaining a surprising 74 percent of gains obtained under the optimum. The result that the Chilean rule tends to spend too much out of copper and too little out of assets is robust across parameter specifications.

Finally, motivated by the quantitative importance of the optimal rule's countercyclical behavior, we also explored the gains from a regime-switching rule with two linear rules, which allows for higher spending when household income is particularly low (private sector in recession). This higher spending in certain states of nature obviously needs higher savings in normal times. The welfare gain in this case is a surprising 83 percent of the optimum. The policy implication is that there would be substantial benefits from adding an escape clause to the Chilean SBR for recessions, when countercyclical spending is valued most, increasing the propensities to spend out of assets and structural income, even though the latter remains below one. The fact that the SBR was effectively abandoned in 2009 may not be coincidental, as it allowed the rule to provide social insurance.

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Procyclicality of Fiscal Policy in Emerging Countries: The Cycle is The Trend

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Economic research on fiscal policy has shown that while developed economies tend to run countercyclical fiscal policies, Latin American countries have been characterized by procyclical policies. One of the explanations given to this phenomenon is that high external debt causes severe constraints on the ability to secure new loans, which forces countries to cut their budget deficits. Another explanation is related to optimal behavior under political constraints (Talvi and Végh, 2005). In this paper, we test a different channel, related to the characteristics of business cycles. Aguiar and Gopinath (2007) find that in developing countries, the cycle is the trend—that is, business cycles tend to become persistent and thus to determine the fundamentals of economic performance in these countries. One possible channel is fiscal policy: in times of recession, the erratic character of the crisis forces developing economies to cut expenditures, while the opposite occurs during booms. This procyclical behavior may characterize other sectors of the economy, far beyond the fiscal policy reaction (Kaminsky, Reinhart, and Végh, 2005).

The recent renewed interest in cyclicality of fiscal policy has mainly taken an empirical focus. This new empirical literature began with Galí (1994), Fiorito and Kollintzas (1994), and Fiorito (1997), who find that fiscal expenditures are countercyclical or acyclical in developed countries. In contrast, Gavin and Perotti (1997) finds

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that fiscal policy is highly procyclical in Latin American countries. These findings led to much research that largely corroborated the earlier studies.

Lane (2003) shows that the cyclicality of fiscal policy varies significantly across categories and also across the member countries of the Organization for Economic Cooperation and Development (OECD), but most advanced economies implement countercyclical fiscal policies. Arreaza, Sørensen, and Yosha (1999), Galí and Perotti (2003), and Strawczynski and Zeira (2009) find further support for countercyclical fiscal policy in the European Union and in OECD countries. Galí (2005) even finds that fiscal policy is countercyclical in all industrialized countries and that countercyclicality intensified after 1991. Darby and Mélitz (2007) find that social expenditures account for the vast majority of countercyclical fiscal policies. Fatás and Mihov (2001) find that most of the countercyclicality of deficits in developed countries is a result of the automatic stabilizers. As mentioned above, the findings for developing countries are very different. Talvi and Végh (2005) show that government spending and taxes are highly procyclical in a large sample of less developed countries. This finding is corroborated by Akitoby and others (2004), Alesina and Tabellini (2005), and Ilzetzki and Végh (2008). The main explanation for this difference in fiscal policy between developed and less developed countries is that governments in less developed countries face credit constraints, which force them to cut expenditures during recessions. Other explanations are based on political economy, as in Talvi and Végh (2005), Alesina and Tabellini (2005) and Ilzetzki (2011).

The paper is organized as follows. In section 1, we characterize procyclicality of government expenditure under a shock to per capita gross domestic product (GDP) and describe the methodology for assessing whether the cycle is the trend. In section 2, we show empirical results on the relationship between "the cycle is the trend" variable and government expenditure, expenditure cuts during recessions, and the composition of government expenditure (consumption, transfers, and investment). We also test for a change in behavior after the 1990s and check whether procyclicality is milder for countries with high foreign direct investment (FDI), high international reserves, low public debt, and inclusion in the emerging markets stock exchange index. Section 3 concludes, and the appendixes present our method for choosing the length of the random walk component and the moving averages of GDP per capita, the sensitivity of our findings to the use of different instrumental variables under generalized methods of moments (GMM) estimation, Granger causality tests, the sensitivity to country fixed effects, an Arellano-Bond specification, and a summary of our sources and definitions.

1. Procyclicality of Government Expenditure under Permanent Shocks

To study the impact of permanent shocks on fiscal policy variables, we concentrate mainly on expenditure. We would also like to test the impact on taxes and the deficit, but the straight interaction between the cycle and tax revenues, and thus the deficit, makes this mission difficult. Furthermore, the unavailability of data on statutory tax rates deters us from studying the impact on taxes.

Similarly to Barro (1979), we consider output and the real interest rate to be exogenous. Unlike Barro's model, however, we take the tax rate as given and assume that government expenditure is endogenous. The government chooses its real expenditure, G_t, in all periods ($t = 1, 2, \ldots$) so as to maximize a utility function, with decreasing marginal utility in government consumption:

$$\max \sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}} \left[-(g^* - g_t)^2 \frac{Y_t}{2} \right], \tag{1}$$

where r is an exogenous interest rate, Y is the exogenous output level, g^* is the maximum level of government expenditure over output (G/Y), and g is its actual level.[1] The intertemporal budget constraint is given by

$$\sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}} (\tau_t - g_t) Y_t + (1+r) Y_0 b_0 = 0, \tag{2}$$

where τ is the exogenous statutory tax rate and b_0 is the ratio of initial general government debt to output. The Lagrangian of this problem is

1. This specification is parallel to Barro (1979), who stresses the tractability of choosing a homogeneous function for maximization, since g is expressed as a percentage of GDP.

$$\ell = \sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}} \left[-(g^* - g_t)^2 \frac{Y_t}{2} \right] - \lambda \left[\begin{array}{l} \sum_{t=1}^{\infty} \frac{1}{(1+r)^{t-1}} (\tau_t - g_t) Y_t \\ +(1+r) Y_0 b_0 \end{array} \right], \tag{3}$$

and the first-order conditions are

$$g^* - g_1 = \lambda; \tag{4}$$
$$\ldots$$
$$g^* - g_\infty = \lambda.$$

The optimal solution deriving from equation (4) is to choose a smooth g in all periods.

Before writing the solution, let us define the permanent value of a variable X (with supra-index ~) as follows:

$$\sum_{i=1}^{\infty} \frac{\tilde{X}}{(1+r)^{i-1}} = X_1 + \frac{X_2}{1+r} + \frac{X_3}{(1+r)^2} + \ldots. \tag{5}$$

Plugging the optimal smooth value of G into the intertemporal budget constraint and taking the permanent value of output as defined in equation (5), we get

$$\tau \tilde{Y} = \tilde{G} + (1+r) B_0 \tag{5'}$$

This equation states that the tax rate is set to finance the permanent level of expenditure and the initial debt using the permanent level of output as the tax base.

If there is an exogenous permanent shock on output, and given that debt and the real interest rate are exogenous, the single way of restoring the equality would be to adjust government expenditure.[2] In a recession (expansion), the equality requires cutting (rising) expenditure; that is, it requires a procyclical fiscal policy. This policy will be similar for both developed and emerging economies, but the outcome is different based on the degree of the permanent shock and the economy's response to it. With regard to the degree of the shock, cycles may become persistent in emerging markets (that is, the cycle is the trend), while they may be purely transitory in

2. Hercowitz and Strawczynski (2004) consider the case in which both the tax rate and government expenditure are endogenous.

developed economies. In this case, we would expect fiscal policy to be acyclical (or countercyclical) in developed economies and procyclical in emerging markets.[3] With regard to the economy's response to the shock, developed and emerging countries may differ as a consequence of the risk perception by economic agents.

To calculate the variable representing the phenomenon of the cycle being the trend, we use the methodology adopted by Aguiar and Gopinath (2007) for Canada and Mexico. We extend the calculation to 22 developed economies and to 23 emerging countries.[4]

The methodology is based on looking at the variability of output over long horizons:

$$\sigma^2_{\Delta K} = K^{-1}\,\mathrm{var}(y_t - y_{t-K}), \tag{6}$$

where $y_t = \log$ (GDP per capita) at time t and K is the amount of lagged differences.

