Global Liquidity, Spillovers to Emerging Markets and Policy Responses

Claudio Raddatz, Diego Saravia,
and Jaume Ventura
editors

Central Bank of Chile / Banco Central de Chile

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Global Liquidity, Spillovers to Emerging Markets and Policy Responses: An Overview

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Global liquidity has become a popular concept in academic and policy discussions of recent years. This concept captures overall "ease of financing" prevalent in the world economy (Caruana, 2013) and it is usually mentioned as a possible cause of capital inflows, global imbalances, excessive credit expansion, high asset prices, and exchange rate appreciations that could pose risks for price and financial stability around the world, but most particularly in emerging market economies.

The importance of global liquidity in academic and policy discussions suggests that global liquidity and its drivers are not only relevant but also determinant for international financial stability, both in the build-up phase for vulnerabilities and when any resulting financial imbalances unwind. With increasing financial integration, global financial conditions have a growing impact on domestic economic conditions, affecting international capital flows and the dynamics of credit, financial asset and property prices in financially integrated economies. Global liquidity can also contribute

The papers that comprise the different chapters of this volume were presented in the XVII Annual Conference on Central Banking that took place at the Central Bank of Chile, Santiago, during November 15 and 16, 2013. We thank assistance of Rolando Campusano.

to the build-up of financial system vulnerabilities in economies with distorted financial markets, which may result in large mismatches across currencies and maturities. Periods of lax financial conditions have usually been followed by periods of lower liquidity. Shortages of global liquidity can have major implications for economic growth, as was experienced in the 2008–09 period.

Global liquidity spreads through international financial flows (e.g. cross-border credit provision and foreign currency lending), which are determined by choices made in both source and recipient economies and by public and private sectors. Global liquidity conditions are the result of interactions among macroeconomic factors (including economic growth), monetary policy, exchange rate regime, capital account policies, public sector policies (including financial regulation) and financial factors that guide the behavior of financial market participants and intermediaries, such as financial innovation and risk appetite.

Both macroeconomic and financial factors change and interact in complex ways, blurring the distinction between driving factors and their associated transmission or amplification mechanisms. This volume contributes to the extensive literature (e.g. Forbes and Warnock, 2012; Fratzscher et al., 2012) that tries to understand the individual and combined effects on global liquidity of its various drivers. In particular, Burnside discusses one avenue through which low interest rates in advanced countries may channel capital toward emerging markets' carry trade flows.

Concerns about global liquidity come from the potential spillovers that it can create through global imbalances, credit expansion, pressures on asset and commodity prices, and exchange rate appreciations in emerging markets. These spillovers, coupled with structural exposure, may result in vulnerabilities for financial stability at the local and global levels. In this volume, García-Cicco et al. analyze structural exposure, and Ventura and Martin and Kalemli-Ozcan address some of the potential global liquidity spillovers to emerging markets.

Global liquidity has a pronounced cyclical nature, while being subject to occasional shocks. This, in turn, implies a twofold objective for policymaking from a financial stability perspective. Firstly, to mitigate global private liquidity surges and cycles and their associated credit and asset price surges,[1] and secondly, to quickly

1. Private liquidity mainly corresponds to the provision of credit by private entities.

respond to sudden shortages of global liquidity and associated disruptions in financial systems and economic growth. To this end, policymakers count with a battery of policy measures including macroprudential policies and the provision of public liquidity.[2]

The strengthening of regulatory frameworks is the first line of defense against the fluctuations in global liquidity. By enhancing the resilience and dampening the procyclicality of the financial system, the frequency and severity of negative liquidity shocks are likely to be reduced. The overall effect remains difficult to assess with certainty,[3] and Costinot et al. and Chamon et al. provide some evidence to help in this task. The first of the mentioned papers looks at capital controls from a different perspective and studies their role in the dynamic manipulation of the terms of trade. The second paper studies the desirability of sterilized interventions under inflation targeting.

As soon as a liquidity boom occurs, macroprudential measures and central bank liquidity provision could be needed to mitigate the effects of an excess of capital flows into a fragile economy. One issue is the extent to which individual countries will want to insure themselves against liquidity shocks by building sufficiently large stocks of foreign reserves. Under most conditions, a situation of abundant capital inflows and low global interest rates is good for developing countries. Theory tells us that, in the absence of frictions, international capital flows not only contribute to expand a country's productive capacity but also allow its citizens to share risk with the rest of the world. However, the presence of pecuniary externalities, inefficient fluctuations in credit standards, or other types of financial frictions, may lead to perverse situations where these inflows result in excessive credit growth, risk taking, or misallocation of capital.

An important body of recent research has been devoted to understanding how an economy may borrow in excess and misallocate credit.[4] Of course, if we believe that these frictions are present and strong, first-best policy actions should aim to undo them. But this may not be feasible, either because we are unsure about the presence,

2. Official liquidity is that provided by institutions such as central banks via their standard operations in money markets and reserve accumulation, by international financial institutions, through their credit lines, or by central governments through their sovereign wealth fund savings.

3. Lim et al. (2011) and Tovar et al. (2012) are two of the many papers that have tried to quantify the impact of various macro-prudential policies.

4. Bianchi (2011), Korinek (2011), Dell'Ariccia et al. (2013).

type, or magnitude of the frictions involved, or because first-best policies cannot be implemented in the timeframe required.

Global liquidity in the decade preceding the 2008 crisis was associated with an increase of global imbalances between countries. The pre-crisis period was characterized by an increase in the dispersion of current account deficits, excessive capital flows and greater cross-border financial holdings, particularly for advanced economies and a global financial environment with low risk aversion and low volatility. Two papers included in this volume assess the global imbalances phenomenon using empirical or theoretical approaches. Bacchetta and Benhima theoretically examine how corporate saving in emerging markets is contributing to global rebalancing. Lane and Milesi-Ferreti review the recent dynamics of global imbalances and examine the cross-country variation in external adjustment over the 2008-2012 period.

As briefly mentioned in the discussion above, this volume is a collection of nine papers that were presented at the Seventeenth Annual Conference of the Central Bank of Chile, which took place in Santiago on November 15 and 16, 2013. The event brought together leading economists from academia and central banks who discussed global liquidity, its spillovers to emerging markets and policymakers' responses.

The rest of this overview highlights these articles and their contribution to the discussion of and literature on global liquidity, its spillovers to emerging economies, and how policy responses affect and are affected by this phenomenon.

Global liquidity drivers and characteristics

The interest rate differential is one of the theoretical drivers of capital flows among countries. Under some conditions, this differential may lead to carry trade which constitutes a relevant channel of global liquidity and global and current account imbalances. Craig Burnside studies the relationship between interest rate differentials, currency carry trade and capital flows, Lane and Milesi-Ferreti and Bacchetta and Benhima analyze how global imbalances behaved in the former financial crisis, and why.

Burnside revisits the evidence of currency carry trades, exploring their relationship to the uncovered interest parity puzzle and the behavior of risk premia. Contrary to the standard prediction of the uncovered interest rate parity condition–a building block of many international macro models, he finds that carry trade is profitable in both developed and developing countries; however, there is stronger evidence against uncovered interest rate in the first group of countries than in the second. Also, the risk factors that explain the returns to carry trade in developed countries do not seem to work in explaining these returns in developing countries. Although the relationship between the interest rate differential and capital flows is statistically significant, he finds that it is quantitatively small, which would suggest that the interest rate differential is not a source of destabilizing capital flows.

Lane and Milesi-Ferreti study whether the adjustment in current account imbalances was the result of cyclical factors, including the initial decline in aggregate demand in deficit countries, like the United States and the European periphery, and the initial decline in commodity prices, or rather the adjustment process was more protracted and consistent with a stronger structural process. They document a significant narrowing of the global imbalances in the current accounts following the financial crisis of 2008 and project a further compression of current accounts into the following years. However, they note that, in spite of this compression, stock (creditor and debtor positions) imbalances have continued to expand in relation to GDP which may be indicative that the current account corrections are not definitively implying the end of the global imbalances era.

They also find that pre-crisis current account gaps and pre-crisis external positions help explain an important part of subsequent differences in demand growth between countries. They show that real exchange rates did not move in a stabilizing direction to a modest extent, but rather the adjustment in current account imbalances came from costly declines in aggregate demand and output in high deficit countries. Finally, they document that only in countries that do not peg their currencies is there a correlation between monetary policy changes during the crisis period and initial imbalances. Countries without a peg see their interest rates drop by more the higher their deficit is. All in all, the authors interpret the evidence as signaling that the narrowing of large external imbalances would be particularly costly in deficit countries that lack monetary autonomy.

Bachetta and Benhima focus on corporate savings to analyze global imbalances. The relevance of the issue comes from the fact that global imbalances were associated with an increase in savings in developing Asian countries and part of this increase came from the corporate sector. The authors extend their own previous work and present a model with a developed country and an emerging country with borrowing constraints and liquidity needs, where both countries differ in their level of credit tightness. The authors consider three shocks that lead to global rebalancing: a credit crunch, a growth slowdown in the developed country, and a growth slowdown in the developing one.

The authors found heterogeneity in the effects of these three shocks on the interest rate. The shocks originating in the developed country lead to a decline in the interest rate while the shock to the developing country ended up in an increase of the interest rate. This suggests that the initial phase of the rebalancing was associated with lower pressure on real interest rates while the latest phase was associated with an increase in world interest rates. Also a slower growth in the emerging country improves the trade balance of the developed country.

The need for liquid assets in the emerging country implies a new channel of international transmission. A decrease in the world interest rate has a negative impact on surplus economies having liquid assets. This effect should be combined with the positive effects that a reduction in interest rates has in countries in need of collateral, and the substitution effect of labor and capital. An interesting aspect of the model is a positive output co-movement in the presence of productive shocks.

Global Liquidity spillovers and consequences in an integrated world

On many occasions, capital inflow episodes have concluded in sudden stops and sharp currency depreciations that were accompanied by recessions and crises. This volume comprises several papers on this issue. While García-Cicco et al. explore how important these effects are to explain business cycle fluctuations in emerging countries, Ventura and Martin and Kalemli-Ozcan address some of the potential consequences of the capital inflows to financially integrated emerging economies though analyzing the appearance of asset price bubbles and the transmission of foreign shocks.

García-Cicco, Kirchner and Justel study the role of financial frictions in the propagation of credit shocks. To do this, they set up a DSGE model with two financial frictions: the first one is the relationship between banks and borrowers, and the second one between depositors and banks. Then they evaluate the behavior of the model using Chilean data from 2001 to 2012 period. In the estimated model, foreign shocks play an important role in explaining relevant variables such as GDP, consumption, trade balance and risk premium. However, the role of these shocks is limited with respect to inflation, the monetary policy interest rate, and the real exchange rate. The authors find that domestic financial frictions are relevant for the propagation of foreign shocks. They also show that, in the presence of domestic financial frictions, the contribution of external factors in explaining the evolution of some macro variables during the 2008-2009 recession is larger and significantly different than in a model without these frictions. These results suggest that small open economies with some level of domestic financial frictions (like Chile) are vulnerable to financial shocks like a global liquidity episode with large capital inflows and then a sudden stop.

Ventura and Martin set up a model to analyze the interactions of capital flows, low interest rates and asset bubbles and their effect on macroeconomic performance. They show that the effects of bubbles on economic activity depend on the circumstances the country is facing. When the supply of funds from international markets is high, bubbles raise net capital inflows, investment and growth. When foreign financing dries up (sudden stop), bubbles have a negative effect on net capital inflows and economic activity. A conclusion of this work is that the bubble that attains the optimal level of investment should be large during normal times and small during sudden stops. Since bubbles are driven by expectations, there is a role for government policies (capital controls) to achieve the desired bubble allocation. They claim that the government should subsidize gross capital outflows and tax gross capital inflows during normal times while adopting the opposite policy during sudden stops. The environment of low interest rates used in the analysis is key in concluding these policy prescriptions that are not what is usually inferred from other contributions in the literature.

Kalemli-Ozcan empirically studies the role of global banks in transmitting the global crisis to emerging markets. She finds a negative relationship between banking integration and synchronization of output cycles in crisis periods. However, this relationship turns positive in tranquil times. Interestingly, she also finds that this correlation is driven mainly by linkage between countries in the developed world. When considering financial links between emerging countries, the findings indicate that the correlation becomes positive.

The author concludes that these findings are consistent with the theory that indicates that in complete markets, financial integration creates divergences under real shocks (tranquil times) and convergence under financial shocks. The disappearance of the negative shock in developing countries' linkages would be in tune with the existence of frictions in international financial markets that hinder capital flows. She also concludes that there was a contagion among the emerging markets that was financially linked, although the crisis was not transmitted to them from advanced economies via financial markets.

Effectiveness and convenience of policy responses to face global liquidity

As observed, episodes of capital inflows combined with distortions may lead an economy into undesirable situations. Consequently, policymakers have implemented not only traditional monetary policy, but also interventions in forex markets, capital-account-management and macro prudential policies. In this volume, Obstfeld, Costinot et al., and Chamon et al. analyze different effects of policies of this kind over the moderation of spillovers to emerging economies producing global financial shocks.

Obstfeld evaluates the capacity of emerging market economies to moderate the domestic impact of global financial and monetary forces through their own monetary policies. Those economies, able to exploit a flexible exchange rate, are far better positioned than those that devote monetary policy to fixing the rate (a reflection of the classical monetary policy trilemma).[5] However, exchange rate changes alone do not insulate economies from foreign financial and monetary shocks. While potentially a potent source of economic benefits, financial globalization does have a downside for economic management: it worsens the tradeoffs monetary policy faces in navigating among multiple domestic objectives. This drawback of globalization raises the marginal value of additional tools of macroeconomic and financial policy. Unfortunately, the availability of such tools is constrained by a financial policy trilemma, distinct from the monetary trilemma. This second trilemma posits the incompatibility of national responsibility

5. Rey (2013) argues that the monetary trilemma is really a dilemma, because emerging economies can exercise no monetary autonomy from United States policy (or the global financial cycle) unless they impose capital controls.

for financial policy, international financial integration, and financial stability.

Costinot, Lorenzoni and Werning look at policies that affect countries' saving decisions and compare these policies with more standard protectionist policies like a temporary import tariff. They show that policies affecting saving keep the real exchange rate undervalued, depressing imports and stimulating exports. Although both policies reduce current imports, the first one entails short-run welfare losses for the domestic country and short-run welfare gains for the trading partner, while the second policy has the opposite welfare effects.

Chamon, Ghosh and Ostry analyze the interaction of inflation-targeting regimes and exchange rate interventions.[6] They argue that interventions need not undermine central banks' credibility provided that they communicate clearly the primacy of the inflation target over the desire to stabilize shocks that move the exchange rate away from its fundamental value. Moreover, by acknowledging the exchange rate instrument, central banks may actually enhance their credibility, as this second instrument provides more room to smooth shocks to the exchange rate in a way consistent with the inflation target.

6. It is common in developing countries to intervene in the exchange rate market when the exchange rate fluctuates considerably. For example, in the capital inflow episode before the crisis, some developing countries saw their currency appreciated and there were central banks that decided to accumulate reserves in response to this phenomenon. Accumulating reserves is a costly strategy in terms of interest rate differentials, however big fluctuations in exchange rates may be costly in emerging economies because of distortions like currency mismatches for example. Thus, a possibility is that inflation-targeting emerging economies would jeopardize their inflation target if they incorporated the exchange rate target in their objectives. Inflation credibility may be at stake, which would impede a successful inflation-targeting regime.

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Trilemmas and Tradeoffs: Living with Financial Globalization

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This paper evaluates the capacity of emerging market economies (EMEs) to moderate the domestic impact of global financial and monetary forces through their own monetary policies. I present the case that those EMEs able to exploit a flexible exchange rate are far better positioned than those that devote monetary policy to fixing the rate—a reflection of the classical monetary policy trilemma. Indeed, this ability was critically important in EMEs' widely successful response to the Global Financial Crisis (GFC) of 2007-2009.

However, exchange rate changes alone do not insulate economies from foreign *financial* and monetary developments. While potentially a potent source of economic benefits, financial globalization does have a downside for economic management. It worsens the tradeoffs monetary policy faces in navigating among multiple domestic objectives. This drawback of globalization raises the marginal value of additional tools of macroeconomic and financial policy.

Unfortunately, the availability of such tools is constrained by a financial policy trilemma, distinct from the monetary trilemma. The second trilemma posits the incompatibility of national responsibility for financial policy, international financial integration, and financial

An earlier and shorter version of this paper was presented at the 17th Annual Conference of the Central Bank of Chile, Santiago, Chile (November 2013). I thank Sandile Hlatshwayo for long-suffering research assistance and comments, and the Risk Research Center at UC Berkeley for financial support. Menzie Chinn, Pierre-Olivier Gourinchas, and Jay Shambaugh also provided helpful comments, as did participants in a seminar at the University of Chicago's Becker-Friedman Institute. For further helpful insights, I thank my discussants at the Inaugural Asian Monetary Policy Forum (May 2014), Claudio Borio and Jonathan Ostry, as well as my discussants at the 13th BIS Annual Conference (June 2014), Otmar Issing and Takatoshi Ito, Gong Cheng, Menzie Chinn, Michael Klein, Gian Maria Milesi-Ferretti, and Jay Shambaugh graciously provided data. All errors are mine.