We then correct the sample variance for small-sample bias by including a degree-of-freedom correction term, $T\ /\ (T - K + 1)$:

$$\sigma^2_{\Delta K} = \frac{T}{K(T-K+1)}\mathrm{var}(y_t - y_{t-K}). \tag{7}$$

For each K, we calculate

$$C_K = \frac{\sigma^2_{\Delta K}}{\sigma^2_{\Delta y}}, \tag{8}$$

where $\sigma^2_{\Delta y}$ is the value of $\sigma^2_{\Delta K}$ when $K = 1$. Thus, for all countries, the value of equation (8) at $K = 1$ is one.

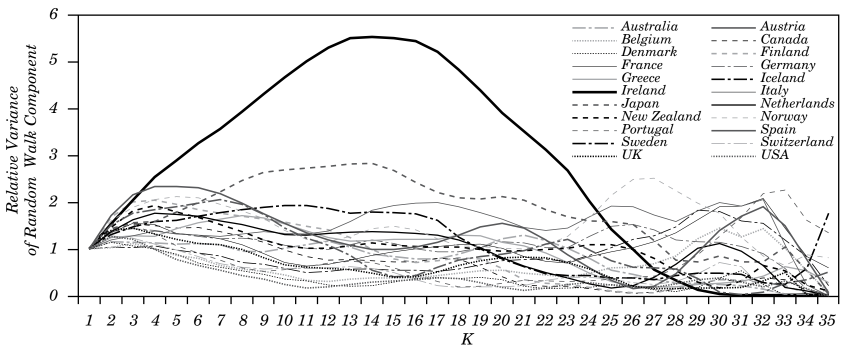
This value gives the ratio between the long-term variability of output and the short-term variability, thereby providing a measure of the extent to which the cycle is the trend. The higher this coefficient, the more strongly countries are expected to be affected by changes in output. Figure 1 shows the result of this measure for the different countries.

3. When shocks are transitory, a countercyclical policy acts as an optimal device for smoothing, as shown formally in Strawczynski and Zeira (2009).

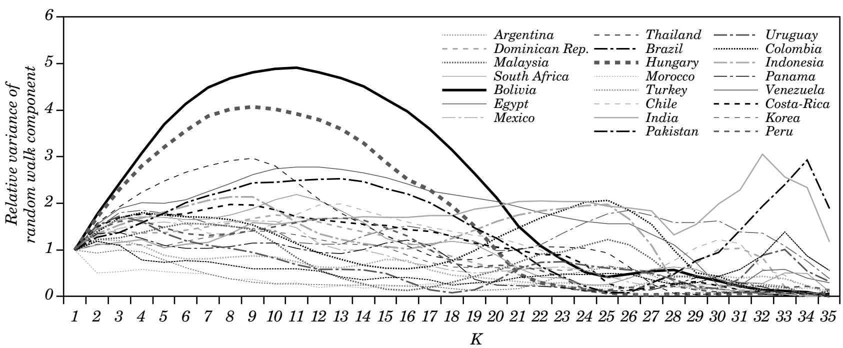
4. The countries in the sample are listed in appendix F. There is no single accepted definition for emerging markets. Some well-known definitions are based on indexes (MSCI and FTSE) and *The Economist*. In our sample, 17 of the 22 countries are included in these lists.

Figure 1. The Cycle is the Trend: Developed and Emerging Countries, 1960–2006

A. Developed countries[a]



B. Emerging countries[b]



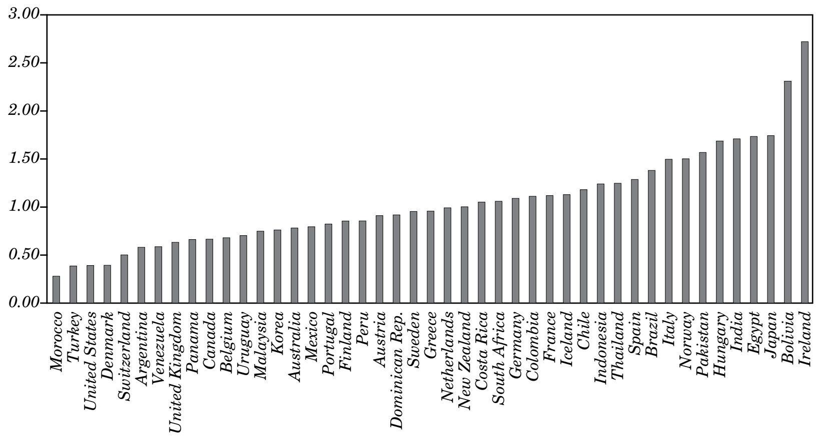
Source: Authors' elaboration.
a. The outlier is Ireland.
b. The outliers are Bolivia and Hungary.

To compare the results internationally, we take the average value of this measure for each country (see appendix A for a discussion of this choice). We expect the value for developed markets to be lower than for emerging markets.[5] In general, emerging countries have a

5. In figure 1, the pattern of procyclicality changes with K, and the pattern of procyclicality in emerging markets is very pronounced when K is between 9 and 11 (see figure A1 in appendix A for $K = 11$).

higher value of the random walk component: 12 countries are over the median (which equals 0.957), while 11 countries are below (see figure 2). In developed countries, 12 countries are below the median and 10 are above it. The average of all developed countries is 1.01 (0.95 excluding Ireland), compared with 1.07 for emerging countries.

Figure 2. Relative Variance of Random Walk component at $K = \bar{K}$



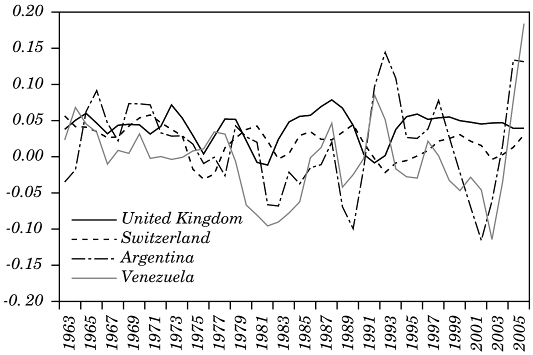
Source: Authors' elaboration.

Next, we multiply this value by the sum of growth over three years (the reason for choosing three years is explained in appendix A):

$$\text{CIIT}_t = (C_{K=\bar{K}})\sum_{n=t}^{t-3} \text{dlog}(y_t). \tag{9}$$

Figure 3 shows this formula applied to two developed countries and two emerging countries. All four countries have a similar, relatively low variance of the random walk component. Nevertheless, the erratic behavior in emerging markets is evident in the graph.

Figure 3. The Cycle is the Trend and Three-Year Changes in Output



Source: IMF, *World Economic Outlook* database.

In the next section, we use CITT as an independent variable in regressions on total government expenditure, government consumption, social transfers and subsidies, and capital expenditure.

2. Data and Empirical Results

For estimating the CITT variable, we use per capita GDP at constant prices. Data for developed countries were taken from OECD Economic Outlook and OECD Historical Statistics. Data for emerging markets are taken from the Government Financial Statistics published by the International Monetary Fund (IMF). Data relate to the general government. See appendix F for a detailed description of our sources and definitions.

2.1 Empirical Specifications for Total Expenditure

We estimate the following types of regression:

$$\text{dlog}(G) = \beta_1 + \beta_2\text{CITT} + \beta_3\text{RATIO} + \beta_4\text{dlog(POP)} \\ + \beta_5(\text{POP15} + \text{POP65}) + \beta_6\bar{K} + \beta_7\text{HyperInfl} + \varepsilon$$

and

$$\begin{aligned}\text{dlog}(G) = {} & \beta_1 + \beta_2\text{CITT} + \beta_3\text{EMERGING} + \beta_4\text{CITT} \times \text{EMERGING} \\ & + \beta_5\text{RATIO} + \beta_6\text{dlog(POP)} + \beta_7(\text{POP15} + \text{POP65}) \\ & + \beta_8\bar{K} + \beta_9\text{HyperInfl} + \varepsilon,\end{aligned}$$

where G is real government expenditure, deflated by GDP prices; CITT is "the cycle is the trend" variable, as defined above; dlog(POP) is the population growth rate; POP15 and POP65 are the populations under 15 and over 65 years old, respectively, as a percentage of total population; $\bar{K}$ is the average of the random walk component, as explained above; RATIO refers to the ratio between the country's GDP per capita and the GDP per capita of the United States, both in purchasing power parity (PPP) values; EMERGING is a dummy variable that equals one for emerging countries and zero otherwise; and HyperInfl is a dummy variable that equals one when yearly inflation is over 100% for two or more consecutive years and zero otherwise.

We repeat these regressions in the framework of three panel models: a simple ordinary least squares (OLS) regression with period fixed effects, an autoregressive (AR) model, and a generalized methods of moments (GMM) model with an AR process. We examine these models for different lengths of the moving average of output (one to four periods). For space considerations, the tables below show only the results for three-period moving average of output using the GMM approach.

The implementation of a GMM model requires choosing an instrumental variable that is correlated with the CITT variable and is not correlated with government expenditure. For this purpose, we use real exports and also check the sensitivity of the results to other instrumental variables (see appendix C).

2.1.1 Budget cuts

Cutting the budget in hard times is particularly painful, since it has a negative impact on economic activity. Thus, it is interesting to study the procyclicality of fiscal policy in recession periods. Table 1 summarizes the number of budget cuts and whether they followed a recession period (which would indicate procyclical behavior), the amount of persistent budget cuts, and the depth of the budget cuts.

Table 1. Budget Cuts

Measure	*Developed economies*	*Emerging economies*[a]
Average number of observations with a government budget cut	5.7	6.8
Average number of events (when real government expenditure was cut) as percent of total years available	12.7	25.6
Average number of persistent events (when government expenditure was cut two consecutive years or more) as percent of total years available[b]	5.5	10.2
Average number of persistent events (two years or more) as percent of total number of events	43.2	39.9
Average number of persistent events (when government expenditure was cut three consecutive years or more) as percent of total years available	2.4	4.1
Average number of persistent events (three years or more) as percent of total number of events	19.2	16.1
Average number of events with parallel reduction in growth as percent of total number of events	6.4	30.1
Average number of events with one-period lagged reduction in growth as percent of total number of events	15.2	20.3
Average cut in government expenditure (percent)	–2.2	–6.8
Average cut in government expenditure when there was a parallel reduction in growth (percent)	–4.0	–10.3
Parallel reduction in growth – average percent of change in GDP	–2.0	–5.2

Source: OECD and Government Financial Statistics.
a. The table reports the number of emerging countries in which data for total government expenditure is available and consistent.
b. Each year in the group of consecutive years is counted as an event.

We estimate the following regression:

$$\begin{aligned}\text{dlog}(G) = {} & \beta_1 + \beta_2\text{CITT} + \beta_3\text{EMERGING} + \beta_4(G^- \times Y^-) \\ & + \beta_5\text{EMERGING} \times \text{CITT} + \beta_6(\text{CITT} \times \text{EMERGING} \times G^- \times Y^-) \\ & + \beta_7\text{RATIO} + \beta_8\text{dlog(POP)} \\ & + \beta_9(\text{POP15} + \text{POP65}) + \beta_{10}\bar{K} + \beta_{11}\text{HyperInfl} + \varepsilon,\end{aligned}$$

where G^- and Y^- are dummy variables that take the value of one when government consumption and real GDP, respectively, have a negative growth rate.

2.1.2 A Change in policy after the 1990s

The globalization of the 1990s exposed emerging countries to international markets to an unprecedented degree. This created new incentives for governments to change their behavior to avoid being isolated from international financial markets. In particular, in countries that are in trouble but in which the governments succeed in convincing foreign investors that the changes being made in the economy will bring a relatively quick end to the bad times, foreign investors will perceive low stock exchange levels as an investment opportunity. This may provide a new mechanism for a recovery: expectations may change quickly, output may reverse, and governments will be less dependent on performing budget cuts during recessions; that is, the procyclicality of fiscal policy would decline.

To examine whether emerging governments changed their behavior after the 1990s in response to globalization, we define a dummy variable, $D(90)$ that takes the value of one after 1990 and zero otherwise. We multiply this dummy by the fiscal variables explained above.

2.2 Empirical Results for Total Government Expenditure

Results for total government expenditure are shown in table 2. The coefficient of permanent shocks is insignificant for the developed economies, whereas emerging markets have a coefficients of around

Table 2. Total Government Expenditure Regressions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Constant	0.06 (0.04)	0.03 (0.04)	0.03 (0.04)	0.02 (0.04)	0.03 (0.04)
dlog(POP)	1.64 (0.44)***	1.37 (0.45)***	1.37 (0.45)***	1.38 (0.45)***	1.47 (0.45)***
POP15 + POP65	−0.001 (0.001)	0.00001 (0.001)	−0.00002 (0.001)	0.0002 (0.001)	−0.0001 (0.001)
RATIO	−0.004 (0.01)	0.001 (0.02)	0.001 (0.02)	0.001 (0.02)	0.003 (0.02)
HyperInfl	−0.05 (0.01)***	−0.03 (0.01)***	−0.03 (0.01)***	−0.02 (0.01)*	−0.02 (0.01)
$\bar{K}$	−0.02 (0.01)**	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)*	−0.01 (0.01)
EMERGING		−0.02 (0.01)	−0.02 (0.01)	−0.03 (0.01)*	−0.02 (0.01)
$G^{-} \times Y^{-}$				−0.002 (0.01)	−0.01 (0.01)
CITT	0.25 (0.04)***	0.08 (0.05)	0.08 (0.05)	0.09 (0.05)*	0.09 (0.05)*
EMERGING × CITT		0.31 (0.07)***	0.31 (0.09)***	0.35 (0.07)***	0.43 (0.08)***
EMERGING × CITT × $D(90)$			−0.004 (0.07)		−0.15 (0.07)**
EMERGING × CITT × $G^{-} \times Y^{-}$				0.22 (0.11)*	0.23 (0.12)*
EMERGING × CITT × $G^{-} \times Y^{-} \times D(90)$					−0.51 (0.25)**
Summary statistic					
No. observations	1,221	1,221	1,221	1,221	1,221
Adjusted R^2	0.54	0.56	0.56	0.55	0.56
Durbin-Watson	1.63	1.66	1.66	1.67	1.66

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(G). The estimation method is GMM, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

0.3 and statistically significant at the 1 percent level (column 2). The coefficient rises during high times (column 4): in periods of parallel reductions in G and Y, the coefficient increases by 0.2. We take these results as the first evidence of our main hypothesis—namely, that GDP shocks in emerging countries are associated with a procyclical reaction in government expenditure. These results are confirmed using the other methods.

Columns 3 and 5 present our results on whether there was a change in expenditure behavior by emerging government after the 1990s, in response to increasing globalization. In column 3, the coefficient is not significant, but in column 5, it is significant at the 5 percent level. This indicates that government expenditure was significantly less procyclical in emerging countries after the 1990s, especially during hard times.

2.3 Government Expenditure Composition

We perform the same analysis for government consumption, transfers and subsidies, and capital expenditure. In the transfers and subsidies analysis, we additionally control for the difference in the unemployment rate (dU), in order to control for the automatic impact of the cycle on unemployment benefits. Results are shown in tables 3, 4, and 5.

Table 3 reveals that while government consumption is procyclical in both developed and emerging economies, it is considerably more so in emerging economies. This behavior does not change significantly in hard times, in contrast to the results for total government expenditure presented earlier. Table 4 shows that government transfers are procyclical in emerging economies, a pattern that was accentuated after the 1990s.