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stability. It therefore impedes effective national prudential policies when capital markets are open to cross-border transactions.[1]

My argument that independent monetary policy is feasible for financially open EMEs, but limited in what it can achieve, takes a middle ground between more extreme positions in the debate about monetary independence in open economies. On one side, Woodford concludes: "I find it difficult to construct scenarios under which globalization would interfere in any substantial way with the ability of domestic monetary policy to maintain control over the dynamics of inflation."[2] However, his pre-GFC analysis leaves aside financial-market imperfections and views inflation targeting as the only objective of monetary control. On the other side, Rey (2013) argues that the monetary trilemma is really a dilemma, because EMEs can exercise no monetary autonomy from United States policy (or the global financial cycle) unless they impose capital controls.

The outline of this paper is as follows. First, I present an overview of the capital flow problem for EMEs. Then, I review mechanisms through which monetary policies and the financial cycle in advanced economies, especially in the U.S., are transmitted to EMEs. One potent mechanism works through interest rate linkages, but financial conditions can also migrate through other channels. Thus, there is a global financial cycle that does not coincide with global monetary-policy shifts (Borio, 2012; Bruno and Shin, 2013; Rey, 2013), and exchange-rate changes alone do not fully offset its effects. The next section sets out empirical evidence on interest rate independence in EMEs, adding to the existing literature by analyzing long-term interest rates. The results leave no doubt that countries that do not peg their exchange rates exercise considerable monetary autonomy at the short end of the term structure; but long-term interest rates are more highly correlated across countries, with little regard for the exchange-rate regime.

In the penultimate section, I describe the relationship between policy trilemmas and tradeoffs in open economies. I present my argument that the fundamental problem for open EMEs is not ineffective monetary policy, per se. The problem is a more difficult tradeoff among multiple objectives, the result of a shortage of reliable policy instruments for attaining those objectives simultaneously.[3]

1. See Schoenmaker (2013) for a broad survey.

2. See p.14 of Woodford (2010).

3. In a closely related spirit, Filardo, Genberg, and Hofmann (2014) propose a "three-pillar" policy strategy for emerging economies—one that navigates among price stability, financial stability, and exchange rate goals.

A brief final section outlines future research directions and also describes how some limited initiatives in international policy cooperation might soften the harsh tradeoffs that EMEs now face.

1. Overview

Since the nineteenth century, emerging and frontier regions have been subject to the ebb and flow of lending from richer countries. Even in the last century, powerful lending cycles buffeted those regions in the 1920s, the 1970s through the early 1980s, the early 1990s, the mid-2000s, and after 2009.

However, with the development of emerging financial markets and the general expansion of global finance, recent decades have revealed some new patterns. First, many emerging countries, which Nurkse (1954) ruled out as portfolio investment destinations based on their colonial history, now receive such flows. Perhaps history is not always destiny after all. Second, even emerging economies with persistent current account surpluses—including several Asian economies—may experience *gross* capital inflow surges, the result of rich-country portfolio shifts in favor of emerging assets. Where these portfolio demands are accommodated through the home central bank's intervention, the financial inflows finance foreign reserve increases. Where the central bank instead allows currency appreciation, net private claims by foreigners still rise, albeit gradually over time, as a result of a reduced current account balance.[4] China's case shows how both mechanisms can operate at once. Whether the central bank intervenes or not, domestic financial conditions are affected immediately; although, the expansionary effect is probably bigger

4. In a pair of classic contributions, Calvo, Leiderman, and Reinhart (1993;1996) linked net emerging market capital inflow surges to monetary ease in the advanced countries. Their theme remains highly relevant, of course, and is the central focus of this paper. For documentation on *gross* capital flow surges and reversals, see Cowan, De Gregorio, Micco, and Neilson (2008), Forbes and Warnock (2012), and Broner, Didier, Erce, and Schmukler (2013). On long-term cycles in capital flows, see Bacha and Díaz-Alejandro (1982), Eichengreen (1991) and Obstfeld and Taylor (2004). Of course, the pattern of net capital flows remains puzzling, as discussed by Prasad, Rajan, and Subramanian (2007) and Gourinchas and Jeanne (2013). On the importance of financing conditions as reflected in gross capital flows, see Borio and Disyatat (2011).

when intervention occurs and causes an increase in the domestic money supply and domestic bank credit.[5]

Capital inflow surges can cause a range of dislocations—not the least of which is to create a range of vulnerabilities to subsequent capital-flow reversals. After the GFC, industrial countries' recoveries slowed by effects of private and public debt overhang, relying on continuing monetary stimulus in the form of ultra-low policy interest rates (sometimes coupled with forward guidance) and unconventional quantitative measures. In general, however, the EMEs—at least those that avoided big debt run-ups—[6] had suffered less in the crisis. With economies growing more briskly than those of advanced countries, these EMEs did not require abnormally accommodative monetary policy settings. Currencies, bonds, equities, and real estate appreciated because of the resulting global portfolio shift into EME assets. Appreciation contributed to financial stability (as well as competitiveness) concerns, and countries that resisted exchange-rate change through intervention saw greater pressure on domestic asset prices, on domestic credit growth, and on general product price levels. Those pressures have now left EMEs more vulnerable to a reversal of global financial flows.

Clearly then, EMEs have an interest in tempering the effects of global portfolio shifts, especially when the sequence is capital feast followed by capital famine. How can EMEs use their macroeconomic tools to do so? Astute observers have long known that *in principle* monetary policy is vital, but cannot furnish the sole to respond to capital inflow surges. Shortly after the Tequila crisis of two decades ago, for example, Calvo, Leiderman and Reinhart (1996) wrote:[7]

> The countries that have been the most successful in managing capital flows… have implemented a comprehensive policy package and not relied on a single instrument. At the outset of the surge in inflows, these countries reacted by treating inflows as temporary and resisted a nominal exchange rate appreciation; the foreign exchange intervention was mostly sterilized. As the inflows

5. For some suggestive evidence that this is the case, and that net private capital inflows are likely to create more financial fragility in economies with less flexible exchange-rate regimes, see Magud, Reinhart, and Vesperoni (2014). The theoretical perspective I sketch later in this paper suggests, however, that a more nuanced understanding would come from studying the impacts of *gross* inflows, as analyzed by some of the references listed in the previous footnote.

6. See Gourinchas and Obstfeld (2012).

7. See p. 137 of Calvo, Leiderman and Reinhart (1996).

> persisted, sterilization efforts were scaled back and the domestic currency was allowed to appreciate. To moderate the extent of the real appreciation and prevent the economy from overheating, fiscal policy was tightened. To moderate the volume of the inflows and lengthen their maturities, exchange rate flexibility was increased and measures to curb inflows were implemented.
>
> A less productive policy mix has consisted of persistent sterilization (which keeps short-term interest rates comparatively high), heavy intervention in the foreign exchange market (which results in little short-run exchange rate uncertainty) and no controls on short-term capital movements. All of these policies have tended to provide especially strong incentives for short-term capital inflows.

Subsequent research and experience suggested, however, that for some countries, the preceding approach was difficult to implement *in practice* during the 1990s. Perhaps most importantly, currency mismatch and the need for an easily verifiable nominal anchor sometimes imparted a strong policy bias toward exchange-rate stability in EMEs, thereby constraining monetary policy (Hausmann, Panizza, and Stein, 2001; Calvo and Reinhart, 2002). In the presence of fixed or highly managed exchange rates, a number of policy failures set the stage for the EME crises of the late 1990s.

More recently, the position of EMEs has evolved considerably. As noted above, international financial flows have increased in scale, particularly in gross terms, driven in significant part by international banking flows. At the same time, domestic financial systems have expanded and deepened. While, for EMEs, these changes are not as extreme as for the advanced countries, they are still highly significant and leave EMEs more exposed to shifts in global financial-market sentiment. For example, a big sell-off of domestic assets by foreign investors is likely to induce a significant exchange rate change before enough buyers come forward to restore market equilibrium. EME corporates and banks increasingly issue bonds offshore, and these foreign-currency liabilities—not captured in standard, residence-based net international investment position data—are a potential source of currency mismatch, as well as direct exposure to foreign financing conditions (Turner, 2014; Shin, 2013).

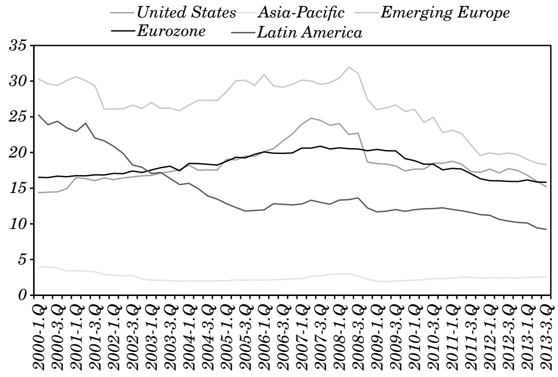
One manifestation of global financial linkages is the importance of cross-border credit, both in local and foreign currency (see Borio, McCauley and McGuire, 2011). Figure 1 shows the ratio of cross-border to domestic bank credit for five regions as measured in the BIS Global Liquidity Indicators. Three regularities stand out. First, apart from the Asia-Pacific grouping (which mixes advanced and emerging economies), cross-border credit is very significant compared to domestic bank credit—currently in the 10 to 20 percent range for the other four regions. Second, in all regions, the ratio of cross-border to domestic credit positively covaries with the global credit boom of the mid-2000s and the subsequent collapse—a reflection of the gross financial flows that helped fuel the GFC. Finally, the cross-border bank credit ratio falls secularly in Latin America and emerging Europe, from a very high level at the start of the millennium to a level roughly on the same order as the U.S. and the eurozone. In part, declining reliance on cross-border bank lending reflects domestic financial deepening; in part, it reflects retrenchment in banks' global activities and growth in bond finance after the GFC. While perhaps reduced compared to its level in 2000, considerable exposure to global banking fluctuations remains for many EMEs, and evidence indicates that net cross-border debt flows fuel domestic credit growth.[8] Moreover, increasing EME recourse to non-bank funding sources has created new exposures, some not even visible in residence-based data on gross external liabilities, such as the Lane and Milesi-Ferretti (2007) data for selected countries shown in figure 2.[9]

8. Locational banking data such as these (based on the residence principle) may well understate banking exposure, as the head offices of domestic affiliates are likely to divert funding in a crisis. See Cetorelli and Goldberg (2011). Lane and McQuade (2014) document a link between net cross-border debt flows and domestic credit growth.

9. For this figure, I exclude tax havens as well as all countries with GDP below $2 billion in 2012.

Figure 1. Cross-Border Credit as a Fraction of Domestic Credit, by Region

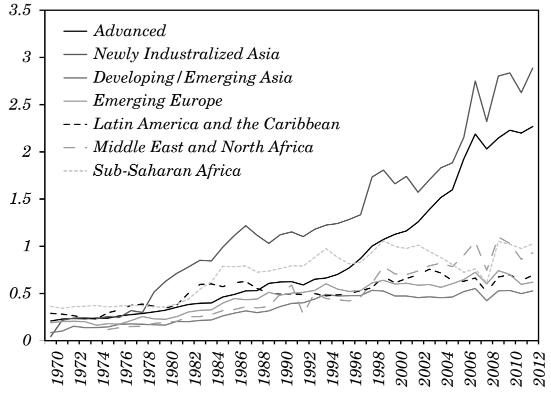
Cross-border/domestic credit ratio (percent)



Source: BIS, Global Liquidity Indicators.

Figure 2. Gross External Liabilities Relative to GDP, by Region

Gross foreign liabilities/GDP, GDP weighted averages



Source: Updated data from Lane and Milesi-Ferretti (2007), courtesy Gian Maria Milesi-Ferretti.

Counteracting the increased vulnerabilities are some policy and institutional enhancements.[10] Over time, EMEs have shifted their gross liability positions away from debt in the direction of equity instruments (portfolio equity and FDI). In this respect, international financial integration promotes international risk sharing and can therefore be a stabilizing factor. Figures 3 and 4 illustrate the recent dramatic shift of external liabilities toward equity (see also Lane and Shambaugh, 2010 and Prasad, 2011).[11] Currency depreciation automatically devalues this portion of external liabilities, but even the remaining external and domestic debt is increasingly denominated in domestic currency (Lane and Shambaugh, 2010; Miyajima, Mohanty and Chan, 2012; Turner, 2012). The growth of domestic bond markets—most advanced among the EMEs in Asia, where corporates are significant players alongside governments—has been an important supporting factor. Moving from a nominal exchange rate anchor to some alternative (often a managed float within the context of an inflation target) has paid dividends for many EMEs, both in providing generally moderate inflation and in relieving the government of the need to defend a definite line in the sand with monetary policy or reserves. The second dividend has generally reduced the incidence of foreign exchange crises, in part, by freeing foreign exchange reserves for purposes other than defense of an exchange rate target.[12] Of course, more reliably moderate inflation itself has helped to promote domestic-currency denomination of domestic and foreign liabilities.

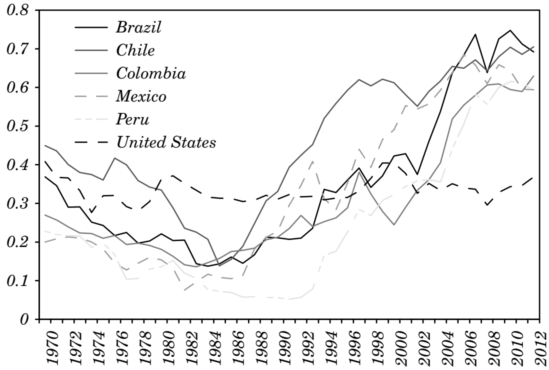
10. See Obstfeld (2014) for a more detailed survey and discussion.

11. In general, the picture in emerging Europe (where some countries are in the eurozone) is more mixed and not as favorable to foreign equity finance. The data in the figures of course reflect stock market price fluctuations, but the trends are still clear. Broadly speaking, if one starts in 1970, the data describe a J shape. Prior to gaining access to private lending markets in the 1970s, developing countries relied primarily on FDI for private foreign financing. Access to debt finance allowed a fall in the FDI share. Only much later did portfolio equity inflows become important. The United States is shown in figure 3 for the purpose of comparison. A caveat to figures 3 and 4 is that the Lane and Milesi-Ferretti data, which are residence-based, do not capture offshore bond issuance by domestic nationals.

12. Ghosh, Ostry, and Qureshi (2015) discuss evidence on the susceptibility of hard and adjustable pegs to crisis. If foreign exchange reserves are not dedicated to defense of the exchange rate, more of them can be used in lender-of-last resort operations in support of domestic entities with short-term foreign-currency liabilities. On the relation between reserve use during the GFC and economic performance, see Dominguez, Hashimoto, and Ito (2012).

Figure 3. External Equity Liabilities Relative to Total External Liabilities, by Country: Western Hemisphere

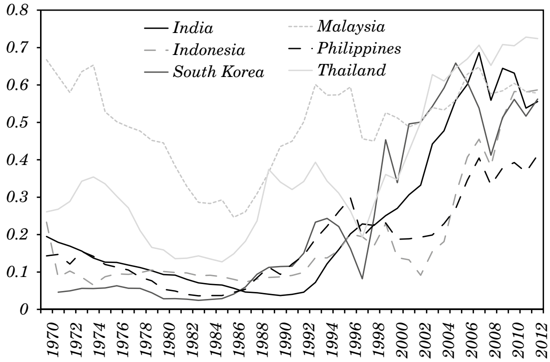
Fraction



Source: Updated data from Lane and Milesi-Ferretti (2007).

Figure 4. External Equity Liabilities Relative to Total External Liabilities, by Country: Asia

Gross foreign liabilities/GDP, GDP weighted averages



Source: Updated data from Lane and Milesi-Ferretti (2007).

A more effective approach to financial oversight, typically including a macro-prudential component, has supplemented these macroeconomic regime changes. Many EMEs, especially in Asia, have accumulated large stocks of foreign exchange reserves that allow the domestic monetary authority to play a lender-of-last-resort role for financial institutions with short-term foreign-currency liabilities. Market perceptions that authorities are able and willing to play that role, as many did quite effectively during the GFC, are a stabilizing factor for capital flows. Moreover, large precautionary reserve holdings are complemented by a higher level of capital-account restrictions than in advanced economies; Bussière et al. (2014) present evidence on the stabilizing effects of reserve stocks and the use of capital-account measures. Figure 5, which is borrowed from their paper, shows that while advanced and advancing countries alike have liberalized cross-border financial flows over the past three decades, the developing/emerging group has, on average, liberalized less and accumulated more international reserves in the process.[13]

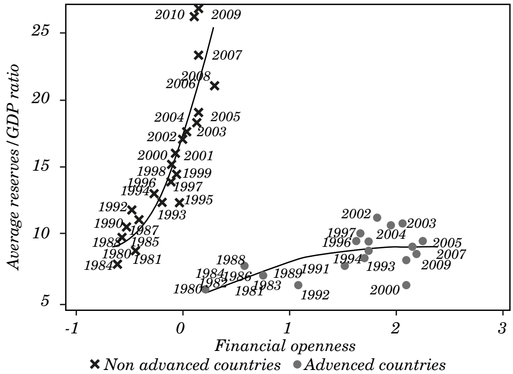
To what degree have the preceding structural changes insulated EMEs from monetary shifts and financial cycles in advanced countries? Both during the accommodative phase of advanced-country monetary policies following the GFC and, more lately, as markets have come to anticipate the tapering of accommodation in the United States, EMEs showed their habitual reluctance to let exchange rates bear the full adjustment burden. Indeed, some of the very structural changes cited as enhancements for EME stability could have downsides. Domestic bond markets, if dominated by foreign asset managers and lacking big domestic players such as pension funds and insurance companies, could be quite volatile, with long-term bond returns tightly linked to those in advanced-country markets (Shin, 2013).[14] Moreover, if foreign holders of EME-currency bonds hedge the currency risk with counterparts in the issuing country, this potentially creates a currency mismatch: the domestic counterparts have incurred a foreign-currency liability which (leaving aside the associated forward claim to a domestic-currency payment from the bond holders) is equivalent to foreign-currency bond issuance (He and McCauley, 2013).