Table 3. Government Consumption Regressions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Constant	−0.01 (0.04)	−0.01 (0.04)	−0.01 (0.04)	−0.03 (0.04)	−0.02 (0.04)
dlog(POP)	1.03 (0.42)**	0.98 (0.42)**	0.98 (0.42)**	1.15 (0.44)***	1.13 (0.44)***
POP15 + POP65	0.001 (0.001)	0.001 (0.001)	0.001 (0.001)	0.002 (0.001)	0.001 (0.001)
RATIO	0.01 (0.01)	0.004 (0.02)	0.004 (0.02)	0.01 (0.02)	0.01 (0.02)
HyperInfl	−0.05 (0.01)***	−0.04 (0.01)***	−0.04 (0.01)***	−0.03 (0.01)**	−0.03 (0.01)**
$\bar{K}$	−0.01 (0.01)**	−0.01 (0.01)	−0.01 (0.01)	−0.02 (0.01)**	−0.02 (0.01)**
EMERGING		−0.02 (0.01)	−0.02 (0.01)	−0.03 (0.01)**	−0.03 (0.01)**
$G^- \times Y^-$				−0.003 (0.01)	−0.002 (0.01)
CITT	0.24 (0.03)***	0.15 (0.05)***	0.15 (0.05)***	0.16 (0.05)***	0.16 (0.05)***
EMERGING × CITT		0.17 (0.07)**	0.19 (0.08)**	0.28 (0.07)***	0.34 (0.08)***
EMERGING × CITT × $D(90)$			−0.03 (0.07)		−0.10 (0.07)
EMERGING × CITT × $G^- \times Y^-$				0.08 (0.11)	0.09 (0.12)
EMERGING × CITT × $G^- \times Y^- \times D(90)$					0.07 (0.26)
Summary statistic					
No. observations (unbalanced)	1,277	1,277	1,277	1,202	1,202
Adjusted R^2	0.56	0.57	0.57	0.57	0.57
Durbin-Watson	1.73	1.76	1.76	1.76	1.76

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(*GC*). The estimation method is GMM, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

Table 4. Government Transfers and Subsidies Regressions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Constant	0.05 (0.06)	0.02 (0.06)	0.01 (0.06)	0.02 (0.06)	0.004 (0.06)
dlog(POP)	1.61 (0.64)**	1.48 (0.68)**	1.49 (0.7)**	1.22 (0.69)*	1.19 (0.7)*
POP15 + POP65	–0.0003 (0.001)	0.0004 (0.002)	0.001 (0.002)	0.001 (0.002)	0.001 (0.002)
RATIO	–0.01 (0.02)	–0.01 (0.03)	–0.01 (0.03)	–0.01 (0.03)	–0.01 (0.03)
HyperInfl	–0.07 (0.02)***	–0.06 (0.02)***	–0.07 (0.02)***	–0.05 (0.02)**	–0.05 (0.02)***
dU	0.01 (0.002)***	0.01 (0.002)***	0.01 (0.002)***	0.01 (0.002)***	0.01 (0.002)***
$\bar{K}$	–0.01 (0.01)	0.001 (0.01)	–0.003 (0.01)	0.002 (0.01)	–0.001 (0.01)
EMERGING		–0.02 (0.02)	–0.03 (0.02)	–0.01 (0.02)	–0.02 (0.02)
$G^{-} \times Y^{-}$				–0.02 (0.01)**	–0.02 (0.01)**
CITT	0.12 (0.06)**	–0.02 (0.07)	–0.01 (0.07)	–0.04 (0.07)	–0.03 (0.07)
EMERGING × CITT		0.29 (0.11)***	–0.01 (0.13)	0.30 (0.11)***	0.09 (0.13)
EMERGING × CITT × D(90)			0.49 (0.13)***		0.33 (0.12)***
EMERGING × CITT × $G^{-} \times Y^{-}$				0.20 (0.2)	0.34 (0.22)
EMERGING × CITT × $G^{-} \times Y^{-}$ × D(90)					–0.06 (0.59)
Summary statistic					
No. observations (unbalanced)	1,062	1,062	1,062	1,053	1,053
Adjusted R^2	0.43	0.45	0.43	0.45	0.44
Durbin-Watson	1.60	1.63	1.64	1.62	1.63

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(*GT*). The estimation method is GMM, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

Table 5. Government Capital Expenditure Regressions[a]

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Constant	0.05	0.15	0.15	0.13	0.14
	(0.11)	(0.11)	(0.11)	(0.11)	(0.11)
dlog(POP)	3.72	4.35	4.35	4.63	4.66
	(1.16)***	(1.19)***	(1.19)***	(1.2)***	(1.21)***
POP15 + POP65	−0.002	−0.002	−0.002	−0.001	−0.001
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
RATIO	0.06	−0.09	−0.09	−0.10	−0.10
	(0.04)	(0.06)	(0.06)	(0.06)*	(0.06)*
HyperInfl	−0.07	−0.06	−0.06	−0.04	−0.05
	(0.03)**	(0.03)*	(0.03)**	(0.03)	(0.03)
$\bar{K}$	−0.02	−0.03	−0.03	−0.04	−0.04
	(0.02)	(0.02)	(0.02)	(0.02)**	(0.02)**
EMERGING		−0.12	−0.11	−0.15	−0.14
		(0.04)***	(0.04)***	(0.04)***	(0.04)***
$G^{-} \times Y^{-}$				−0.01	−0.02
				(0.01)	(0.01)
CITT	0.60	0.48	0.49	0.49	0.49
	(0.09)***	(0.14)***	(0.14)***	(0.14)***	(0.14)***
EMERGING × CITT		0.22	0.15	0.30	0.22
		(0.19)	(0.22)	(0.18)*	(0.22)
EMERGING × CITT × $D(90)$			0.04		0.01
			(0.18)		(0.18)
EMERGING × CITT × $G^{-} \times Y^{-}$				0.15	0.07
				(0.31)	(0.33)
EMERGING × CITT × $G^{-} \times Y^{-} \times D(90)$					−0.23
					(0.69)
Summary statistic					
No. observations (unbalanced)	1,245	1,245	1,245	1,177	1,177
Adjusted R^2	0.54	0.54	0.54	0.54	0.55
Durbin-Watson	1.81	1.80	1.80	1.79	1.79

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(*GI*). The estimation method is GMM, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

Capital expenditure tends to be procyclical even in developed economies, as documented by Lane (2003) and Ilzetzky and Végh (2008). Lane (2003) summarizes both the macroeconomic and political economy factors that are behind this phenomenon. One possible explanation is that the fruits of investment projects are yielded many years after the initiation of a project; politicians may therefore be tempted to start investment projects only in times of abundant tax revenues, and they may find it natural to cut these projects in difficult times—without any immediate consequences. In table 5, the results of our regressions on government capital expenditure show, as expected, that cuts in capital expenditure are procyclical in both developed and emerging economies. This procyclical behavior is not significantly different in the two sample groups.

2.4 Other Issues to Consider

So far we have found that fiscal policy in emerging countries is procyclical, with some signs of a change in behavior after the 1990s. In this subsection, we explore other issues that may shed light on the mechanisms underlying this process.

2.4.1. Foreign direct investment and international reserves

One possible explanation for the improved performance after the 1990s is that countries are less on their own as a result of globalization: the increased exposure to investors around the world has smoothed governments' financing options, so that emerging countries no longer need to cut expenditure so sharply in hard times. One possible indicator of this exposure is the level of foreign direct investment (FDI). We expect that countries with a high level of FDI will institute milder procyclical fiscal policy. Table 6 shows the average levels of FDI for developed and emerging countries. One clear feature arising from this table is that FDI closely mirrored the globalization process, with a huge increase in the 1990s and 2000s after being stable in the 1970s and 1980s. For developed economies, the FDI level in the 1990s was more than double the level of the 1970s and 1980s, and by the 2000s, it had increased to more than five times the 1970s level. For emerging markets, FDI tripled between the 1970 and the 1990s and had nearly quadrupled by the 2000s. Another interesting feature of FDI flows is their high variance, with some developing countries being discovered by foreign investors only in the last decade.

Table 6. Average Net FDI Inflows as Percent of GDP

Sample group	*1970s*	*1980s*	*1990s*	*2000÷06*
Developed countries	0.74	0.75	1.97	3.78
Emerging countries	0.83	0.84	2.53	2.96
All countries	0.79	0.79	2.26	3.36

Source: U.N. Conference on Trade and Development (UNCTAD), May 2010.

In table 7, we explore whether the FDI level has some explanatory power for procyclical fiscal policies in emerging countries. For this purpose, we performed two regressions, one using an interaction variable between CITT and FDI (column 1) and another using an interaction between CITT and a dummy variable, $\bar{D}$ (FDI), that takes the value of one when FDI is higher than the median for each group of countries in each decade or 0 otherwise (column 2). Results are significant and in the expected direction; for emerging countries with high levels of FDI the coefficient of procyclicality decreases from 0.42 to 0.14 (column 2).