To diagnose and assess the threat from ongoing potential

13. Figure 5 uses the Chinn and Ito (2006) measure of capital-account openness.

14. Highly diversified fund managers might have little incentive to focus on particular countries' economic fundamentals, as argued by Calvo and Mendoza (2000).

Figure 5. Financial Openness and International Reserves of Advanced and Developing/Emerging Countries
By year



Source: Bussière et al. (2014), courtesy Menzie Chinn, based on the updated Chinn-Ito (2006) index.

vulnerabilities, it is important to carefully consider the transmission mechanisms between advanced and EME financial markets, and whether there are effective tools that EMEs can use to cope with financial shocks from abroad.

2. Transmission Mechanisms

In the early 1970s, inflation surged worldwide. One obvious mechanism driving synchronized global inflation was the system of fixed exchange rates central to the Bretton Woods system, under which all countries pegged to the U.S. dollar (thereby surrendering monetary autonomy) while the U.S. retained monetary discretion (thereby dominating global monetary conditions). Both relatively loose monetary policy in the U.S., together with a huge speculative portfolio shift away from the dollar in anticipation of its debasement, led to big increases in foreign exchange reserves and money supplies outside of the United States.

A major motivation for the subsequent move to generally floating exchange rates (at least among industrial economies) was, therefore, to regain control over domestic inflation. Yet, industrial-country inflation rates did not diverge. They rose in concert in the

1970s, continuing even after the abandonment of fixed exchange rates, and largely fell starting in the following decade. Ciccarelli and Mojon (2010) document a powerful common component in 22 OECD countries' inflation rates over the 1960-2008 period. EME inflation rates remained higher in some countries throughout the 1980s, notably in Latin America, but those rates also converged downward starting in the 1990s. While trend inflation rates still differ across countries, the cross-country range of variation has become relatively small. The proposition that countries can control their inflation rates over the long term is widely accepted, and observed inflation convergence is regarded as a country-specific or currency union-specific phenomenon reflecting synchronized improvements in economic literacy and economic governance.[15]

The degree of national control over short- to medium-term macro developments (including but not restricted to price-level dynamics) is more controversial. When countries' financial markets are linked, even imperfectly, macroeconomic models incorporating realistic good- or asset-market frictions imply that policy and other shocks will be transmitted to trading partners, possibly causing unwanted spillovers even when currency exchange rates float freely. Two related questions have been especially prominent in recent debate about the scope for independent and effective monetary policy by EMEs. First, can EMEs offset shifts in advanced-country monetary policies—most importantly U.S. monetary policy—through their own monetary instruments? Second, in the face of a global financial cycle that is in principle distinct from monetary policy cycles—but which also causes portfolio shifts with respect to EME assets—what scope do EMEs have for an effective policy response? Some recent analysis has been pessimistic. Perhaps most provocatively, Rey (2013) argues that EMEs have essentially *no* room for monetary policy that diverges from U.S. conditions: the monetary trilemma is really a dilemma, with independent monetary policy possible if and only if capital markets

15. McKinnon (1982) hypothesized that even with floating exchange rates, a high degree of substitutability among the major industrial-country currencies made national inflation depend on world money-supply growth. If this view were right, even long-term inflation would be out of the hands of any single central bank. There is little theoretical or empirical support for McKinnon's "global monetarist" hypothesis, although some recent authors have used global monetary aggregates as proxy variables for global liquidity conditions. An example of the empirical critiques is Wallace (1984).

are segmented from the outside world. On this view, global rather than national liquidity is central.[16]

To assess such arguments, it is useful to review some main mechanisms of transmission of foreign monetary and financial shocks to EME financial markets.[17]

2.1 Direct Interest Rate Linkages

Perhaps most fundamental in a world of integrated financial markets are direct interest rate linkages between countries, which reflect forces of cross-border arbitrage on rates of return. Conventional monetary policy manipulates a short interest rate directly but has effects at all maturities, and these effects induce portfolio shifts into foreign assets. In turn, those portfolio shifts generally affect exchange rates, asset prices, capital accounts, and macroeconomic policies abroad.

If an emerging country fixes its exchange rate against the currency of a central country (for example, the United States), then it has no choice but to match the latter's choice of policy interest rate. Moreover, provided the exchange rate peg is credibly permanent, risk-free nominal interest rates *at all maturities* must match those of the U.S. Thus, U.S. monetary policy is passively imported, in accordance with the monetary trilemma.

More generally, exchange-rate flexibility of various types and degrees will alter the international transmission of interest rates. If e is the domestic price of the U.S. dollar, i the short-term policy rate of interest, and ρ a foreign-currency risk premium, then domestic and U.S. short rates will be linked by an interest-parity relationship of the form:

$$i_t = i_t^{US} + E_t e_{t+1} - e_t + \rho_{t.}$$

Above, the risk premium ρ might reflect the covariance between the depreciation rate of domestic currency and a stochastic discount factor for domestic currency payments. Now, changes in the U.S.

16. For recent assessments of the concept of global liquidity, see Borio, McCauley, and McGuire (2011), Committee on the Global Financial System (2011), Gourinchas (2012), and Landau (2014).

17. For complementary discussions see Caruana (2012), He and McCauley (2013), and McCauley, McGuire, and Sushko (2014).

interest rate need not feed one-for-one into i_t, depending on the behavior of the exchange rate and the risk premium. For example, if the EME central bank holds its interest rate absolutely constant when the U.S. cuts its interest rate, and the risk premium does not change, then foreign currency will appreciate sharply (a fall in the price of dollars, e_t), overshooting its expected future value so as to maintain interest parity. The EME central bank can still set the policy interest rate it prefers, but a sharp exchange rate change may well have effects on its economy that strongly influence the monetary policy response.

A powerful inhibition to allowing full exchange rate adjustment in such circumstances is the negative effect on domestic export competitiveness. The EME central bank may intervene to dampen appreciation, thereby (typically) acquiring international reserves and allowing a jump in the net private capital inflow into its economy. In turn, an increased money supply will likely cause a rise in domestic bank lending. Sterilization of the monetary effects (if somewhat effective) could raise longer-term rates at home and (if carried out on a large enough scale) lower them in the U.S., eliciting further pressure through the capital account. The carry-trade dynamics may be reinforced by the perception that the central bank is merely slowing an inevitable appreciation of its currency. The probable effect, in this case, therefore remains transmission of U.S. monetary ease.

Since sterilized foreign exchange intervention is often limited in its effectiveness, stronger efforts to limit currency appreciation are likely to enhance the correlation between the domestic and U.S. policy interest rates. Even when there is no intervention, consequential two-way private gross capital flows could occur, such as increased U.S. bank loans to the EME country, the proceeds of which are deposited in banks abroad. This increase in cross-border credit could well have an impact on domestic financial conditions (as suggested in partial-equilibrium models such as Bruno and Shin, 2013); I return to this issue below. Even a fully floating exchange rate cannot provide full insulation from the expansion of gross foreign assets and liabilities.

Further international linkages occur through the longer-term interest rates set in bond markets. These rates affect activity in key economic sectors and drive real wealth through asset-valuation effects. As in the case of short-term interest rates, direct arbitrage between national markets links long-term rates with exchange rates, but long-term rates reflect, not only short-term rates, but also expected future short rates as well as risk factors. To the extent that monetary policy works through its effect on longer-term interest rates, such as mortgage rates or corporate borrowing rates, stronger international linkages between long-term rates could hamper monetary autonomy, in the sense of requiring sharper changes in short-term rates (and perhaps in forward guidance on those rates) to achieve a given desired result.

To make the discussion more precise, consider the simplest two-period example. So an approximate term structure model would represent the domestic nominal risk-free yield $i_t^{(2)}$ on a two-period discount bond as depending on an average of current and future expected short rates:

$$i_t^{(2)} = \tfrac{1}{2}i_t + \tfrac{1}{2}E_t i_{t+1} + \tau_t.$$

Here, τ_t tis a term premium that might reflect the covariance between future interest rates and a stochastic discount factor for domestic currency payments, and because of the interest parity relationship, τ_t obviously is closely related to the currency risk premium ρ_t in general equilibrium. Subtracting from this the parallel relationship for the U.S. shows that international long-term rates obey an interest parity relationship in the form:

$$\begin{aligned} i_t^{(2)} = i_t^{US\ (2)} &+ \tfrac{1}{2}(E_t e_{t+1} - e_t) + \tfrac{1}{2}(E_t e_{t+2} - E_t e_{t+1}) \\ &+ \tfrac{1}{2}\rho_t + \tfrac{1}{2}E_t \rho_{t+1} + \tau_t - \tau_t^{US}. \end{aligned}$$

Exchange rate variability matters for long-term risk-free interest rate correlations across countries as well as for short, but to the extent that expected exchange-rate movements tend to slow or be reversed over time, long-rates could be more highly correlated than short rates—perhaps the EME central bank allows short-run movements, but its long-run inflation target is similar to that of the United States and expected real exchange rate changes are small. High international correlation among term premiums could also induce long-rate correlation across countries. For example, He and McCauley (2013) and Turner (2014) argue that U.S. quantitative easing policies that reduce term premiums spill over into a reduction of term premiums abroad.[18] In this way, U.S. unconventional easing may be spread abroad.

18. Neely (2013) carries out an econometric study.

Empirically, long-term interest rates tend to be more highly correlated across countries than short-term rates, consistent with results of the next section. Goodhart and Turner summarize a widely held view of the evidence:

Long-term interest rates are more correlated across countries than short-term rates. A central bank operating under a flexible exchange rate regime can set its policy rate independently of the Fed funds rate.

However, it has much less power over the long-term rate in its own currency because yields in all bond markets integrated into the financial system tend to rise whenever U.S. yields jump. Bond yields in countries with a weaker macroeconomic of financial fundamentals often rise even more.[19]

Why is this so? One reason, documented in the next section, is that there is mean reversion in short-term policy rate differentials. In addition, countries' term premiums appear to be increasingly correlated over time and closely linked to U.S. bond premiums (see, for example, Hellerstein, 2011; Dahlquist and Hasseltoft, 2012). Our understanding of these premiums in terms of reliable structural models is limited, but they are clearly related to investor risk aversion. In any case, to the extent that long-term rates are strongly subject to global forces, the power of short-term rates to steer the economy could diminish. While recent attention has focused on the effects on EME long-term rates of monetary-policy shifts in the U.S., even U.S. long-term rates appear subject to global influences, as evidenced by several empirical studies. Also related is the anecdotal evidence of the "Greenspan conundrum:" the relative constancy of long-term rates in the face of rising policy rates in the mid-2000s.[20]

The apparently high cross-country correlation in term premiums could reflect factors that drive global financial cycles—for example, changes in risk appetite—so I turn the discussion to the impact of international financial developments.[21]

19. See Charles Goodhart and Philip Turner, "Pattern of Policy Tightening is Different This Time," *Financial Times,* April 3, 2014, p. 20. See also Bernanke (2013) and Sheets and Sockin (2013).

20. Another possibly relevant factor is that uncovered interest parity seems to hold more closely for long-term nominal interest rates than for short-term rates. See Chinn and Quayyum (2012).

21. Consistent with the financial-cycle view is the evidence of Gonzáles-Rozada and Levy Yeyati (2008) that emerging market bond spreads (on foreign-currency debt) respond strongly to proxies for U.S. risk appetite and liquidity.

2.2 Transmission of the Financial Cycle

Like monetary policy, the financial cycle has effects that are transmitted abroad. The level of interest rates certainly can play a catalytic role, among other causes.[22] Changes in credit volumes, including banking flows, can have strong effects across borders. The mid-2000s saw a powerful credit cycle, originating primarily in the U.S. and Europe, but also related to the pattern of global current account imbalances. Until the cycle collapsed in September 2008, most EMEs—including those in Asia—navigated it fairly successfully, although some countries experienced problems with capital inflows and appreciation.

A first transmission channel comes from the compression of risk premiums. Consider first the case just under discussion: long-term government bonds. A general decline in risk aversion originating in the U.S. might compress term premiums both at home and abroad. But the latter can be a powerful source of policy spillovers. Looking at the preceding long-term interest parity relation, we can see that the immediate exchange rate response might have to be quite big if EME long-term rates and the long-term nominal exchange rate do not adjust. For example, a 10 basis point fall in the term premium on a U.S. two-year bond would require a 20 basis point currency appreciation. Just as small movements in exchange rates can be consistent with big discrepancies between short-term interest rates, small discrepancies between long-term rates will require substantial exchange-rate movements unless offset by risk premium changes.

Financial conditions can migrate across borders by relaxing the quantitative borrowing constraints that agents may face. A financial boom in the U.S. will spill over into increased credit supply abroad, appreciating foreign currencies and raising foreign asset values. In turn, those developments will raise collateral values in the recipient countries, with a procyclical effect on their borrowing and asset markets. A number of models suggest different mechanisms through which the process could be, to some degree, self-reinforcing. Examples include Gertler and Karadi (2011), who focus on the franchise value of intermediaries as a limit to lending, and Bruno and Shin (2013), who emphasize the role of currency appreciation in strengthening unhedged borrowers' balance sheets.

22. For some evidence on the role of interest rates on U.S. bank behavior, see Dell'Ariccia, Laeven, and Suarez (2013).

If the current account is slow to adjust in the short-run, then a financial inflow will necessarily be matched by an equal outflow. Absent central bank intervention, a higher *private* inflow is matched by a higher *private* outflow. Partial equilibrium models of banking inflows such as Bruno and Shin (2013) do not capture this consequence.[23] However, the resulting expansion of gross liabilities and assets is quite likely to worsen the balance of financial stability risks, increasing the challenge for macroprudential policy. Challenges for macroeconomic policy could also be accentuated. Goldberg (2013) presents some evidence that a substantial foreign banking presence can reduce monetary independence, as measured by interest-rate independence.

A major spillover channel for easier foreign financial conditions is the compression of corporate spreads, which occurs as domestic financial conditions also ease. Figure 6 shows the behavior of South Korean domestic corporate spreads (with the Fed's target policy rate superimposed).[24] Spreads are highly variable, rising with the wave of bankruptcies following the dot-com crash, rising in the South Korean credit-card crisis, and falling sharply afterward only to spike upward with the Lehman collapse in September 2008. The relationship to U.S. monetary policy is not mechanical due to the influence of common factors. Starting in mid-2004, for example, the Fed funds rate rises and South Korean spreads decline, both in response to the ongoing global boom in credit and liquidity that ended in the GFC.

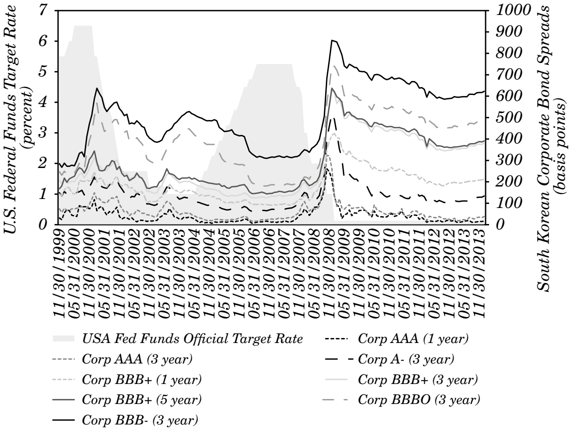
2.3 Foreign Currency Credit

While dollar, euro, and yen credit is extended to non-residents, the dollar is dominant, with credit transactions often between two non-U.S. residents (Borio, McCauley and McGuire, 2011). Figure 7 displays some trends. Since 2000, dollar bank credit to non-banks outside of the U.S. has risen from an amount equal to 23 percent of total U.S. domestic bank credit to about 35 percent—while U.S. domestic bank credit itself has risen to a level about equal to annual U.S. GDP.

23. The development of general-equilibrium models should therefore be a research priority.

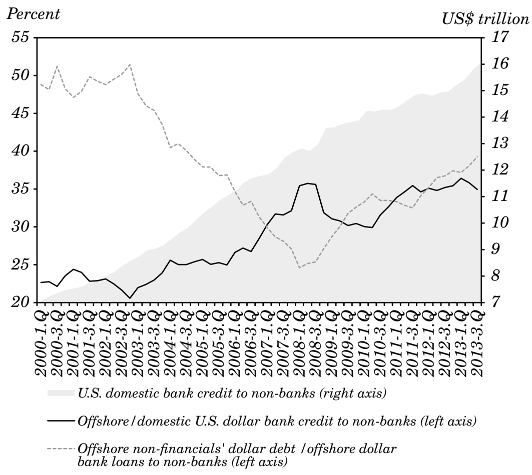
24. Spreads are for local currency yields computed relative to a South Korean government bond of the same tenor.

Figure 6. South Korea, Corporate Bond Spreads versus U.S. Federal Funds Target



Source: Asian Development Bank, Asian Bonds Online.

Figure 7. Offshore U.S. Dollar Bank Credit and Offshore U.S. Dollar Debt



Source: BIS, Global Liquidity Indicators.

Thus, more than a third of global dollar lending by banks to non-banks now takes place outside U.S. borders. Alongside offshore dollar bank credit, there is also significant offshore issuance of dollar debt securities by non-financial borrowers. While such issuance stood at about half of offshore dollar borrowing from banks by non-banks in 2000, the ratio fell sharply up to the GFC as international banking expanded in an environment of low interest rates. The GFC then caused a contraction in bank lending everywhere. More recently, however, offshore dollar bank lending and debt issuance have begun to expand in tandem, with debt issuance rising especially rapidly after the crisis as a result of low long-term dollar interest rates following the Fed's unconventional operations (McCauley, McGuire and Sushko, 2014).

Foreign currency credit presents another transmission channel, most importantly for shocks originating in U.S. financial markets. The effective cost of borrowing in dollars, if those are swapped into domestic currency, is still the domestic interest rate if covered interest parity applies, and a shortage of funding for covered interest arbitrage (as in Ivashina, Scharfstein and Stein, 2012) will only raise the cost of covered dollar borrowing.[25] However, there are channels through which the interest rate on dollar loans and the loans' availability can directly affect credit flows in economies outside the U.S.

Domestic residents who hedge foreign-currency borrowing will still effectively face the domestic interest rate if covered interest parity holds. However, some may engage in unhedged carry trades, either because they are financially unsophisticated or believe (perhaps wrongly) that domestic currency depreciation is very unlikely. Under this scenario, a fall in the cost of unhedged foreign borrowing will be expansionary in the short run, though possibly highly contractionary later in the event that significant currency depreciation does occur.

More generally, the heavy participation of global non-U.S. banks in intermediating U.S. dollars creates a potent channel for U.S. monetary and financial developments to influence their balance sheets and lending activities, including domestic and foreign lending denominated in dollar currencies. In other words, shocks to the non-dollar component of an international bank's balance sheet are bound

25. Munro and Wooldridge (2012) argue, however, that domestic borrowers can overcome some financial frictions by borrowing in foreign currency and swapping the proceeds into domestic currency.

to spill over to the rest of the balance sheet. For example, a decline in dollar funding rates is likely to raise banking profits, spurring asset expansion across all currencies. The GFC provided vivid examples of negative effects of dollar funding disruptions on non-U.S. banks. Not only non-U.S. banks, but also non-U.S. non-bank dollar borrowers, whether they borrow from banks or in capital markets, may feel effects of changes in dollar interest rates or dollar funding conditions.

2.4 Implications

A country that pegs its exchange rate to the dollar and has open capital markets will import U.S. monetary policy. While a flexible exchange rate allows the country to control inflation independently, as in Woodford's (2010) exposition, monetary policy has additional objectives, and globalization might worsen the tradeoff between these and inflation. Some of these are related to the exchange rate, where big changes could have adverse effects on financial stability or internal resource allocation. Even with exchange-rate flexibility, the influence of monetary policy over long-term interest rates could be reduced compared to a closed economy. Spillovers may be easy to absorb when countries throughout the world face common shocks, but less so when their positions are asymmetric, as was the case in the years immediately following the GFC.

Policy rates of interest are central to financial conditions, and induce portfolio shifts toward EMEs, but other aspects of advanced economy financial conditions can spill across borders to EMEs in the form of incipient or actual net capital flows, and gross flows. These factors potentially have substantial impacts on exchange rates, asset prices, and credit volumes, and likewise on economic activity, inflation, and financial stability. Given the prevalence of dollar credit internationally, movements in U.S. interest rates and financial conditions are likely to be especially important.

3. Evidence on Interest Rate Independence

Because some interest rate independence is a necessary condition for an effective monetary policy aimed at domestic goals, a central empirical question is the correlation between domestic and foreign interest rates, and its relation to the exchange rate regime. This section presents some evidence adding to the findings of previous studies by analyzing long-term nominal rates of interest.[26]

A first test, based on approaches of Shambaugh (2004), Obstfeld, Shambaugh and Taylor (2005), and Klein and Shambaugh (2013), investigates the average coherence between a short-term nominal interest rate and a base-country rate in panels of countries. More specifically, consider the regression equation linking country *j's* nominal interest rate to the interest rate of base country b:

$$\Delta i_{jt} = \alpha + \beta \Delta i_{bt} + \boldsymbol{\gamma}' \boldsymbol{X}_{jt} + u_{jt}. \tag{1}$$

Above, $\beta = 1$ and $\gamma = 0$ under a fully credible currency peg. With some exchange rate flexibility, however, there would generally be less than full pass-through of the base rate to the domestic rate, $\beta < 1$, and the interest rate might also respond to domestic variables included in the vector $\boldsymbol{X}_{jt}$ (for example, through a Taylor rule mechanism). Thus, information about the magnitude of β and the statistical significance of the coefficient vector γ is informative about the degree of monetary independence. In specification (1), differences of interest rates are preferred to levels so as to avoid spurious regression problems.

In general there are at least two concerns in interpreting regression (1). First, if a peg is non-credible, it is possible that elements of $\boldsymbol{X}_{jt}$ could affect the domestic interest rate by creating realignment expectations. But in that case, we would also expect to see an amplified response of the home interest rate to changes in the base rate, $\beta > 1$ (and we would not view this as evidence of monetary independence).

A second concern is with unobserved global shocks that are not fully captured by the included vector $\boldsymbol{X}_{jt}$. For example, shifts in global risk tolerance or global liquidity might simultaneously move the base and domestic rates in the same direction. Such an omitted variable

26. This section builds on earlier work by Frankel, Schmukler and Servén (2004); Shambaugh (2004); Obstfeld, Shambaugh and Taylor (2005); and Klein and Shambaugh (2013). The general conclusion of these studies (which the evidence in this section supports) is that there is some scope for short-run interest rate independence when exchange rates are flexible. Alternative methodologies attempt to identify exogenous monetary shocks but reach broadly similar conclusions to the previous studies, see Miniane and Rogers (2007) and Bluedorn and Bowdler (2010). In a related vein, Sheets and Sockin (2013) argue that U.S. policy rates strongly influence policy rates of the other major industrial countries, but do so primarily by shifting the arguments in those countries' Taylor rules rather than forcing deviations from Taylor rules.

would induce a positive correlation between Δi_{bt} and u_{jt}, raising the OLS estimate of β even under substantial monetary independence. (In this case, the upward biased estimate could be indicating positive transmission of the financial cycle, not of monetary policy.) Alternatively, the global shock might be a generalized shift in portfolio preference between base-country bonds and foreign bonds in general (for example, safe-haven inflows to the base country). In this case u_t, would tend to have a negative correlation with Δi_{bt}, which would induce a downward bias in the OLS estimate of β. One way to address the issue is to recognize that different countries have different "natural" base rates—the U.S. dollar for Mexico, the euro for Poland, and the South African rand for Botswana, for example. Accounting for this heterogeneity allows one to control for common time effects in the panel version of (1), and thereby attempt to capture unobserved global shocks.

Several researchers have argued that the Chicago Board Options Exchange's equity option volatility index (VIX) is a useful summary statistic for the state of the financial cycle, lower values being associated with a greater tolerance for risk-taking—including increases in leverage (see Bruno and Shin, 2013; Rey, 2013; among many others). If countries in the sample are matched to their heterogeneous bases, one can enter the percent change in the VIX as an independent variable in the regressions, rather than time fixed effects. This yields an alternative way to control for shocks to the global cycle that potentially move national and base interest rates simultaneously. If the change in the VIX is a stand-in for global shocks that cause global interest rates to move up or down in concert, then adding the VIX should reduce the estimated coefficient $\hat{\beta}$ in (1). On the other hand, VIX movements could be more highly correlated with portfolio shifts between advanced and emerging markets—the waves of capital flow into or out of the developing world discussed by Calvo, Leiderman, and Reinhart—and in that case, we should expect $\hat{\beta}$ to rise when the VIX change is added as a regressor.

To gauge the additional autonomy loss due to pegging, I will use the interactive specification

$$\beta = \beta_0 + \beta_1 \times PEG, \tag{2}$$

where *PEG* is an indicator variable.

A second type of test, following Frankel, Schmukler, and Servén (2004) and Obstfeld, Shambaugh, and Taylor (2005), considers dynamic adjustment to a long-run levels relationship between home and base-country interest rates. To this end, I will estimate country-j specific equations of the form:

$$\Delta i_{jt} = \sum_{p=1}^{P} \rho_p \Delta i_{jt-p} + \sum_{q=0}^{Q} \beta_q \Delta i_{bt-q} + \sum_{q=0}^{Q} \boldsymbol{\gamma}_q^{\prime} \Delta \boldsymbol{X}_{jt-q} + \theta\,(i_{jt-1} - \xi i_{bt-1} - \boldsymbol{\omega}^{\prime} \boldsymbol{X}_{jt-1}) + u_{jt}. \quad (3)$$

In estimating (3), I do not pool over j because of the likelihood of heterogeneous dynamics across economies. In specification (3), the coefficient ξ is the long-run *levels relationship* between the home and base interest rate, and $-\theta$ is the *adjustment speed* toward that relationship. We would expect ξ to be in the neighborhood of 1, with $-\theta$ an inverse measure of the scope for departure from the long-run relation.

Table 1 reports the result of estimating specification (1) as a pooled or panel regression using my full sample of countries (22 advanced, other than the U.S. and 34 emerging/developing, dictated by data availability).[27] None of the specifications will include country fixed effects, on the grounds that a steady positive or negative country-specific nominal interest rate trend is implausible in my data; however, some will include time effects motivated by the possibility of unobserved global shocks that induce higher interest rates everywhere. The results in table 1 provide a very crude first pass that accounts for neither exchange-rate regime nor level of development. Nonetheless, the findings display several regularities that prove robust to more nuanced cuts in the data.

Columns (1)-(4) report regressions of short-term nominal interest rate changes (SR) on the short rate change in a base country, whereas columns (5)-(8) do the same for long-term nominal interest rates (LR). Also included in the $\boldsymbol{X}$ variables that enter equation (1) are current values and lags of the change in real GDP and the change in CPI inflation, where I use the Bayesian Information Criterion to determine the number of lags to include —up to a maximum of six.[28] Thus, the observations are at quarterly frequency. The short-term interest rate is the quarterly average of end-of-month rates on 90-day or 91-day government securities; the long-term rate is the quarterly average of end-of-month rates on 10-year government bonds.

27. Data coverage is detailed in an appendix. Even where longer data series are available, I generally estimate over the period starting around 1990 so as to capture the regularities that apply during the recent period of high and growing financial globalization. See Klein and Shambaugh (2013) for analysis of longer time series.

28. To save space, I do not report coefficients on these auxiliary variables.

Table 1. Pooled and Panel Regressions of Nominal Interest Rate Changes on Base-Currency Changes

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
U.S.-base SR change	0.0605							
	(0.158)							
Multi-base SR change		0.201	0.0121	0.241				
		(0.172)	(0.228)	(0.177)				
U.S.-base LR change					0.354***			
					(0.0597)			
Multi-base LR change						0.552***	0.433***	0.636***
						(0.0670)	(0.136)	(0.0616)
VIX Percent change				0.00252*				0.00298***
				(0.00131)				(0.000668)
Constant	-0.00170**	-0.00154**	0.000170	-0.00153**	-0.000798***	-0.000626***	-0.00113**	-0.000636***
	(0.000755)	(0.000760)	(0.000724)	(0.000755)	(0.000173)	(0.000166)	(0.000438)	(0.000166)
N	3258	3258	3258	3258	3071	3071	3071	3071
adj. R^2	0.035	0.036	0.061	0.037	0.048	0.085	0.138	0.095
Optimal lags	5	5	5	5	0	0	0	0
p-value for F Test that growth and inflation change variables (and their lags, where applicable) do not enter	2.13011E-11	6.3826E-11	1.01883E-06	3.12899E-10	0.0713856	0.183389806	0.041894423	0.138324958

Clustered standard errors in parentheses (at country level) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Column (1) assumes that the U.S. dollar is the base currency for all other countries, and the estimated coefficient on its interest rate turns out to be tiny and statistically insignificant. Once countries are matched to more appropriate base currencies—in the currencies they are most likely to shadow, however—the estimated coefficient better than triples (to 0.201) but it remains rather small, and insignificant. In column (3), adding time effects to the column (2) specification reduces the coefficient, as one would expect when the time effect captures global shocks that induce positive covariation in policy rates of interest. Adding the change in the VIX in column (4) *raises* $\hat{\beta}$ compared to column (2), but not significantly so. However, the change in the VIX itself is significant at the 10 percent level, with a rise in the VIX raising the domestic interest rate. The results are consistent with the view that reductions in global-risk aversion are associated with portfolio shifts toward EMEs.

In all column (1)-(4) regressions there is overwhelming evidence for a role of lagged changes in domestic output and inflation—effects that would be absent were domestic interest rates determined entirely by nominal arbitrage without exchange-rate variability. These results, together with the low estimates $\hat{\beta}$, are compatible with substantial interest-rate independence at the short end.

Columns (5)-(8), which analyze long-term rates, present a starkly different picture. In column (5), which takes the U.S. dollar as the universal base, the coefficient on the U.S. bond rate change is significantly different from zero at the 1 percent level, though significantly below 0.5. However, once countries are matched to their most natural base currencies, the coefficient rises above 0.5, remaining highly significant. Time effects lower the coefficient (to 0.433), but the change is not significant and the new slope estimate remains significant at the 1 percent level. Finally, adding the VIX change raises $\hat{\beta}$ substantially, and the VIX variable is itself highly significant, suggesting that the global financial cycle is communicated to long-term interest rates. The effect of a change in the VIX is small but precisely estimated for long-term rates. Interestingly, the auxiliary domestic macro variables usually do not enter this regression with very high significance, and the adjusted R^2 in columns (5)-(8) are uniformly higher than those in columns (1)-(4). The LR picture is one of much less interest-rate independence than in the SR case.

Table 2 breaks out the role of exchange rate pegs by adding specification (2) to specification (1), thereby interacting the interest-rate response with the peg indicator.[29] For the SR case in the first four columns, positive correlations with the base-currency interest rate change are almost entirely due to being pegged. Adding time effects lowers the estimated SR peg effect somewhat, but leaves it potentially large. Adding the VIX change has little impact compared to column (2). Perhaps surprisingly, the peg interactions are not themselves statistically significant, even at the 10 percent level. It may be that the limited commitment under a de facto peg allows substantial room for interest-rate deviations from the base, at least for some of currencies.

The LR $\hat{\beta}$s in the last four columns follow the pattern familiar from table 1. They are reasonably big and very significantly different from zero. While a peg is always estimated to raise the correlation, that result is never statistically significant. It should be noted, however, that because the different base long rates tend to be highly correlated among themselves, adding time effects in this case induces some multicollinearity. As earlier, adding the VIX change raises the estimated coefficient on the base interest rate (both for pegs and non-pegs), and the VIX change itself is highly significant. As in table 1, the auxiliary output and inflation variables are not usually highly significant in the LR regressions of table 2, regardless of the exchange rate regime. (These regressions allow the coefficients on the auxiliary variables to differ as between pegs and non-pegs).

The summary of table 2 is that there is considerable independence at the short end of the term structure apart from pegged exchange rates, whereas long rates remain significantly correlated with those of base-currency countries even in the absence of a peg (although pegs appear to raise the correlation somewhat, compared to non-pegs). As in table 1, given the base long-term rate, the domestic long-term rate appears less responsive to standard domestic macro variables.

29. I adapt, to quarterly data, the de facto currency regime coding method from Klein and Shambaugh (2013) who themselves look at a finer gradation of regimes than just peg or non-peg. See the discussion in the next section. (See the appendix.) I thank Michael Klein and Jay Shambaugh for providing the files underlying their paper.