Kandil and Morsy (2010) find that international reserves help for performing countercyclical policy in emerging countries. We use their methodology for testing the role of international reserves and build a dummy variable, D(Reserves), that takes the value 1 if the international reserves at the end of the year are higher than the sum of 3 months of imports (using average monthly imports of the corresponding year). Columns 3 and 4 show that the coefficients have the expected sign and are significant at 10 percent.

Table 7. Total Government Expenditure Regressions with FDI and International Reserves[a]

Explanatory variable	1973–2006 (1)	1973–2006 (2)	1971–2006 (3)	1971–2006 (4)
Constant	0.06 (0.04)	0.05 (0.05)	0.04 (0.04)	0.04 (0.04)
dlog(POP)	1.55 (0.5)***	1.40 (0.49)***	1.45 (0.45)***	1.45 (0.45)***
POP15 + POP65	–0.001 (0.001)	–0.001 (0.001)	–0.0003 (0.001)	–0.0003 (0.001)
RATIO	–0.003 (0.02)	–0.003 (0.03)	–0.003 (0.02)	–0.003 (0.02)
HyperInfl	–0.03 (0.01)**	–0.03 (0.01)**	–0.03 (0.01)***	–0.03 (0.01)***
$\bar{K}$	–0.01 (0.01)	–0.01 (0.01)	–0.01 (0.01)*	–0.01 (0.01)*
EMERGING	–0.02 (0.01)	–0.02 (0.02)	–0.02 (0.01)*	–0.02 (0.01)*
FDI / GDP	–0.001 (0.001)			
$\bar{D}(FDI)$		–0.0002 (0.01)		
D(Reserves)			0.01 (0.003)*	0.01 (0.003)*
CITT	0.06 (0.05)	0.09 (0.05)	0.10 (0.05)**	0.10 (0.05)**
EMERGING × CITT	0.39 (0.08)***	0.42 (0.09)***	0.38 (0.09)***	0.38 (0.09)***
(FDI / GDP) × EMERGING × CITT	–0.04 (0.02)***			
EMERGING × CITT × $\bar{D}(FDI)$		–0.28 (0.09)***		
EMERGING × CITT × D(Reserves)			–0.13 (0.07)*	–0.13 (0.08)*
EMERGING × CITT × D(Reserves) × D(90)				0.01 (0.08)
Summary statistic				
No. observations (unbalanced)	1,130	1,170	1,195	1,195
Adjusted R^2	0.55	0.54	0.55	0.55
Durbin-Watson	1.68	1.67	1.66	1.66

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(G). The estimation method is GMM. Standard errors are in parenthesis.

2.4.2 Government debt

As mentioned in the literature survey, government debt is considered one of the main explanatory factors for procyclical fiscal policy in developing countries. Many emerging countries carry high levels of debt, although the debt levels vary substantially among countries.

In table 8, we present the results of regressions that include the debt level as an independent variable, DEBT / GDP, as well as a dummy variable, $\bar{D}$ (DEBT), that takes the value of one when a country's debt is higher than the median for its group in each decade and zero otherwise (column 3). Column 1 shows that the coefficient of debt as a percent of GDP is negative and significant, which means that countries with high debt tend to reduce government expenditure. This means that debt can be considered an alternative explanation for government expenditure. Therefore, we include debt as an additional variable in our basic specification, and we further create an interaction variable between CITT and debt. Ex ante we do not have a clear expectation about the sign of the coefficient: a high level of debt may imply international pressure to cut expenditure, which would result in a negative coefficient, or it could represent a country's ability to access international capital markets, which implies a positive coefficient. In columns 2 and 3, the coefficients tend to be negative, but they are not significant in the second specification.

Table 8. Total Government Expenditure Regressions with Debt[a]

Explanatory variable	*(1)*	*(2)*	*(3)*
Constant	0.07 (0.04)	0.04 (0.04)	−0.01 (0.04)
dlog(POP)	0.46 (0.48)	0.65 (0.46)	1.05 (0.48)**
POP15 + POP65	−0.0002 (0.001)	0.0002 (0.001)	0.0001 (0.001)
RATIO	−0.02 (0.02)	0.002 (0.02)	0.04 (0.02)
HyperInfl	−0.02 (0.02)	−0.01 (0.02)	−0.01 (0.02)
$\bar{K}$		0.01 (0.01)	0.001 (0.01)
EMERGING	0.04 (0.02)**	−0.01 (0.01)	0.02 (0.01)
DEBT / GDP	−0.0004 (0.0001)***	−0.0004 (0.0001)***	
$\bar{D}(Debt)$			−0.003 (0.004)
CITT		0.01 (0.04)	0.05 (0.05)
EMERGING × CITT		0.39 (0.1)***	0.25 (0.08)***
(DEBT / GDP) × EMERGING	−0.001 (0.0002)***		
(DEBT / GDP) × EMERGING × CITT		−0.004 (0.002)**	
EMERGING × CITT × $\bar{D}(Debt)$			−0.13 (0.100)
Summary statistic			
No. observations (unbalanced)	900	894	963
Adjusted R^2	0.59	0.59	0.58
Durbin-Watson	1.66	1.59	1.53

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(G). The estimation method is GMM, and the sample period is from 1973 to 2006. Standard errors are in parenthesis.

Table 9. Total Government Expenditure Regressions Excluding Five Developing Markets Not Included in the Emerging Markets Index[a]

Explanatory variable	*1*	*2*	*3*	*4*	*5*
Constant	0.07 (0.04)*	0.04 (0.04)	0.05 (0.04)	0.05 (0.04)	0.05 (0.04)
dlog(POP)	1.53 (0.44)***	1.32 (0.46)***	1.32 (0.46)***	1.36 (0.45)***	1.39 (0.44)***
POP15 + POP65	−0.001 (0.001)	−0.0003 (0.001)	−0.0003 (0.001)	−0.0003 (0.001)	−0.0004 (0.001)
RATIO	−0.01 (0.01)	−0.01 (0.02)	−0.01 (0.02)	−0.01 (0.02)	−0.01 (0.02)
HyperInfl	−0.06 (0.01)***	−0.04 (0.01)***	−0.04 (0.01)***	−0.03 (0.01)**	−0.03 (0.01)**
$\bar{K}$	−0.02 (0.01)**	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)	−0.01 (0.01)
EMERGING		−0.02 (0.02)	−0.02 (0.02)	−0.02 (0.01)	−0.02 (0.01)
$G^{-} \times Y^{-}$				−0.01 (0.01)	−0.02 (0.01)***
CITT	0.21 (0.04)***	0.06 (0.05)	0.06 (0.05)	0.09 (0.05)*	0.09 (0.05)*
EMERGING × CITT		0.29 (0.08)***	0.28 (0.09)***	0.25 (0.07)***	0.31 (0.08)***
EMERGING × CITT × $D(90)$			−0.01 (0.07)		−0.08 (0.07)
EMERGING × CITT × $G^{-} \times Y^{-}$				0.18 (0.13)	0.21 (0.13)
EMERGING × CITT × $G^{-} \times Y^{-} \times D(90)$					−0.63 (0.23)***
Summary statistic					
No. observations	1,107	1,107	1,107	1,107	1,107
Adjusted R^2	0.55	0.56	0.56	0.56	0.56
Durbin-Watson	1.73	1.75	1.75	1.75	1.73

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(G). The estimation method is GMM, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

2.4.3 Emerging versus developing countries

Our sample includes five countries that are not considered emerging markets by either the MSCI or FTSE index (see appendix F for further information on the countries included in these indexes). The countries in question are Bolivia, Costa Rica, the Dominican Republic, Panama, and Uruguay. We repeated the regressions reported in table 3 excluding the five countries; the results are presented in table 9. The coefficient of procyclicality is lower for the restricted sample than for the full sample.

3. Summary and Conclusions

This paper explores whether developed and emerging economies react differently to persistent shocks to output. From a theoretical perspective, we expected to find procyclical behavior in countries that are subject to persistent shocks to per capita GDP—that is, they will increase expenditure during booms and cut it during recessions. To assess the extent to which the cycle is the trend for developed and emerging economies, we adopted Aguiar and Gopinath (2007) definition of shocks to examine how government expenditure and its components (namely, consumption, transfers, and investment) react to these shocks.

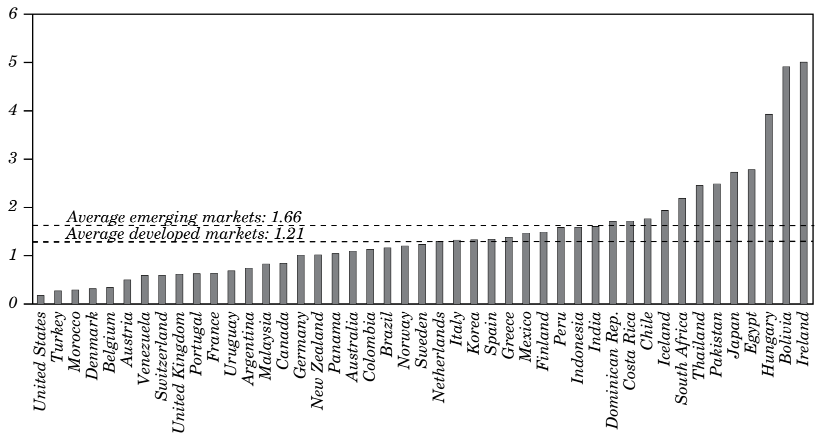
We found that while government expenditure in developed economies is not affected by these shocks (with the exception of government investment), emerging countries do tend to pursue procyclical fiscal policy in reaction to persistent shocks to per capita GDP. This is in line with previous findings for investment, which show that both developed and emerging countries act procyclically in this area. However, procyclical policy in emerging countries is particularly evident for total expenditure and is implemented in government investment, consumption and transfers.

There are signs of a reduction in the extent of procyclical expenditure policy in emerging countries after the 1990s, in response to increasing globalization. Moreover, we found that countries with a high level of FDI implemented milder procyclical policies, as did those included in emerging markets indexes.

Appendix A
The Length of Shocks Affecting Government Expenditure

The interaction between the sum of the three-period shocks and "the cycle is the trend" variable (CITT) is a central explanatory variable in our regressions. As stated in Aguiar and Gopinath (2007), there is a trade off between precision (using a small number for K) and an unbiased sample (using a large K). Choosing different values of K implies a different pattern for the CITT variable. Figure A1 shows the relative variance of the random walk component at $K = 11$, whereas figure 2 in the main text is based on the average K. A comparison of the two figures reveals that there is a sharper distinction between the random walk component of developed and emerging markets with $K = 11$.

Figure A1. Relative Variance of Random Walk Component at $K = 11$



Source: Authors' elaboration.

To check the sensitivity of the results to K, we run the following regression:

$$\text{dlog}(G_t) = \beta_1 + \beta_2 (C_K) \sum_{n=t}^{t\text{-}j} \text{dlog}(y_t) + \beta_3 \text{RATIO} + \beta_4 \text{dlog(POP)}$$
$$+ \beta_5 (\text{POP15} + \text{POP65}) + \beta_6 \text{HyperInfl} + \varepsilon,$$

where K takes different values and j ranges from 1 to 4.

Results for the four different possibilities of accumulated shocks show that the best result using the t statistic, adjusted R^2, and Akaike criterion occurs when $K = 2$. At the same time, the differences between the regressions, as measured by the adjusted R^2 and Akaike criterion, are negligible. Since choosing $K = 2$ would clearly increase the potential bias of our estimation, we chose the average K as the option that balances precision and bias. The t statistic for the regression using average K is very high ($t = 9$), and the difference in significance is negligible when compared with the case in which $K = 2$.

Our second choice is related to the length of the moving average of output shocks. In the accumulated three-period shock specification of the above equation, we get a significantly higher t statistic of the CITT variable, a higher adjusted R^2, and a higher Akaike criterion (in absolute value) than in all other options. We therefore chose this option as the benchmark.

To check the sensibility of results to the different values of K, we show in this appendix the results of the following main regression (as presented in table 3, column 2):

$$\text{dlog}(G) = \beta_1 + \beta_2 \text{CITT} + \beta_3 \text{EMERGING} + \beta_4 \text{CITT} \times \text{EMERGING}$$
$$+ \beta_5 \text{RATIO} + \beta_6 \text{dlog(POP)} + \beta_7 (\text{POP15} + \text{POP65})$$
$$+ \beta_8 K + \beta_9 \text{HyperInfl} + \varepsilon.$$

For space considerations we show only the coefficients and significance of the main variables, the adjusted R^2, and the Durbin-Watson value in table A1. We also run the regressions with a different number of accumulated shocks (using $K = \bar{K}$). Table A2 shows results for the specification described above.

Table A1. Coefficients and Statistics of the Main Variables for Alternative Values of K[a]

K	$CITT$	$CITT \times EMERGING$	$Adjusted\ R^2$	$Durbin\text{-}Watson$
$K = 2$	0.02 (0.05)	0.29 (0.07)***	0.57	1.67
$K = 3$	0.03 (0.04)	0.24 (0.06)***	0.57	1.67
$K = 4$	0.04 (0.04)	0.2 (0.05)***	0.56	1.66
$K = 5$	0.06 (0.04)	0.17 (0.05)***	0.56	1.66
$K = 6$	0.06 (0.04)*	0.15 (0.05)***	0.55	1.65
$K = 7$	0.07 (0.04)*	0.13 (0.05)***	0.55	1.65
$K = 8$	0.07 (0.03)**	0.13 (0.04)***	0.55	1.65
$K = 9$	0.07 (0.03)**	0.12 (0.04)***	0.55	1.65
$K = 10$	0.06 (0.03)**	0.13 (0.04)***	0.55	1.65
$K = 11$	0.07 (0.03)**	0.15 (0.04)***	0.55	1.65
$K = 12$	0.07 (0.03)**	0.16 (0.04)***	0.55	1.65
$K = 13$	0.07 (0.03)**	0.17 (0.04)***	0.55	1.66
$K = 14$	0.07 (0.03)**	0.19 (0.05)***	0.55	1.67
$K = 15$	0.07 (0.03)**	0.22 (0.05)***	0.56	1.67
$K = 16$	0.08 (0.03)**	0.24 (0.05)***	0.56	1.68
$K = 17$	0.08 (0.03)**	0.27 (0.06)***	0.55	1.67
$K = 18$	0.08 (0.04)**	0.31 (0.07)***	0.55	1.67
$K = 19$	0.08 (0.04)*	0.35 (0.07)***	0.54	1.66
$K = 20$	0.09 (0.05)*	0.36 (0.08)***	0.54	1.64
$K = 21$	0.1 (0.05)*	0.35 (0.08)***	0.53	1.63
$K = 22$	0.1 (0.06)*	0.34 (0.08)***	0.53	1.63
$K = 23$	0.1 (0.06)	0.34 (0.08)***	0.53	1.63
$K = 24$	0.12 (0.07)*	0.32 (0.09)***	0.52	1.62
$K = 25$	0.17 (0.08)*	0.28 (0.1)***	0.51	1.61
$K = 26$	0.22 (0.09)**	0.3 (0.11)***	0.51	1.61
$K = 27$	0.25 (0.1)**	0.39 (0.12)***	0.52	1.63
$K = 28$	0.23 (0.1)**	0.66 (0.14)***	0.55	1.69
$K = 29$	0.17 (0.09)*	0.64 (0.13)***	0.55	1.71
$K = 30$	0.16 (0.08)*	0.55 (0.12)***	0.55	1.72
$K = \bar{K}$	0.08 (0.05)	0.31 (0.07)***	0.56	1.66

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. Standard errors are in parenthesis.

Table A2. Regressions with Accumulated Shocks[a]

No. of accumulated shocks	*CITT*	*CITT × EMERGING*	*Adjusted* R^2	*Durbin-Watson*
1 shock	–0.09 (0.09)	–0.05 (0.13)	0.50	1.65
2 shocks	–0.12 (0.07)*	0.44 (0.1)***	0.54	1.72
3 shocks	0.08 (0.05)	0.31 (0.07)***	0.56	1.66
4 shocks	0.15 (0.04)***	0.18 (0.06)***	0.53	1.71

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
*** Statistically significant at the 1 percent level.
a. Standard errors are in parenthesis.

Appendix B
Granger Causality Test

In this appendix, we use Granger causality tests for the relationship between GDP per capita and government expenditure. We start by testing whether GDP per capita causes government expenditure (with three lags) and then this hypothesis again after adding fixed effects for the different countries. Finally, we run a full regression including all the control variables used in our paper—namely, dlog(POP), POP15 + POP65, HyperInfl, and RATIO. The null hypothesis is that each of the coefficients of GDP per capita up to three lags equals zero. It is rejected in all three specifications.