Table 2. Exchange-Rate Pegs Versus Non-Pegs

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
U.S.-base SR change	0.0261							
	(0.178)							
Peg * U.S.-base SR change	0.122							
	(0.256)							
Multi-base SR change		-0.0256	-0.0948	0.0290				
		(0.312)	(0.394)	(0.322)				
Peg * Multi-base SR change		0.375	0.278	0.362				
		(0.310)	(0.298)	(0.311)				
U.S.-base LR change					0.348***			
					(0.0638)			
Peg * U.S.-base LR change					0.0189			
					(0.158)			
Multi-base LR change						0.495***	0.430***	0.583***
						(0.0976)	(0.157)	(0.0870)
Peg * Multi-base LR change						0.0964	0.00816	0.0890
						(0.111)	(0.101)	(0.107)
VIX Percent change				0.00301*				0.00297***
				(0.00158)				(0.000672)

Table 2. (continued)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
Constant	-0.00181**	-0.00116	0.00123	-0.00114	-0.000836***	-0.000629***	-0.00112**	-0.000643***
	(0.000767)	(0.000760)	(0.00138)	(0.000756)	(0.000202)	(0.000162)	(0.000422)	(0.000161)
N	3258	3258	3258	3258	3071	3071	3071	3071
adj. R^2	0.066	0.087	0.113	0.088	0.048	0.085	0.137	0.095
Optimal lags	5	5	5	5	0	0	0	0
p-value for F Test that growth and inflation change variables (and their lags, where applicable) do not enter	0.000271181	5.45319E-05	3.56323E-05	4.27134E-05	0.054861746	0.271829271	0.138256524	0.225336173
p-value for F Test that controls and Peg interaction term coefficients (and lags, where applicable) sum to zero	3.95008E-18	1.28064E-07	1.08185E-08	1.24208E-07	0.355502	0.661292639	0.265738535	0.569184142
Clustered standard errors in parentheses (at country level) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$								

Tables 3 and 4 contrast the results for developing/emerging and advanced economies (with Newly Industrialized Asia placed in the emerging group). Short-term rates for the developing/EME non-pegs appear less tightly linked to base-currency short-rates than for the advanced group of non-pegs, and for the advanced countries, the marginal effect of being pegged is greater for dollar pegs than for pegs in general; although, there is little difference for developing/EME countries. The time effects regression in column (3) of table 4 suggests that much of the synchronization of advanced short-term rates with base rates is due to common responses to global shocks. Long-term rate coherence with base rates also seems much greater for advanced economies, with quantitatively important pegs only for advanced countries pegged to the U.S. dollar. By and large, the results are not inconsistent with substantial monetary independence in terms of short policy rates, even though the advanced economies move in step to a considerable degree. While the coherence among movements in long-term interest rates being much more pronounced for advanced countries, advanced-country data series on long rates are much longer, and reflect much thicker markets, so the results in table 3, columns (5)-(8), should be interpreted cautiously. To the extent that long-term rate co-movement among advanced countries represents forces of arbitrage, it could capture a weakening of the potency of domestic monetary policies and a channel for monetary spillovers from abroad. A final finding in tables 3 and 4 is the importance of the VIX change for movements in long-term interest rates, given base rate changes for both country groups, but especially for non-advanced economies.

The apparently higher short-term rate independence for developing/emerging economies, compared to advanced economies, could follow from a greater prevalence of capital controls (recall figure 5). As Klein and Shambaugh (2013) document, however, only thoroughgoing and long-standing controls seem effective in conferring greater monetary independence—other things equal.

Turn next to estimation of the dynamic relationship (3). The approach of Pesaran, Shin and Smith (2001), hereinafter PSS, allows for a levels relationship as in (3) between domestic and base rates of interest, even when interest rate levels are stationary. However, different critical regions for test statistics apply depending on whether interest rates are I(0) or I(1). PSS tabulate the appropriate critical values. Because the data are monthly, the vector $\boldsymbol{X}$ in (3) includes only the level of CPI inflation.

Tables 5 and 6 report results for short-term and long-term nominal interest rates, respectively, with all countries measured against the U.S. dollar as base currency. The columns labeled "PSS F stat" indicate whether the hypothesis $\theta=\xi=\omega=0$ (i.e., no levels relationship) is rejected at the 5 percent level (indicator = 1) or not (indicator = 0) under the alternative assumptions that the variables in specification (3) are, respectively, I(0) and I(1). Similarly, the columns labeled "PSS T stat" concern the hypothesis $\theta=0$.

As expected, there is considerable heterogeneity across countries, even within broad country groupings. Looking at country-group averages, however, the values of ξ have a central tendency in the neighborhood of 1 for both groups, for both short- and long-term interest rates; although, estimates are much more precise for the advanced countries. Thus, the levels relationship (when it exists) is consistent with long-run equality of nominal interest rates at short and long maturities (up to a constant). The average adjustment speed θ for long rates is nearly the same for both country groups, implying adjustment half-lives of about 14.6 to 17.5 months. For short-term rates the adjustment speed appears to be quite a bit faster for developing/emerging economies (about a year, as opposed to over two years), though once again, the standard error of estimation is comparatively large. The data seem consistent with the existence of a long-term levels relationship in a good number of cases when the data are I(0), but generally less so when the data are I(1). It is particularly hard to detect a levels relationship for developing/emerging short-term rates. It is also very hard to reject the hypothesis $\theta=0$ for those rates.

These averages, as noted, conceal considerable idiosyncrasies, even within Asia. For example, with respect to short-term interest rates, Hong Kong shows unitary long-run coherence with U.S. rates and an extremely rapid adjustment speed (half-life below 4 months). Singapore's adjustment speed is even more rapid, but its estimated ξ is only 0.39. Malaysia shows both a ξ value of 0.58, and a slow adjustment speed that implies an estimated half-life of about a year and a half. The results for long-term rates are, on the whole, similar.

The overall impression is that nominal interest rates trend strongly with U.S. rates in the long run, in both country groups, but there is usually considerable medium-run scope for interest-rate independence. As before, however, the possibility of unobserved global shocks to interest rates bedevils the interpretation of these results.

Table 3. Developing/Emerging Economy Subsample

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
U.S.-base SR change	-0.313							
	(0.412)							
Peg * U.S.-base SR change	0.377							
	(0.430)							
Multi-base SR change		-0.407	-0.260	-0.337				
		(0.515)	(0.560)	(0.550)				
Peg * Multi-base SR change		0.480	0.300	0.449				
		(0.500)	(0.542)	(0.513)				
U.S.-base LR change					0.0590			
					(0.132)			
Peg * U.S.-base LR change					0.211			
					(0.188)			
Multi-base LR change						0.194	0.622	0.332***
						(0.125)	(0.490)	(0.113)
Peg * Multi-base LR change						0.0995	0.0390	0.0729
						(0.163)	(0.186)	(0.159)
VIX Percent change				0.00344				0.00375**
				(0.00276)				(0.00141)

Table 3. (continued)

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
Constant	-0.00230	-0.00180	-0.000213	-0.00178	-0.00113**	-0.000971***	-0.00122	-0.000992***
	(0.00153)	(0.00144)	(0.00126)	(0.00144)	(0.000456)	(0.000332)	(0.000832)	(0.000332)
N	1775	1775	1775	1775	1286	1286	1286	1286
adj. R^2	0.073	0.099	0.153	0.099	0.005	0.014	0.088	0.022
Optimal lags	5	5	5	5	0	0	0	0
p-value for F Test that growth and inflation change variables (and their lags, where applicable) do not enter	0.012799281	1.00957E-08	6.81558E-10	2.26485E-09	0.363421235	0.073372722	0.009637445	0.040628087
p-value for F Test that controls and Peg interaction term coefficients (and lags, where applicable) sum to zero	1.30925E-12	1.64653E-06	4.69456E-06	1.21227E-06	0.319557116	0.77502473	0.310767234	0.744519193
Clustered standard errors in parentheses (at country level) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$								

Table 4. Advanced Economy Subsample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
U.S.-base SR change	0.260***							
	(0.0415)							
Peg * U.S.-base SR change	0.671***							
	(0.0936)							
Multi-base SR change		0.518***	0.306*	0.546***				
		(0.133)	(0.152)	(0.129)				
Peg * Multi-base SR change		0.223	0.129	0.225				
		(0.153)	(0.165)	(0.153)				
U.S.-base LR change					0.484***			
					(0.0502)			
Peg * U.S.-base LR change					0.454***			
					(0.0558)			
Multi-base LR change						0.753***	0.582***	0.798***
						(0.107)	(0.147)	(0.104)
Peg * Multi-base LR change						0.0590	-0.0317	0.0639
						(0.124)	(0.0992)	(0.120)
VIX Percent change				0.00197*				0.00199***
				(0.00107)				(0.000475)

Table 4. (continued)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	U.S.-base SR	*Multi-base SR*	*Multi-base SR with Time Effects*	*Multi-base SR with VIX Percent Change*	*U.S.-base LR*	*Multi-base LR*	*Multi-base LR with Time Effects*	*Multi-base LR with VIX Percent Change*
Constant	-0.00109***	-0.000694***	-0.0000462	-0.000705***	-0.000675***	-0.000394***	-0.00111**	-0.000397***
	(0.000158)	(0.000117)	(0.000145)	(0.000114)	(0.0000939)	(0.0000782)	(0.000481)	(0.0000786)
N	1598	1598	1598	1598	1785	1785	1785	1785
adj. R^2	0.086	0.215	0.298	0.221	0.233	0.388	0.482	0.399
Optimal lags	0	0	0	0	0	0	0	0
p-value for F Test that growth and inflation change variables (and their lags, where applicable) do not enter	0.00050801	0.000189404	0.120686741	0.000332068	0.016935281	0.051729132	0.048043523	0.057385095
p-value for F Test that controls and Peg interaction term coefficients (and lags, where applicable) sum to zero	6.16506E-12	0.106312651	0.880379827	0.413387934	8.95003E-11	0.09259661	0.063848163	0.204935031
Clustered standard errors in parentheses (at country level) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$								

Table 5. Short-Term Interest Rate Dynamic Equations with United States as Base Currency

		Coverage	*No. of Obs. (based on optimal number of lags)*	ξ		θ		*PSS F test stat*	*PSS F stat sig. at 0*	*PSS F stat sig. at 1*	*PSS T test stat*	*PSS T stat sig. at 0*	*PSS T stat sig. at 1*	*Half-life (in months)*
	Advanced													
1	Australia	May 1989-Jun 2012	271	0.43	(0.30)	-0.03	(0.01)	6.13	1	1	-3.69	1	1	26.34
2	Belgium	May 1989-Jan 2014	297	1.27	(0.30)	-0.03	(0.01)	6.36	1	1	-3.27	1	0	26.06
3	Canada	May 1989-Feb 2014	297	1.07	(0.27)	-0.03	(0.01)	2.16	0	0	-2.53	0	0	21.06
4	Cyprus	May 1989-Mar 2008	227	0.58	(0.36)	-0.02	(0.01)	1.23	0	0	-1.67	0	0	34.60
5	Denmark	May 1989-Jan 2014	241	1.61	(0.63)	-0.03	(0.01)	2.12	0	0	-2.29	0	0	20.17
6	France	May 1989-Feb 2014	298	1.42	(0.36)	-0.03	(0.01)	3.98	1	0	-3.05	1	0	25.78
7	Germany	May 1989-Feb 2014	298	1.31	(0.26)	-0.02	(0.01)	6.86	1	1	-3.48	1	0	27.50
8	Greece	Nov 1992-Feb 2014	293	-2.03	(1.89)	-0.28	(0.05)	9.50	1	1	-5.34	1	1	2.13
9	Iceland	May 1989-Jan 2013	285	0.78	(0.23)	-0.10	(0.02)	11.91	1	1	-5.94	1	1	6.27
10	Ireland	Feb 1997-Feb 2014	205	0.88	(0.15)	-0.06	(0.02)	5.03	1	1	-3.40	1	0	11.55

Table 5. (continued)

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Advanced													
11	Italy	May 1989-Jan 2014	297	1.14	(0.40)	-0.03	(0.01)	4.32	1	0	-3.33	1	0	20.60
12	Japan	May 1989-Jan 2014	296	0.73	(0.44)	-0.01	(0.01)	1.39	0	0	-1.88	0	0	62.04
13	Malta	May 1989-Feb 2014	298	0.90	(0.20)	-0.03	(0.01)	6.04	1	1	-3.02	1	0	26.68
14	Netherlands	May 1989-Jan 2014	297	1.48	(0.33)	-0.02	(0.01)	8.04	1	1	-3.35	1	0	35.77
15	Norway	May 1989-Feb 2014	296	1.18	(0.27)	-0.05	(0.01)	5.85	1	1	-3.92	1	1	12.46
16	Portugal	May 1989 -Feb 2014	287	1.91	(0.74)	-0.01	(0.01)	2.07	0	0	-2.18	0	0	46.21
17	Spain	May 1989-Feb 2014	297	1.24	(0.39)	-0.02	(0.01)	5.53	1	1	-3.33	1	0	38.61
18	Sweden	May 1989-Jan 2014	297	1.20	(0.35)	-0.04	(0.01)	4.72	1	0	-3.61	1	1	17.04
19	Switzerland	May 1989-Feb 2014	296	0.91	(0.28)	-0.03	(0.01)	4.68	1	0	-3.05	1	0	24.25
20	United Kingdom	May 1989-Jan 2014	296	1.42	(0.22)	-0.03	(0.01)	3.95	1	0	-3.36	1	0	23.70

Table 5. (continued)

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Developing/ emerging													
1	Albania	Sep 1994-Oct 2013	228	3.11	(1.62)	-0.02	(0.01)	2.20	0	0	-2.02	0	0	38.61
2	Argentina	Nov 2002-Feb 2014	52	11.69	(16.79)	-0.18	(0.22)	0.79	0	0	-0.82	0	0	3.55
3	Armenia	Nov 1995-Feb 2014	165	4.32	(11.52)	-0.03	(0.03)	0.94	0	0	-0.77	0	0	25.48
4	Azerbaijan	Feb 2008-Feb 2014	66	2.40	(2.83)	-0.10	(0.07)	1.19	0	0	-1.43	0	0	6.35
5	Brazil	Mar 1995-Nov 2012	203	1.39	(0.61)	-0.15	(0.03)	9.56	1	1	-4.41	1	1	4.19
6	Bulgaria	Mar 1998-Jan 2008	118	0.49	(0.21)	-0.10	(0.03)	5.26	1	1	-3.20	1	0	6.74
7	Chile	Sep 1997-Sep 2012	171	0.08	(0.69)	-0.06	(0.02)	5.12	1	1	-3.05	1	0	11.81
8	China	Aug 1997-Dec 2013	194	-0.46	(0.45)	-0.05	(0.02)	5.75	1	1	-2.27	0	0	13.01
9	Colombia	Mar 1998-Feb 2014	165	0.88	(0.22)	-0.17	(0.03)	13.96	1	1	-6.42	1	1	3.62
10	Croatia	Feb 2001-Dec 2013	155	0.14	(0.42)	-0.06	(0.02)	2.00	0	0	-2.44	0	0	11.87

Table 5. (continued)

		Coverage	*No. of Obs. (based on optimal number of lags)*	ξ		θ		*PSS F test stat*	*PSS F stat sig. at 0*	*PSS F stat sig. at 1*	*PSS T test stat*	*PSS T stat sig. at 0*	*PSS T stat sig. at 1*	*Half-life (in months)*
	Developing/ emerging													
11	Czech Republic	Oct 1993- Jan 2014	243	1.05	(0.39)	-0.02	(0.01)	7.05	1	1	-3.46	1	0	27.66
12	Egypt	Mar 1991- Feb 2014	275	-0.23	(0.46)	-0.05	(0.01)	6.03	1	1	-3.21	1	0	14.51
13	Fiji	May 1989- Jun 2013	290	0.46	(0.25)	-0.09	(0.03)	5.38	1	1	-3.56	1	1	7.32
14	Ghana	Mar 1990- Mar 2013	277	3.83	(1.85)	-0.02	(0.01)	2.56	0	0	-2.58	0	0	31.97
15	Guyana	May 1989- Dec 2013	274	1.05	(1.24)	-0.02	(0.01)	3.09	0	0	-2.53	0	0	39.01
16	Hong Kong	Aug 1991- Feb 2014	271	1.09	(0.10)	-0.17	(0.04)	6.70	1	1	-4.41	1	1	3.72
17	Hungary	Mar 1992- Feb 2014	258	0.05	(1.01)	-0.03	(0.02)	1.90	0	0	-2.28	0	0	19.89
18	India	Mar 1993- Jan 2014	251	0.73	(0.28)	-0.09	(0.03)	3.29	0	0	-3.14	1	0	7.50
19	Israel	Mar 1992 - Jan 2014	263	1.01	(0.34)	-0.05	(0.01)	30.97	1	1	-4.74	1	1	13.77
20	Kazakhstan	Jun 1994- Feb 2014	225	1.74	(0.65)	-0.08	(0.02)	7.84	1	1	-4.35	1	1	8.41

Table 5. (continued)

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Developing/ emerging													
21	Kenya	May 1989- Dec 2013	293	1.48	(0.96)	-0.06	(0.01)	6.90	1	1	-4.36	1	1	11.73
22	Kuwait	May 1989- Jan 2005	189	1.78	(0.79)	-0.02	(0.01)	2.01	0	0	-1.47	0	0	31.50
23	Kyrgyzstan	Mar 1994- Dec 2013	211	6.92	(1.71)	-0.15	(0.04)	4.82	1	0	-3.69	1	1	4.30
24	Latvia	July 1994- Jan 2014	234	1.19	(1.08)	-0.03	(0.01)	2.86	0	0	-2.74	0	0	22.83
25	Lebanon	Feb 2003- Feb 2014	124	-0.04	(0.09)	-0.07	(0.02)	5.82	1	1	-3.43	1	0	9.60
26	Malaysia	Jan 1989- Feb 2014	298	0.58	(0.21)	-0.04	(0.01)	3.81	1	0	-3.22	1	0	17.76
27	Mexico	May 1989- Dec 2013	293	3.14	(1.42)	-0.08	(0.04)	3.23	0	0	-1.82	0	0	8.68
28	Moldova	May 1995- Feb 2014	197	2.63	(1.14)	-0.08	(0.03)	3.57	0	0	-3.16	1	0	8.10
29	Nepal	May 1989- Dec 2013	296	0.76	(0.47)	-0.06	(0.02)	5.14	1	1	-2.86	0	0	12.23
30	Nigeria	Mar 1995- Feb 2014	228	0.53	(0.82)	-0.04	(0.02)	2.64	0	0	-2.56	0	0	16.69