To check reverse causality, we test all three specifications replacing the dependent variable with GDP per capita. The null hypothesis is that each of the coefficients of government expenditure up to three lags equals zero. The null hypothesis cannot be rejected in any of the three specifications at 5 percent significance. The table B1 summarizes the results.

Table B1. Results of Granger Causality Tests

Causality test and type of regression	*F statistic*	*Significance level*	*Result*
GDP per capita does not cause G			
Simple Granger causality	14.0	Under 1%	The null hypnosis can be rejected
With cross-section fixed effects	11.4	Under 1%	The null hypnosis can be rejected
Full regression	14.2	Under 1%	The null hypnosis can be rejected
G does not cause GDP per capita			
Simple Granger causality	1.87	14%	The null hypnosis cannot be rejected
With cross-section fixed effects	1.96	12%	The null hypnosis cannot be rejected
Full regression	2.19	9%	The null hypnosis cannot be rejected

Source: Authors' elaboration.

Appendix C
Alternative Instruments

In this section, we discuss the sensitivity of the results to our basic instrumental variable—namely, the logarithmic change in countries' exports at constant dollars. Since our instrumental variable is based on a three-year moving average (consistent with the length chosen for the explanatory variable), it is centered at a lag of one and a half years. This feature avoids a contemporary endogeneity with the left-hand variable (the logarithmic change of government expenditure) through the exchange rate channel.[6] However, since the last year of the moving average is contemporary with the left-hand-side variable, we need to check the sensitivity of the results to an alternative instrumental variable, based on the one-period lagged moving average.

Table C1 shows the results for total government expenditure, government consumption, transfers, and capital expenditure, using the regression specification shown in the last column of table 3. The results follow a similar pattern to the results shown in table 3: emerging economies have a clearly more procyclical pattern for total government expenditure and government consumption than developed economies (although here the coefficient of total expenditure for this group of countries is significant), transfers are procyclical in hard times, and capital expenditure is procyclical for both groups.

6. This channel would be relevant to the extent that government expenditure affects the real exchange rate and the real exchange rate affects exports. The existing empirical literature on the relationship between government expenditure and the real exchange rate shows a contemporary correlation between these two variables: see De Gregorio, Giovannini, and Wolf (1994), Lee, Milesi-Ferretti, and Ricci (2008), and Galstyan and Lane (2009). The last two papers use a dynamic specification with one lag and one forward period; that is, they are centered on the contemporaneous correlation.

Table C1. Total Government Expenditure and Its Composition[a]

	Dependent variable			
Explanatory variable	*dlog(G)* *(1)*	*dlog(GC)* *(2)*	*dlog(GT)* *(3)*	*dlog(GI)* *(4)*
Constant	0.04	−0.02	0.003	0.18
	(0.05)	(0.04)	(0.06)	(0.12)
dlog(POP)	1.91	1.42	1.47	5.66
	(0.48)***	(0.45)***	(0.69)**	(1.31)***
POP15 + POP65	−0.0003	0.001	0.001	−0.002
	(0.001)	(0.001)	(0.002)	(0.003)
RATIO	0.002	0.004	−0.004	−0.11
	(0.03)	(0.02)	(0.03)	(0.07)*
HyperInfl	−0.01	−0.01	−0.05	−0.04
	(0.01)	(0.01)	(0.02)***	(0.03)
DU			0.01	
			(0.002)***	
$\bar{K}$	−0.03	−0.03	−0.01	−0.08
	(0.01)***	(0.01)***	(0.01)	(0.02)***
EMERGING	−0.02	−0.03	−0.01	−0.14
	(0.02)	(0.01)**	(0.02)	(0.04)***
$G^{-} \times Y^{-}$	−0.01	0.001	−0.02	−0.02
	(0.01)	(0.01)	(0.01)	(0.02)
CITT	0.26	0.27	0.02	0.89
	(0.07)***	(0.06)***	(0.08)	(0.18)***
EMERGING × CITT	0.38	0.36	0.08	0.01
	(0.1)***	(0.09)***	(0.13)	(0.26)
EMERGING × CITT × $D(90)$	−0.18	−0.12	0.16	−0.06
	(0.07)***	(0.07)*	(0.11)	(0.19)
EMERGING × CITT × $G^{-} \times Y^{-}$	0.22	0.17	0.52	−0.12
	(0.12)*	(0.12)	(0.2)***	(0.31)
EMERGING × CITT × $D(90) \times G^{-} \times Y^{-}$	−0.62	−0.16	−0.08	−0.46
	(0.24)***	(0.24)	(0.57)	(0.64)
Summary statistic				
No. observations (unbalanced)	1,217	1,198	1,049	1,173
Adjusted R^2	0.52	0.54	0.45	0.52
Durbin-Watson	1.63	1.74	1.66	1.76

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The estimation method is GMM. The instrumental variable is constant-dollar exports with a one-year lag. The sample period is from 1971 to 2006. Standard errors are in parenthesis.

In table C2, we use an alternative instrumental variable, introduced by Panizza and Jaimovich (2007) and used also by Ilzetzki and Végh (2008), which is based on the weighted average of real GDP growth of the main export partners.[7] Data restrictions shrink our sample considerably from 1983 onward, so we are constrained to using the regressions shown in column 3 of tables 3, 4 and 5 (that is, excluding the dummy for the period after the 1990s). Here again, results are fairly similar, except for a significant procyclical reaction of total government expenditure in developed countries.

Table C2. Total Government Expenditure and its Composition[a]

	Dependent variable			
Explanatory variable	*dlog(G)* *(1)*	*dlog(GC)* *(2)*	*dlog(GT)* *(3)*	*dlog(GI)* *(4)*
Constant	0.11 (0.05)**	0.05 (0.06)	0.04 (0.08)	0.32 (0.14)**
dlog(POP)	1.63 (0.59)***	1.72 (0.66)***	1.37 (0.89)	4.75 (1.56)***
POP15 + POP65	−0.01 (0.03)	−0.002 (0.03)	−0.01 (0.04)	−0.13 (0.07)*
RATIO	−0.02 (0.01)*	−0.04 (0.01)***	−0.06 (0.02)***	−0.03 (0.04)
d*U*			0.01 (0.002)***	
HyperInfl	−0.02 (0.01)**	−0.02 (0.01)**	−0.002 (0.01)	−0.06 (0.02)***

7. The main export partners of a country are defined as the countries that receive at least 5% of total exports. The second criterion requires that the main export partners together comprise at least 50% of the country's exports. If the countries receiving more than 5% of exports together do not account for 50% of total exports, then smaller trading partners are included. For example, a country that has only one export partner that accounts for over 50 percent of its total exports (such as Canada and Mexico) will have only one main export partner in our calculation. Other countries that have less centralized export characteristics may have six or seven main trading partners, with some of them accounting for less then 5 percent of total exports. The weighted average of the GDP growth rate is based on the export partners' weights in total exports. We normalized the weights so the sum equals one.

Table C2. (continued)

	Dependent variable			
Explanatory variable	*dlog(G)* *(1)*	*dlog(GC)* *(2)*	*dlog(GT)* *(3)*	*dlog(GI)* *(4)*
$\bar{K}$	−0.01	−0.004	−0.02	−0.02
	(0.01)	(0.01)	(0.01)	(0.02)
EMERGING	−0.01	−0.03	0.0003	−0.11
	(0.02)	(0.02)	(0.02)	(0.04)***
$G^{-} \times Y^{-}$	−0.01	−0.004	−0.02	−0.02
	(0.01)	(0.01)	(0.01)	(0.02)
CITT	0.18	0.24	0.03	0.59
	(0.06)***	(0.07)***	(0.08)	(0.15)***
EMERGING × CITT	0.26	0.27	0.30	0.23
	(0.08)***	(0.09)***	(0.13)**	(0.21)
EMERGING × CITT × $G^{-} \times Y^{-}$	−0.06	−0.16	0.11	−0.15
	(0.13)	(0.12)	(0.25)	(0.38)
Summary statistic				
No. observations (unbalanced)	878	863	843	762
Adjusted R^2	0.50	0.55	0.43	0.48
Durbin-Watson	1.60	1.72	1.65	1.84

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The estimation method is GMM. The instrumental variable is the weighted average of the real GDP growth of the main export partners (normalized so that the weights sum to one) multiplied by exports as a percent of GDP. The sample period is from 1983 to 2006. Standard errors are in parenthesis.

APPENDIX D
Country Fixed Effects

Controlling for the random walk component in the main regressions technically impedes us from using country fixed effects. To check the sensitivity of the results to the use of the random walk, we replaced the random walk component with country fixed effects, using different values of K. This test is performed using the specification in column 5 of table 3; the results confirm our main hypothesis (see table D1).

Table D1. Using Country Fixed Effects[a]

Explanatory variable	$K = 7$ *(1)*	$K = 9$ *(2)*	$K = 11$ *(3)*	$K = \bar{K}$ *(4)*
Constant	–0.11 (0.06)*	–0.12 (0.06)**	–0.14 (0.06)**	–0.13 (0.06)**
dlog(POP)	1.56 (0.63)**	1.49 (0.61)**	1.44 (0.61)**	1.69 (0.65)***
POP15 + POP65	0.002 (0.001)	0.002 (0.001)*	0.003 (0.001)**	0.002 (0.001)*
RATIO	0.08 (0.05)	0.08 (0.05)	0.08 (0.05)*	0.08 (0.05)
HyperInfl	–0.03 (0.01)**	–0.03 (0.01)*	–0.01 (0.02)	–0.02 (0.01)
$G^{-} \times Y^{-}$	–0.01 (0.01)	–0.01 (0.01)	–0.01 (0.01)	–0.01 (0.01)
CITT	0.13 (0.05)**	0.13 (0.05)**	0.11 (0.05)**	0.19 (0.08)**
EMERGING × CITT	0.21 (0.08)***	0.20 (0.07)***	0.29 (0.08)***	0.46 (0.12)***
EMERGING × CITT × $D(90)$	–0.10 (0.04)**	–0.09 (0.04)**	–0.10 (0.04)**	–0.16 (0.07)**
EMERGING × CITT × $G^{-} \times Y^{-}$	0.16 (0.07)**	0.16 (0.07)**	0.14 (0.07)**	0.21 (0.12)*
EMERGING × CITT × $G^{-} \times Y^{-} \times D(90)$	–0.28 (0.18)	–0.33 (0.17)**	–0.41 (0.18)**	–0.60 (0.25)**

Table D1. (continued)

Explanatory variable	$K = 7$ *(1)*	$K = 9$ *(2)*	$K = 11$ *(3)*	$K = \bar{K}$ *(4)*
Summary statistic				
No. observations	1,217	1,217	1,217	1,217
Adjusted R^2	0.53	0.53	0.52	0.53
Durbin-Watson	1.63	1.63	1.62	1.62

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(G). The estimation method is GMM, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

Appendix E
Arellano-Bond Regressions

The regressions could be affected by possible endogeneity arising from the effect of government expenditure on GDP. To verify whether this is the case, we estimate the regressions presented in table 3 with a dynamic Arellano-Bond method, using the dynamic instrument for the CITT variable—namely, dlog(RealExports)—with a two-year lag. The results are shown in table A7, and they confirm our main results.

Table E1. An Arellano-Bond Specification

Explanatory variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
dlog(POP)	1.71 (0.08)***	1.61 (0.1)***	1.49 (0.1)***	1.59 (0.12)***	1.95 (0.36)***
POP15 + POP65	0.004 (0.0004)***	0.004 (0.0003)***	0.003 (0.0003)***	0.004 (0.001)***	0.003 (0.001)***
RATIO	0.08 (0.02)***	0.06 (0.04)*	0.06 (0.04)*	0.07 (0.04)*	0.07 (0.09)
HyperInfl	–0.14 (0.1)	–0.09 (0.04)**	–0.09 (0.04)**	–0.05 (0.04)	–0.17 (0.79)
CITT	0.12 (0.01)***	0.01 (0.01)	–0.001 (0.01)	0.01 (0.01)	–0.01 (0.02)
EMERGING × CITT		0.26 (0.02)***	0.31 (0.02)***	0.20 (0.02)***	0.22 (0.02)***
EMERGING × CITT × $D(90)$			–0.06 (0.01)***		–0.28 (0.77)
EMERGING × CITT × G^{-} × Y^{-}				0.58 (0.06)***	0.53 (0.01)***
EMERGING × CITT × $D(90)$ × G^{-} × Y^{-}					–1.83 (3.0)
Summary statistic					
No. observations	1,240	1,223	1,223	1,223	1,223
Hansen J statistic	37.32	36.47	34.62	37.44	35.71
Null hypothesis: the model is valid			Cannot be rejected		

Source: Authors' elaboration.
* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
a. The dependent variable is dlog(G). The estimation method is dynamic Arellano-Bond, and the sample period is from 1971 to 2006. Standard errors are in parenthesis.

Appendix F

Classification of Emerging Markets, Data Coverage, and Sources

In the regressions, we base our analysis on 22 developed economies (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden Switzerland, the United Kingdom, and the United States) and 23 emerging markets (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Egypt, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, South Africa, Thailand, Turkey, Uruguay, and Venezuela). The choice of emerging markets is based on two indexes (as defined at the end of our sample period, in 2006): MSCI and FTSE.

The MSCI Emerging Markets Index includes the following countries (the countries in bold are included in our sample): **Argentina, Brazil**, **Chile,** China, **Colombia**, the Czech Republic, **Egypt, Hungary, India, Indonesia,** Israel, Jordan, **Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, the** Philippines, Poland, Russia**, South Africa,** Taiwan**, Thailand, Turkey, and Venezuela.** The countries that are not in bold (excluding Israel) are not included because they have insufficient data on government expenditure for the full sample period. Israel is excluded from the sample because it has since been upgraded to a developed market classification.[8] Argentina, Pakistan, and Venezuela have been downgraded from the MSCI index in 2006, but they are still included in our sample.

The FTSE Emerging Markets Index is similar to the MSCI index except that it does not include Korea and Venezuela. Five countries are included in the sample that are not officially classified as emerging markets: Bolivia, Costa Rica, the Dominican Republic, Panama, and Uruguay.

Three countries were dropped from some of the regressions. Mexico was dropped from transfers and subsides and from total expenditure because local government data were not available. Data are available for government consumption and capital expenditure,

8. Strawczynski and Zeira (2007) show that fiscal policy in Israel has evolved from strongly procyclical to mildly procyciclical since 1985.

however, so the country was not dropped in those regressions. Chile was dropped from regressions on government total expenditure and on transfers and subsidies because data on transfers between governments are not available. Finally, Colombia was dropped from the transfers and subsidies regressions since we did not have enough observations.

The data used in this research are taken from several databases. Table F1 summarizes the sources for the different variables used.

Table F1. Data Coverage and Sources

Variable name	*Coverage*[a]	*Source*
Total government expenditure and composition		
Developed markets	1960–2006	OECD Historical Statistics; OECD Economic Outlook
Emerging markets	1972–2006	IMF Government Finance Statistics (GFS)
GDP: Gross domestic product	1960–2006	OECD Historical Statistics; IMF International Financial Statistics (IFS); and World Bank World Development Indicators (WDI)
RATIO	1960–2006	The Conference Board and Groningen Growth and Development Centre, Total Economy Database (except for Panama, which is based on WDI data for the period 1980–2006)
POP15: Population under 15 years old	1960–2006	WDI
POP65: Population over 65 years old	1960–2006	WDI
FDI	1970–2006	U.N. Conference on Trade and Development (UNCTAD), with supplemental data from IFS for Indonesia and Panama

Table F1. (continued)

Variable name	*Coverage*[a]	*Source*
Government debt: total, domestic and foreign		
Developed markets	1970–2006	GFS; OECD Historical Statistics
Emerging markets in Latin America, South Africa, and Pakistan.		
Rest of emerging markets	1972–2006	GFS, with supplemental data from Panizza (2008)
International reserves and imports	1960–2006	IFS
Export data		
Exports as % of GDP and in constant dollars.	1960–2006	WDI
Export partners.	1980–2006	IMF Direction of Trade Statistics (DOTS)

Source: Authors' elaboration.

a. For some countries, coverage is partial.

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