Table 5. (continued)

		Coverage	*No. of Obs. (based on optimal number of lags)*	ξ		θ		*PSS F test stat*	*PSS F stat sig. at 0*	*PSS F stat sig. at 1*	*PSS T test stat*	*PSS T stat sig. at 0*	*PSS T stat sig. at 1*	*Half-life (in months)*
	Developing/ emerging													
31	Oman	Jun 1996-Feb 2014	213	1.02	(0.09)	-0.11	(0.03)	5.56	1	1	-4.00	1	1	6.00
32	Pakistan	May 1991-Feb 2014	274	1.27	(0.71)	-0.03	(0.01)	6.14	1	1	-2.64	0	0	24.92
33	Philippines	May 1989-Feb 2014	294	2.34	(0.52)	-0.06	(0.02)	5.03	1	1	-3.67	1	1	11.21
34	Poland	Jul 1991-Feb 2014	260	1.12	(0.37)	-0.07	(0.02)	8.64	1	1	-3.76	1	1	9.95
35	Romania	May 1994-Sep 2005	130	4.47	(2.49)	-0.31	(0.12)	3.13	0	0	-2.58	0	0	1.89
36	Russia	Sep 1994-Feb 2014	190	1.36	(1.16)	-0.28	(0.06)	7.98	1	1	-4.79	1	1	2.08
37	Rwanda	Mar 1999-Feb 2014	179	-0.08	(0.38)	-0.06	(0.03)	3.43	0	0	-2.39	0	0	10.62
38	Singapore	May 1989-Jan 2014	297	0.39	(0.05)	-0.23	(0.04)	13.06	1	1	-6.21	1	1	2.63
39	Slovakia	Apr 1993-Dec 2007	177	1.81	(2.40)	-0.03	(0.02)	1.82	0	0	-1.51	0	0	19.87
40	Slovenia	Mar 2000-Feb 2014	159	1.73	(0.51)	-0.04	(0.01)	3.95	1	0	-3.10	1	0	17.43

Table 5. (continued)

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Developing/ emerging													
41	South Africa	May 1989-Jan 2014	291	1.31	(0.29)	-0.04	(0.01)	6.10	1	1	-4.08	1	1	15.97
42	South Korea	Nov 2006-Feb 2014	88	0.53	(0.09)	-0.09	(0.02)	11.48	1	1	-4.99	1	1	7.23
43	Taiwan	May 1989-Feb 2014	298	1.02	(0.29)	-0.02	(0.01)	2.27	0	0	-2.38	0	0	35.51
44	Tanzania	Feb 1994-Jan 2014	229	-0.22	(0.68)	-0.10	(0.03)	5.64	1	1	-3.62	1	1	6.72
45	Thailand	Mar 1997-Feb 2014	178	0.25	(0.17)	-0.07	(0.01)	19.49	1	1	-6.89	1	1	9.12
46	Turkey	May 1989-Feb 2014	281	1.10	(2.70)	-0.12	(0.04)	3.62	0	0	-3.16	1	0	5.36
47	Uganda	May 1996-Feb 2014	213	0.30	(0.54)	-0.09	(0.03)	5.11	1	1	-3.35	1	0	6.97
48	Uruguay	Feb 1993-Dec 2013	183	-0.14	(0.30)	-0.27	(0.04)	12.68	1	1	-6.13	1	1	2.23
49	Venezuela	Feb 1997-Dec 2003	83	-0.33	(2.50)	-0.10	(0.05)	1.74	0	0	-2.18	0	0	6.61
50	Zambia	May 1989-Feb 2014	292	-1.34	(2.76)	-0.06	(0.02)	6.95	1	1	-3.88	1	1	11.41

Table 5. (continued)

Coverage	No. of Obs. (based on optimal number of lags)	ξ	θ	PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
Average										
	Advanced	0.97 (0.42)	-0.05 (0.01)		75%	50%		75%	25%	25.44
	Developing/ Emerging	1.43 (1.39)	-0.09 (0.03)		60%	54%		60%	38%	13.12

Standard errors in parentheses.
ξ: Levels relationship.
θ: Adjustment speed to shocks in the levels relationship.
Sig. at 0: whether we can reject no levels relationship at the 5% level if we assume the data are stationary.
Sig. at 1: whether we can reject no levels relationship at the 5% level if we assume the data are nonstationary.
Half-life: The half-life of a shock (in months), based on the adjustment speed.

Table 6. Long-Term Interest Rate Dynamic Equations with United States as Base Currency

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Advanced													
1	Australia	May 1989-Jun 2012	271	0.74	(0.39)	-0.03	(0.01)	4.07	1	0	-2.28	0	0	24.3
2	Austria	May 1989-Jan 2014	297	1.10	(0.11)	-0.06	(0.02)	6.73	1	1	-3.90	1	1	11.4
3	Belgium	May 1989-Jan 2014	297	1.20	(0.15)	-0.05	(0.01)	5.06	1	1	-3.35	1	0	14.9
4	Canada	May 1989-Feb 2014	298	1.29	(0.11)	-0.05	(0.02)	3.21	0	0	-3.08	1	0	13.2
5	Cyprus	Jan 1998 - Feb 2014	194	0.01	(0.71)	-0.02	(0.02)	1.28	0	0	-1.48	0	0	30.3
6	Denmark	May 1989-Jan 2014	297	1.40	(0.10)	-0.07	(0.02)	7.50	1	1	-4.30	1	1	9.2
7	Finland	May 1989-Jan 2014	297	1.71	(0.29)	-0.03	(0.01)	2.54	0	0	-2.70	0	0	22.8
8	France	May 1989-Feb 2014	298	1.18	(0.11)	-0.05	(0.01)	6.29	1	1	-3.98	1	1	12.3
9	Germany	May 1989-Feb 2014	298	1.15	(0.06)	-0.09	(0.02)	16.02	1	1	-5.84	1	1	7.1
10	Greece	May 1989-Jan 2014	255	-0.90	(2.14)	-0.03	(0.01)	1.93	0	0	-2.33	0	0	21.5
11	Iceland	May 2004 - Jan 2014	117	1.09	(0.23)	-0.32	(0.07)	8.11	1	1	-4.73	1	1	1.8

Table 6. (continued)

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Advanced													
12	Ireland	Feb 1997-Jan 2014	204	0.14	(0.95)	-0.02	(0.02)	1.48	0	0	-1.35	0	0	28.9
13	Italy	Mar 1989-Feb 2014	297	1.58	(0.55)	-0.02	(0.01)	2.15	0	0	-2.48	0	0	30.1
14	Japan	May 1989-Jan 2014	297	0.69	(0.21)	-0.03	(0.01)	2.70	0	0	-2.53	0	0	25.8
15	Malta	Feb 2000 - Feb 2014	169	1.18	(0.62)	-0.03	(0.02)	2.24	0	0	-1.43	0	0	24.9
16	Netherlands	May 1989-Jan 2014	297	1.18	(0.08)	-0.07	(0.01)	9.86	1	1	-4.76	1	1	9.8
17	Norway	May 1989-Feb 2014	298	1.26	(0.13)	-0.05	(0.01)	4.83	1	0	-3.75	1	1	12.8
18	Portugal	May 1989-Jan 2014	264	0.99	(0.68)	-0.04	(0.01)	5.55	1	1	-3.97	1	1	17.5
19	Spain	May 1989-Feb 2014	298	1.11	(0.49)	-0.02	(0.01)	3.21	0	0	-2.38	0	0	30.6
20	Sweden	May 1989-Jan 2014	298	1.55	(0.20)	-0.04	(0.01)	4.53	1	0	-3.52	1	0	17.2
21	Switzerland	Mar 1989-Feb 2014	298	0.88	(0.07)	-0.07	(0.02)	8.69	1	1	-4.63	1	1	9.5
22	United Kingdom	May 1989-Jan 2014	297	1.37	(0.11)	-0.07	(0.02)	6.35	1	1	-4.02	1	1	9.8

Table 6. (continued)

		Coverage	*No. of Obs. (based on optimal number of lags)*	ξ		θ		*PSS F test stat*	*PSS F stat sig. at 0*	*PSS F stat sig. at 1*	*PSS T test stat*	*PSS T stat sig. at 0*	*PSS T stat sig. at 1*	*Half-life (in months)*
	Developing/ emerging													
1	Brazil	Jan 2000-Dec 2006	84	-3.42	(8.78)	0.04	(0.06)	4.34	1	0	0.75	0	0	..
2	Bulgaria	Mar 1998-Nov 2009	141	0.46	(1.17)	-0.05	(0.03)	1.54	0	0	-2.05	0	0	12.5
3	Chile	Sep 2004-Feb 2014	94	0.39	(0.14)	-0.21	(0.05)	6.31	1	1	-3.91	1	1	2.9
4	China	Dec 2006-Feb 2014	87	0.11	(0.14)	-0.13	(0.04)	4.51	1	0	-3.38	1	0	5.1
5	Czech Republic	Jun 2000 - Feb 2014	165	1.16	(0.33)	-0.06	(0.02)	3.43	0	0	-2.60	0	0	11.2
6	Fiji	Feb 2001-Jun 2013	149	0.83	(1.08)	-0.03	(0.02)	1.07	0	0	-1.51	0	0	19.5
7	Hong Kong	Dec 1996-Jan 2014	206	1.53	(0.27)	-0.09	(0.03)	3.24	0	0	-3.08	1	0	7.7
8	Hungary	Mar 1999-Feb 2014	180	0.11	(0.29)	-0.12	(0.04)	3.70	0	0	-3.31	1	0	5.4
9	India	May 1989-Jan 2014	297	0.98	(0.44)	-0.03	(0.01)	3.15	0	0	-2.25	0	0	21.2

Table 6. (continued)

		Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
	Developing / emerging													
10	Israel	Mar 1997-Feb 2014	204	1.23	(1.11)	-0.02	(0.01)	6.24	1	1	-1.46	0	0	33.6
11	Kazakhstan	May 1998-Feb 2014	190	2.01	(1.00)	-0.02	(0.01)	1.91	0	0	-1.81	0	0	29.0
12	Latvia	Feb 1999-Dec 2013	177	-0.05	(1.12)	-0.03	(0.01)	2.42	0	0	-2.20	0	0	21.5
13	Malaysia	Mar 1996-Jan 2014	215	0.64	(0.23)	-0.04	(0.02)	3.78	0	0	-2.69	0	0	16.7
14	Mexico	Dec 1999-Feb 2014	104	0.64	(0.23)	-0.11	(0.04)	3.76	0	0	-2.92	1	0	5.9
15	Pakistan	May 1989-Feb 2014	290	-1.12	(0.69)	-0.02	(0.01)	4.43	1	0	-1.92	0	0	36.46
16	Philippines	Apr 1999-Jul 2013	172	2.66	(0.95)	-0.04	(0.02)	1.34	0	0	-1.99	0	0	16.9
17	Poland	Jul 1999-Feb 2014	176	1.44	(0.40)	-0.06	(0.02)	5.25	1	1	-3.31	1	0	11.4
18	Russia	Feb 1997-Feb 2014	205	1.82	(2.20)	-0.07	(0.04)	1.94	0	0	-1.76	0	0	10.3

Table 6. (continued)

		Coverage	*No. of Obs. (based on optimal number of lags)*	ξ		θ		*PSS F test stat*	*PSS F stat sig. at 0*	*PSS F stat sig. at 1*	*PSS T test stat*	*PSS T stat sig. at 0*	*PSS T stat sig. at 1*	*Half-life (in months)*
	Developing/ emerging													
19	Singapore	Aug 1998-Feb 2014	185	0.64	(0.06)	-0.19	(0.04)	9.83	1	1	-5.33	1	1	3.3
20	Slovakia	Jan 1995-Feb 2014	226	5.49	(3.20)	-0.03	(0.02)	2.74	0	0	-1.62	0	0	25.0
21	Slovenia	May 2002-Feb 2014	142	-0.56	(0.39)	-0.09	(0.03)	4.82	1	0	-3.52	1	0	7.5
22	South Africa	May 1989 -Feb 2014	298	1.49	(0.29)	-0.05	(0.02)	5.57	1	1	-3.62	1	1	12.3
23	South Korea	Dec 2000-Feb 2014	158	0.92	(0.24)	-0.08	(0.03)	2.29	0	0	-2.59	0	0	8.9
24	Taiwan	May 1995-Jan 2014	227	1.16	(0.25)	-0.03	(0.01)	2.45	0	0	-2.68	0	0	21.8
25	Tanzania	Dec 2002-Jan 2014	134	0.18	(1.35)	-0.06	(0.03)	2.00	0	0	-2.42	0	0	10.91
26	Thailand	May 1989-Feb 2014	298	1.50	(0.24)	-0.04	(0.01)	9.66	1	1	-3.91	1	1	15.1
27	Vietnam	Jul 2009-Feb 2014	56	2.75	(1.60)	-0.07	(0.04)	3.73	0	0	-1.90	0	0	9.88
28	Zambia	Oct 2007-Feb 2014	77	-0.16	(1.77)	-0.05	(0.04)	0.80	0	0	-1.14	0	0	13.23

Table 6. (continued)

Coverage	No. of Obs. (based on optimal number of lags)	ξ		θ		PSS F test stat	PSS F stat sig. at 0	PSS F stat sig. at 1	PSS T test stat	PSS T stat sig. at 0	PSS T stat sig. at 1	Half-life (in months)
Average												
	Advanced	1.00	(0.39)	-0.06	(0.02)		59%	45%		59%	45%	17.54
	Developing/ Emerging	0.89	(1.07)	-0.06	(0.03)		36%	21%		36%	14%	14.64

Standard errors in parentheses.
ξ: Levels relationship.
θ: Adjustment speed to shocks in the levels relationship.
Sig. at 0: whether we can reject no levels relationship at the 5% level if we assume the data are stationary.
Sig. at 1: whether we can reject no levels relationship at the 5% level if we assume the data are nonstationary.
Half-life: The half-life of a shock (in months), based on the adjustment speed.

4. Trilemmas and Tradeoffs

In line with previous research, the results of the preceding section indicate considerable scope for countries that do not peg their exchange rates to vary *short-term* nominal interest rates independently of foreign nominal interest rates. In addition, changes in short-term rates appear to reflect changes in domestic variables such as inflation and output. Independence of *long-term* rates seems lower, regardless of the exchange regime, and the relation of changes in long-term rates to key domestic macro variables is more tenuous.

Rey (2013) summarizes earlier studies and new evidence of her own suggesting that foreign financial shocks beside interest rates spill across national borders, even when exchange rates are flexible. She concludes that:

> Monetary conditions are transmitted from the main financial centers to the rest of the world through gross credit flows and leverage, irrespective of the exchange rate regime…. Fluctuating exchange rates cannot insulate economies from the global financial cycle, when capital is mobile. The "trilemma" morphs into a "dilemma"—independent monetary policies are possible if and only if the capital account is managed, directly or indirectly, regardless of the exchange-rate regime.

Because nominal interest-rate independence is demonstrably less where currencies are pegged, one is led to ask if this interest-rate independence matters at all. Is there any advantage to having a flexible exchange rate? Rose (2014), for example, shows that it is hard to detect systematic differences between economic outcomes for hard currency pegs and inflation targeting regimes for small economies. As he acknowledges, however, currency regime choice is not exogenous (and, in particular, seems related to the degree of democracy). Di Giovanni and Shambaugh (2008) take a more direct approach to seek benefits from partial independence of interest rates. They demonstrate that comparative interest-rate independence allows countries with flexible exchange rates to shield themselves from the contractionary output effects of higher interest rates abroad. In contrast, countries with pegs suffer more.[30]

Such evidence suggests that, provided an EME's policy interest rate feeds through to other domestic interest rates and demand,

30. Aizenman, Chinn and Ito (2010) report a similar finding and also trace different country groups' approaches to navigating the monetary trilemma over time.

its central bank retains a capacity to steer the economy, and the capacity is greater the more willing the bank to allow exchange rates to fluctuate and depart from the U.S. interest rate. Klein and Shambaugh (2013) present striking confirmation that even countries that dampen exchange rate fluctuations still enjoy some short-term interest-rate independence (though not as much as those that freely float). And of course, countries that manage exchange rates flexibly (or let them float) do not provide a one-way bet for speculators—they seem to be less susceptible to various types of crisis, including growth collapses of the type seen recently in some eurozone countries.[31]

Thus, it strikes me as not really fruitful to ask if the exchange-rate regime materially influences the scope for monetary policy independence. Of course it does. It is unquestionably true, as Rey asserts, "monetary conditions are transmitted from the main financial centers to the rest of the world through gross credit flows and leverage." However, the exchange rate regime is central to the channels of transmission and to the range of policy responses available. The monetary trilemma remains valid.

This is not to say that even monetary independence makes the available menu of options attractive when the capital account is fully open. We learned soon after the fall of the Bretton Woods system in 1973 that floating exchange rates could be helpful in the face of some economic shocks but almost never provide full insulation against disturbances from abroad. Rather, they provide an expanded choice menu for policymakers, but with no guarantee that the available choices will be pleasant. This has proven especially true in the face of recent financial cycles in the rich economies. The monetary *trilemma* remains, but the difficulty of the *tradeoffs* that alternative policy choices entail can be worsened by financial globalization.

To understand the tradeoff problem we need to ask what exactly monetary policy autonomy or independence *means*. I would define it as the ability to pursue a range of domestic goals. An exchange rate peg clearly precludes this pursuit when capital flows freely across the border. Woodford's (2010) analysis demonstrates that when there is one target only—an inflation rate—then monetary autonomy is possible if the exchange rate floats. Woodford shows within a variety of New Keynesian models that under a float, the central bank can

31. See Ghosh, Ostry and Qureshi (2015). Rose's (2014) discussion points to the recent durability of flexible exchange-rate/inflation targeting regimes.

always shift the dynamic aggregate demand curve to achieve a desired inflation target.

Normally, however, the monetary authority has *multiple* goals, and this is where the tradeoff problem arises.

Even in a hypothetical closed economy, monetary policy faces difficult tradeoffs. The most basic is that between inflation and unemployment. Under certain favorable conditions—essentially, that price pressure (as modeled by a New Keynesian Phillips curve) depends only upon the gap between output and its first-best level—there is no tradeoff, as monetary policy can hit both targets simultaneously. This is Blanchard and Galí's (2007) "divine coincidence." But in general, for example, when there are real wage rigidities, the coincidence fails, and the single instrument of monetary policy has somehow to navigate between the two targets, minimizing a policy loss function subject to a less favorable inflation/unemployment tradeoff.

Opening up the economy may raise further non-financial problems because the impact of exchange-rate changes on sectoral resource allocation and income distribution is generally far from neutral. Neither in theory not in practice is there generally a "divine coincidence" for the exchange rate.

Speaking from the central banker's perspective, Fischer (2010) summarizes eloquently:

Not infrequently we hear central bankers say something like: "We have only one instrument, money growth (or the interest rate), and so we can have only one target, inflation." This view may be based on the targets and instruments approach of Tinbergen, of over fifty years ago, the general result of which was that you need as many instruments as targets. That view is correct if you have to hit the target exactly.

But it is not correct if the problem is set up as is typical in microeconomics, where the goal is to maximize a utility function subject to constrains, in a situation where for whatever reason it is not possible to hit all the targets precisely and all the time. Among the reasons we may not be abble to hit our targets precisely and all the time is that there may be more targets than instruments, for instance when the central bank's maximum is a function of output and growth. In that case we have to find marginal conditions for a maximum, and talk about tradeoffs in explaining the optimum.

Most relevant for the present discussion are the implications for financial stability. The GFC and euro crises underscore that the tradeoff problem arises, even in a closed economy, when monetary policy is additionally burdened with a financial stability remit. In an economy with nominal rigidities, for example, excessive private borrowing may entail negative demand externalities, which private agents do not internalize (see Eggertsson and Krugman, 2012; Farhi and Werning, 2013; among others). High debt may then lead to recession and liquidity traps. If authorities do not have the first-best tools available to correct the externalities from debt issuance, then even in an economy characterized by a "divine coincidence" between output and inflation goals, monetary policy might need to deviate from price stability and full employment in order to restrain debt buildups. In the absence of effective macroprudential tools, an optimal monetary policy could be drawn away from exclusive devotion to traditional macroeconomic goals (even if these would be attainable absent financial stability concerns).

In this hypothetical closed-economy setting, monetary policy does not become *ineffective*, but "independence" of monetary policy certainly remains; however, because authorities now face a *tradeoff* between standard macro objectives and other targets, they will intentionally set monetary policy so as to miss all targets in a way that balances the marginal costs of the various discrepancies. Monetary policy simply carries a bigger burden than it would without financial-market distortions.

No one would expect this problem to disappear in an open economy, especially when its capital account is full open. And it does not. By themselves, exchange-rate changes would not shut out global financial developments even for policymakers willing to allow exchange rates to float free of intervention. Several theoretical models provide ample confirmation that even in the unrealistically favorable case where national policymakers cooperate, financial frictions that cannot be addressed through other tools will lead to deviations from price stability.[32]

Indeed, the problem confronting monetary policy is likely to be *even worse* in the open economy, because openness to global financial markets will inevitably degrade the effectiveness of the macro-prudential tools that are available. The tradeoff between macro stabilization and financial stability becomes even worse in the sense that the optimal monetary policy will deviate even more from first-best macro stabilization than in the closed economy. If the effects

32. For a recent contribution, see Kolasa and Lombardo (2014).

of monetary tools are weakened because of openness, tradeoffs will become harsher still. Despite this, independent monetary policy will still be possible, and more so the less tightly the exchange rate is managed. For example, if a bigger interest rate change is needed to bring about a given demand response in an open economy, this may worsen the macro-prudential problem by increasing the fragility of banks and encouraging gross financial inflows.

The proposition that the efficacy of financial stability policies is weakened in the open economy follows from the *financial trilemma* formulated by Schoenmaker (2013). According to this trilemma, only two of the following three can be enjoyed simultaneously:

1. National control over financial policies.
2. Financial integration with the global market.
3. Financial stability.

For example, it may do little good to place restrictions on lenders within one's jurisdiction if foreign lenders can enter the market and operate without restriction. As another example, direct limitation of residents' domestic foreign-currency borrowing is less effective if the same entities can issue foreign-currency debt in offshore markets. [33]

Moreover, the reliance of financial insurance and resolution policies on the national budget can segment global financial and capital markets along national lines (while also damaging stability), as in the eurozone today. In a world of large-scale globalized finance, countries need to preserve precautionary fiscal space against financial crises. Thus, the financial trilemma can imply heavier constraints on fiscal policy as well as on monetary policy in its pursuit of domestic objectives.

Of course, the Basel Committee on Banking Supervision has been grappling with the financial trilemma since 1974, gradually but continually extending the scope and efficacy of international regulatory cooperation. The Basel III blueprint is part of the latest reform wave. Significantly (as observed by Borio, McCauley and McGuire, 2011), Basel III calls for jurisdictional reciprocity in the application of countercyclical capital buffers so that foreign banks with loans to a country that has invoked the supplementary capital

33. Ostry, Ghosh, Chamon, and Qureshi (2012) assess the effects of macroprudential and capital-control policies for a sample of 51 EMEs over 1995-2008. While finding that these policies can favorably influence aggregate indicators of financial fragility, they note the difficulty of using macroprudential policy effectively when activity can migrate to unregulated venues.

buffer are also subject to the buffer with respect to those loans.[34] By raising the effectiveness of domestic authorities' macro-prudential tools, this provision reduces the burden on monetary policy.[35]

To summarize, even for small economies buffeted by a global financial cycle, the monetary trilemma is still valid: with open capital markets, monetary authorities have far more room for maneuver than if they pegged the exchange rate. That does not mean their lives will be easy, however. Because of the financial trilemma, the impact of monetary policy on financial stability will inevitably play a bigger role in their decisions. In the face of a less favorable tradeoff between financial and macro stability, they may well be forced farther from both.

5. Conclusion

Smaller economies face downsides in living with globalization. There is an inherent tension between lowering trade barriers—an approach that offers a range of gains from trade—and the implied necessity for exposing oneself to shocks and trends from abroad. These foreign disturbances range from external relative price trends that alter the home income distribution, to financial developments of the type discussed above. Government policies, including monetary and financial policies, have the potential to move the economy to a preferred point on the tradeoff between downsides and benefits.

Inefficacy of one policy instrument, however, raises the burden on the others, leaving the economy worse off in general. I have argued that while globalization places some limits on *monetary* policy, even with flexible exchange rates, the bigger problem is the enhanced difficulty of effective *financial* policy in an open economy: the financial trilemma. As for monetary policy, most emerging economies that have chosen a resolution of the monetary trilemma based on exchange rate flexibility have gained.

The paper's analysis raises questions for both future research and policy:

34. See Basel Committee on Banking Supervision (2011, p. 58, n. 49).

35. Some countries are also taking unilateral action. For example, the Federal Reserve, in February 2014, required foreign banking organizations with sufficiently large U.S. assets to set up U.S. intermediate holding companies for their American subsidiaries. These holding companies will be subject to U.S. regulation.

• One of the most potent channels for international monetary and financial transmission clearly runs through long-term interest rates. What factors are most important in determining these correlations—expected short-term rates, term premiums, or currency risk premiums? And what are the implications for domestic monetary control?

• If capital flows create a severe tradeoff problem and macroprudential policies are weakened by imperfect international coordination, then as Rey (2013) points out, the costs and benefits of capital controls come into focus. When are capital controls helpful, what types of controls are even effective, and what globally agreed norms and procedures might allow controls to play a constructive role in the international system? In particular, in what ways does it matter that countries might use capital controls to pursue competitiveness as well as financial stability goals?

• If explicit regular coordination of central bank monetary policies is unrealistic, are there other areas for cooperation that could partially substitute and thereby supplement the Basel process? One potential example is the network of central bank swap lines introduced during the GFC, and established on a permanent basis among six advanced-country central banks in October 2013. This innovation effectively allows the lender-of-last resort function to be practiced in multiple currencies. Could it gradually be extended to a broader set of participant countries?

In discussing measures to mitigate the downsides of financial globalization, it is important to keep the upsides in view. Financial market integration promotes not just gross debt expansion through two-way capital flows, but also international risk sharing. The trend shift from foreign debt to equity finance, illustrated in figures 3 and 4, is a stabilizing effect of globalization with the potential to make domestic monetary policy more, not less, effective. Thus, policies to discourage debt finance further, including the very high debt levels of globally active banks, have considerable potential to raise national welfare.

Data Appendix

Short-term interest rates: Three-month, local-currency, short-term interest rates come from the Global Financial Data database. Three-month treasury bill rates are used for all countries, other than Libor-like three-month money market rates for Azerbaijan, Moldova, Oman, Qatar, and Vietnam. In a few cases (e.g., Kenya), treasury bill rate data are the time series reported by central banks and government statistical agencies. The quarterly data analyzed are averages of end-month rates.

Long-term interest rates: Ten-year, local-currency, government bond rates come from Thomson Reuters Datastream and the Global Financial Data database. The quarterly data analyzed are averages of end-month rates.

Consumer price indices: Monthly consumer price indices (CPI) from Thomson Reuters Datastream and Global Financial Data. For Australia, producer price index.

Real GDP: Quarterly seasonally adjusted GDP data from Thomson Reuters Datastream, OECD, Eurostat, and the Federal Reserve Economic Data (FRED) database of the St. Louis Fed. Where necessary, nominal GDP data were deflated by the GDP deflator and non-seasonally adjusted data were adjusted. Seasonal adjustments were based on the X-12-ARIMA quarterly seasonal adjustment method from the U.S. Census Bureau. The following countries' GDP data were seasonally adjusted by this method: Armenia, Brazil, China, Croatia, Egypt, Hong Kong, Hungary, India, Indonesia, Jordan, Kazakhstan, Latvia, Nigeria, and Poland.

Pegs/non-pegs: The paper uses Klein and Shambaugh's (2013) annual de facto coding method to distinguish pegs from non-pegs, but I apply it at quarterly frequency and require that a peg lasts at least eight consecutive quarters. In the present paper, only the most restricted classification of pegs is used (that is, soft pegs, as defined by Klein and Shambaugh, are not considered to be pegs). Pegs are defined as restricted within a +/- 2% band relative to the base country currency. The Klein-Shambaugh soft pegs move within a +/- 5% band.

Base countries: From Klein and Shambaugh (2013). The only exceptions are Cyprus and Malta, assigned the base country of Germany rather than France. Taiwan, not included in the Klein-Shambaugh sample, has the U.S. as its base country.

CBOE S&P 500 Volatility Index (VIX): Quarterly average of end-month data, from Global Financial Data.

Data coverage for the dynamic interest-rate equations is detailed by country in tables 5 and 6. Coverage for the pooled/panel regressions (tables 1-4) is as follows:

	Advanced	*Base currency*	*LR pooled / panel*	*SR pooled / panel*
1	Australia	U.S.	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
2	Austria	Germany	Q3 1989 - Q4 2013	Q3 1989-Q4 1990
3	Belgium	Germany	Q2 1995 - Q4 2013	Q2 1995 - Q4 2013
4	Canada	U.S.	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
5	Cyprus	Germany	Q1 1998 - Q4 2013	Q2 1995 - Q1 2008
6	Denmark	Germany	Q2 1991 - Q4 2013	Q2 1991 - Q4 2013
7	Finland	Germany	Q2 1990 - Q4 2013	Q2 2012 - Q2 2013
8	France	Germany	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
9	Germany	U.S.	Q2 1991 - Q4 2013	Q2 1991 - Q4 2013
10	Greece	Germany	Q2 2000 - Q2 2008	Q2 2000 - Q2 2008
11	Iceland	U.S./Germany	Q2 2004 - Q4 2013	Q2 1997 - Q1 2013
12	Ireland	Germany	Q2 1997 - Q4 2013	Q2 1997 - Q4 2013
13	Italy	Germany	Q2 1991 - Q4 2013	Q2 1991 - Q4 2013
14	Japan	U.S.	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
15	Malta	Germany	Q2 2000- Q4 2007	Q2 2000 - Q4 2007
16	Netherlands	Germany	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
17	Norway	Germany	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
18	Portugal	Germany	Q2 1995 - Q4 2013	Q2 1995 - Q4 2013
19	Spain	Germany	Q2 1995 - Q4 2013	Q2 1995 - Q4 2013
20	Sweden	Germany	Q2 1993 - Q4 2013	Q2 1993 - Q4 2013
21	Switzerland	Germany	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
22	United Kingdom	Germany	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013

	Non-Advanced	*Base currency*	*LR pooled / panel*	*SR pooled / panel*
1	Albania	Germany	..	Q2 2005- Q4 2013
2	Argentina	U.S.	..	Q4 2002 - Q4 2013
3	Armenia	U.S.	..	Q2 1996- Q4 2013
4	Brazil	U.S.	Q1 2000 - Q4 2006	Q2 1995 - Q4 2012
5	Bulgaria	Germany	Q3 1993 - Q3 2009	Q2 1997 - Q1 2008
6	Chile	U.S.	Q4 2004 - Q4 2013	Q2 2003- Q3 2012
7	China	U.S.	Q1 2007 - Q4 2013	Q3 1997 - Q4 2013
8	Colombia	U.S.	Q4 2002 - Q4 2013	Q2 2000 - Q3 2012
9	Croatia	Germany	Q2 2012- Q3 2013	Q2 2006 - Q3 2013
10	Czech Republic	Germany	Q3 2000 - Q4 2013	Q1 1996- Q4 2013
11	Egypt	U.S.	..	Q2 2007- Q4 2013
12	Ghana	U.S.	..	Q2 2006 - Q2 2013
13	Hong Kong	U.S.	Q1 1997- Q4 2013	Q3 1991 - Q4 2013
14	Hungary	U.S./Germany	Q2 1999 - Q4 2013	Q2 1995- Q4 2013
15	India	U.S.	Q3 2004 - Q4 2013	Q3 2004 - Q4 2013
16	Indonesia	U.S.	Q3 2009- Q4 2013	Q2 2000 - Q4 2003
17	Israel	U.S.	Q2 2006 - Q4 2013	Q2 2006 - Q4 2013
18	Kazakhstan	U.S.	Q2 1998 - Q4 2013	Q3 1994 - Q4 2013
19	Kenya	U.S.	Q2 2011- Q3 2013	Q2 2000- Q3 2013
20	Latvia	U.S./Germany	Q1 1999 - Q4 2013	Q2 1995 - Q4 2013
21	Mexico	U.S.	Q1 2000 - Q4 2013	Q2 1993 - Q4 2013
22	Nigeria	U.S.	Q2 2009 - Q3 2013	Q3 1995 - Q3 2013
23	Philippines	U.S.	Q2 1999 - Q3 2013	Q2 1998 - Q4 2013
24	Poland	Germany	Q3 1999- Q4 2013	Q2 1996 - Q4 2013
25	Romania	U.S./Germany	Q2 2012- Q4 2013	Q2 2000- Q3 2005

(continued)

	Non-Advanced	*Base currency*	*LR pooled / panel*	*SR pooled / panel*
26	Russia	U.S.	Q2 2003 - Q3 2013	Q2 2003 - Q3 2013
27	Singapore	Malaysia	Q3 1998 - Q4 2013	Q3 1989 - Q4 2013
28	Slovakia	Germany	Q2 1997- Q4 2013	Q2 1997 - Q4 2007
29	Slovenia	Germany	Q2 2002 - Q4 2013	Q3 2000 - Q4 2013
30	South Africa	U.S.	Q3 1989 - Q4 2013	Q3 1989 - Q4 2013
31	South Korea	U.S.	Q1 2001 - Q4 2013	Q4 2006 - Q4 2013
32	Taiwan	U.S.	Q2 1995- Q4 2013	Q3 1989 - Q4 2013
33	Thailand	U.S.	Q2 1993 - Q4 2013	Q2 1997 - Q4 2013
34	Turkey	U.S.	Q2 2012 - Q4 2013	Q2 1998 - Q4 2013

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Corporate Saving in Global Rebalancing

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The increase in global imbalances in the last decade posed a theoretical challenge for international macroeconomics. Why did some less developed countries with a higher need for capital, like China, lend to richer countries? The inconsistency of standard dynamic open-economy models with actual global capital flows had already been recognized, (for example, by Lucas, 1990), but the sensitivity to this issue became more acute with increasing global imbalances. This stimulated the development of several alternative theoretical frameworks.[1] However, global imbalances have declined since the global financial crisis. What light can the recent models shed on this global rebalancing?

In this paper, we focus on a specific dimension of global imbalances: corporate saving. Increased global imbalances were greatly associated with an increase in net saving in emerging Asia. Part of this increase can be explained by an increase in corporate saving.[2] This aspect has typically been ignored in the literature, but it is the focus of our previous work in Bacchetta and Benhima (2015), in which we propose a two-country model where firms need

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1. See Gourinchas and Rey (2014) for a survey.
2. See, for example, Jain-Chandra, Nabar and Porter (2009).

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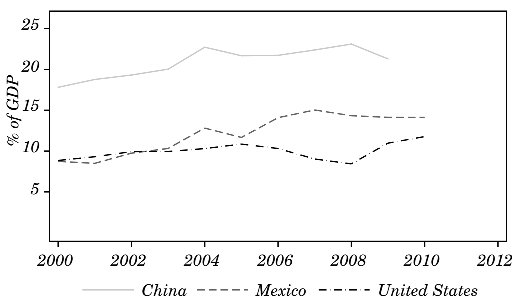
to save in liquid assets to finance their working capital. We show that a country with a less developed financial system and strong growth has a higher corporate saving rate and that saving exceeds investment. The model is consistent with the main features of global imbalances, but it also has interesting properties for international spillovers. The strategy of this paper is to adopt a modified version of the Bacchetta-Benhima model and focus on corporate saving in the context of global rebalancing.

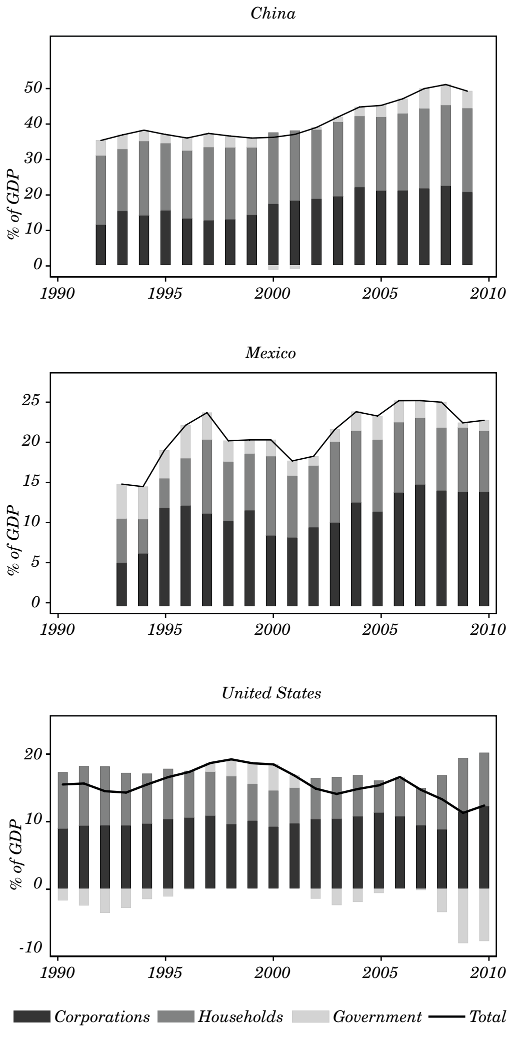
Global imbalances increased sharply from 2000 to 2007. This was associated with an increase in China's total saving, and part of the increase came from the growth of corporate saving. Figure 1 shows the evolution of the corporate saving rate for three countries: China, the United States and Mexico. Between 2000 and 2008, the corporate saving rate increased significantly in China, while there was little change in the United States. Mexico has not been a key player in global imbalances, but corporate saving increased from 2003 to 2007, which coincides with an increase in output growth and a slight improvement in the country's current account deficit. To put corporate saving in perspective, figure 2 shows the evolution of total saving and its components. While the literature typically focuses on household or government saving, corporate saving also contributed significantly to changes in total saving. It is too early to assess the evolution of corporate saving after the crisis (the data are published with a long delay), but the available data indicate that corporate saving has increased in the United States and declined slightly in China and Mexico.

Figure 1. Corporate Saving Rates



Sources: National Bureau of Statistics of China, United Nations Statistics Division.

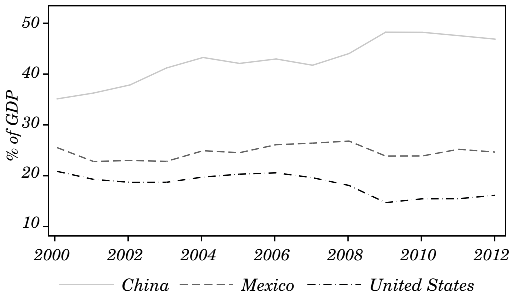
Figure 2. Saving and its Components



Sources: National Bureau of Statistics of China, United Nations Statistics Division.

With regard to the evolution of investment, figure 3 shows that it increased sharply in China and less strongly in Mexico, while it declined in the United States. There is thus a relationship between increases in corporate saving and increases in investment in the period under review. This positive link is a key aspect of our theoretical analysis.

Figure 3. Investment Rates



Source: IMF World Economic outlook.

The process of global rebalancing occurred after the global financial crisis in 2008 and the subsequent recession in developed countries. More recently, the global economy has been affected by a slowdown in emerging market economies. We examine the impact of these developments on global imbalances in a model where corporate saving and investment determine the current account. We consider an asymmetric world economy with an Emerging country and a Developed country and examine the impact of three shocks: a credit crunch and a growth slowdown in the Developed country and a growth slowdown in the Emerging country. We find that all three shocks lead to global rebalancing, but they have different impacts on the world interest rate. The two shocks originating in the Developed country have a negative impact on the interest rate, while the shock in the Emerging country has a positive impact. This implies that the initial phase of rebalancing was associated with downward pressure on real interest rates, whereas the recent period is more likely to be associated with an increase in world interest rates. We also notice that slower growth in the Emerging country improves the trade balance of the Developed country.

As mentioned, the model used in this paper is a simplified version of Bacchetta and Benhima (2015). Since we already conducted a systematic study of the model and its dynamic properties, in this paper we focus on some implications of the model, including international spillovers. In the Bacchetta-Benhima model, firms need liquid assets in the spirit of Holmstrom and Tirole (2001, 2011). To introduce this aspect in a dynamic macroeconomic model, we follow

Woodford (1990), where entrepreneurs have two-period projects.[3] In the first period, entrepreneurs invest in illiquid capital and decide on their liquid asset holdings. In the second period, they produce using a labor input. To pay for wages, firms can either borrow or use their liquid assets. When borrowing is limited, firms need more liquid assets. This is the reason why fast-growing countries with tight borrowing limits have higher liquid asset holdings and higher corporate saving. Moreover, higher growth leads to a joint increase in saving and investment. When we consider an asymmetric two-country model, we assume that the liquidity motive is strong in the Emerging country and weaker in the Developed country. Consequently, the Developed country behaves similarly to standard open-economy models, while the Emerging country has a different behavior.

The strong need for liquid assets in the Emerging country introduces a new channel of international transmission. A decrease in the world interest rate has a negative impact on surplus economies holding liquid assets. This negative liquidity channel is combined with two other, more standard channels. First, there is a substitution channel as firms substitute capital for labor. Second, there is a collateral channel as credit constraints are looser with a lower interest rate. We analyze theoretically and numerically the different factors determining the strength of these different channels. In addition to affecting the spillover mechanism of interest rate changes, the large liquidity holdings in the Emerging country affect the response of the world interest rate to fundamental shocks. An interesting aspect of the model is a positive output comovement in the presence of productivity shocks. This contrasts with standard intertemporal open-economy macroeconomic models, where productive shocks have negative spillovers (for example, Obstfeld and Rogoff, 1996). However, the mechanism leading to this positive comovement is different whether the shock originates in the Developed or in the Emerging country. Nevertheless, the liquidity needs of the Emerging country play a key role in these mechanisms, as they affect either the direct impact of the shock on the world interest rate or the spillover channel.

The rest of the paper is organized as follows. In the next section we present the model, from the individual entrepreneur to the global economy. Section 2 examines the impact of interest rate shocks, which

3.Woodford (1990) presents two models: one with credit-constrained consumers and endowments and one with credit-constrained entrepreneurs and production. Our approach is based on his second model.

represent the main spillover channel across the countries. Section 3 examines numerically the impact of the three shocks mentioned above. Section 4 concludes.

1. A Two-Country Model with Corporate Saving

We consider a two-country model with an Emerging country and a Developed country. The structure of both economies, based on Bacchetta and Benhima (2015). features a demand for liquidity (short-term bonds) from entrepreneurs, which they can trade domestically and internationally. Three ingredients in the model are necessary to generate a demand for liquidity. First, production takes time: capital needs one installation period before it can be used in the production process. Second, the wage bill has to be paid before output can be sold, which generates a need for funds. Third, entrepreneurs face credit constraints. This implies that entrepreneurs are not always able to borrow all the funds needed to hire labor for production, so they need to keep liquid assets when they invest in capital. This creates a liquidity channel of the interest rate through which a decrease in the world's interest rate on liquid assets has a negative effect on production.

To distinguish the Developed country from the Emerging one, we denote the Developed country variables with an asterisk. Since the two economies have the same structure and differ only in their parameter values, we first lay down the model for the Emerging economy. The model is then closed through the equilibrium on the bond market, which defines the world interest rate.

1.1 The Production Process

Entrepreneurs are infinitely lived and maximize the present value of their utility. They have two-period production projects, as it takes one period to install capital before producing. An entrepreneur starting a project at time t invests K_{t+1}. At $t + 1$, after capital is installed, he hires labor, l_{t+1}, to produce $Y_{t+1} = F(K_{t+1}, Z_{t+1}l_{t+1})$, where Z_t measures productivity and F is a constant-return-to-scale production function, and pays wages, $w_{t+1}l_{t+1}$. This production is available only at $t + 2$. At $t + 2$, the entrepreneur gets another investment opportunity. The entrepreneur consumes c_t each period and can borrow or lend short-term bonds with a gross interest rate r_t.

In this setup, working capital in the form of early payment of wages interacts with credit constraints to generate a demand for liquidity. Entrepreneurs can use part of the proceeds from previous production to invest K_{t+1}. At $t + 1$, however, they have no income to pay $w_{t+1}l_{t+1}$ for workers. Consequently, they have an incentive to borrow an amount L_{t+2}. When an entrepreneur is credit-constrained, he will not be able to borrow the desired amount to pay for the wage bill. He will therefore have a demand for liquidity at time t in the form of a positive demand for bonds, A_{t+1}.

1.2 Optimal Behavior

Entrepreneurs maximize

$$\sum_{s=0}^{\infty}\beta^s u(c_s). \tag{1}$$

Consider an entrepreneur who invests every other period, starting at time t. Denote by W_t his initial income at time t. It is made up of the output from production initiated at date $t - 2$, $Y_{t+1} = F(K_{t+1}, Z_{t+1}l_{t+1})$, minus debt repayments, r_tL_t. Hence, $W_t = Y_{t-1}\ r_tL_t$. His budget constraints at t and $t + 1$ are as follows:

$$W_t = c_t + K_{t+1} + A_{t+1}; \tag{2}$$

$$r_{t+1}A_{t+1} = c_{t+1} + w_{t+1}l_{t+1} - L_{t+2}. \tag{3}$$

The entrepreneur's income at date t is allocated to consumption, c_t, investment in a new project, K_{t+1}, and bond holdings, A_{t+1}. In the following period, at $t + 1$, the only income is the bond return, $r_{t+1}A_{t+1}$. This has to pay for consumption, c_{t+1}, and the wage bill, $w_{t+1}l_{t+1}$. Typically the entrepreneur will borrow, so that at the optimum $L_{t+2} \geq 0$.

The entrepreneur might face a credit constraint at date $t + 1$. Due to standard moral hazard arguments, a fraction $0 \geq \phi \geq 1$ of output can be used as collateral for bond repayments:[4]

$$r_{t+2}L_{t+2} \leq \phi\, Y_{t+1}. \tag{4}$$

4. There could be a similar constraint at date t, but it is never binding precisely because of the demand for liquidity. The results are similar if we assuming that capital is used as collateral instead of output, as in Bacchetta and Benhima (2015).

Let λ_{t+1} denote the multiplier associated with this constraint. The entrepreneur's program yields the following first-order conditions:

$$F_{K_{t+1}}\left(1+\phi\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right)=r_{t+1}r_{t+2}\left(1+\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right); \tag{5}$$

$$F_{l_{t+1}}\left(1+\phi\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right)=w_{t+1}r_{t+2}\left(1+\frac{\lambda_{t+1}}{\beta^2 u'(c_{t+2})}\right). \tag{6}$$

When the production function is Cobb-Douglas, that is, $F(K, Zl) = K^{\alpha}(Zl)^{1-\alpha}$, the first-order conditions (5) and (6) give a straightforward relationship between the liquidity needs, $w_{t+1}l_{t+1}$, and capital, K_{t+1}:

$$w_{t+1}l_{t+1}=\frac{1-\alpha}{\alpha}r_{t+1}K_{t+1}. \tag{7}$$

With log utility, it can be shown that an entrepreneur who invests at t consumes a fixed fraction of his revenue:

$$c_t=(1-\beta)W_t. \tag{8}$$

Using the Euler equation at t, we get the following rule for consumption at $t + 1$:

$$c_{t+1}=\beta(1-\beta)r_{t+1}W_t\ . \tag{9}$$

From equations (2) and (8), saving at t is as follows:

$$S_{t+1}=A_{t+1}+K_{t+1}=\beta W_t\ . \tag{10}$$

Equation (10) states that saving at t is a constant fraction of total revenues. When the constraint at $t + 1$ is binding, the availability of funds to finance the wage bill at $t + 1$ is limited. The fraction of saving allocated to liquidity, A_{t+1}, therefore depends on the liquidity needs at $t + 1$, $w_{t+1}l_{t+1}$. To determine K_{t+1}, we use equation (3), the binding credit constraint (4) and equations (9) and (10) to get

$$K_{t+1}+\frac{w_{t+1}l_{t+1}}{r_{t+1}}=\beta^2 W_t+\phi\frac{Y_{t+1}}{r_{t+1}r_{t+2}}. \tag{11}$$

This consolidated budget constraint states that in present-value terms, firms have to use their saving, along with their external finance capacities, to pay for inputs. Combining this equation with equations (7) and (10), we can jointly determine K_{t+1}, l_{t+1} and A_{t+1} in the constrained case.

To determine whether entrepreneurs are constrained or not, it is useful to look at labor market conditions. Entrepreneurs are constrained ($\lambda_{t+1} > 0$) whenever the market wage is lower than the first-best wage. Define

$$\hat{w}\left(r_{t+1}, r_{t+2}, Z_{t+1}\right) = Z_{t+1}\left(1-\alpha\right)\left(\frac{\alpha^{\alpha}}{r_{t+1}^{\alpha} r_{t+2}}\right)^{1/(1-\alpha)}$$

as the first-best wage. Entrepreneurs are constrained when $w_{t+1} < \hat{w}_{t+1}$.[5] In that case, the entrepreneur could make infinite profits by increasing the production scale, but is prevented by the binding credit constraint. If $w_{t+1} = \hat{w}_{t+1}$, the production scale is undetermined, because of constant returns to scale. There is no reason for the entrepreneur to be constrained in that case.

1.3 Labor Market

Each entrepreneur has access to a project every two periods. There are two groups of entrepreneurs, each with mass one, with overlapping projects. One group of entrepreneurs gets a project in odd periods, while the other group gets a project in even periods. In a given period, the demand for labor comes from the group of entrepreneurs in their production period, so the aggregate demand for labor is given by equation (7).

Labor is supplied domestically by a continuum of hand-to-mouth workers of mass one who do not have access to the production technology and consume all their income: $c_t^w = w_t l_t$. We assume that workers have the following labor supply:

5.This can be seen by combining the first-order conditions in equations (5) and (6) in the benchmark case, which yields

$$w_{t+1}\left[\left(1+\frac{\lambda_{t+1}c_{t+2}}{\beta}\right)\Big/\left(1+\phi\,\frac{\lambda_{t+1}c_{t+2}}{\beta}\right)\right]^{1-\alpha} = \hat{w}\left(r_{t+1}, r_{t+2}, Z_{t+1}\right).$$

$$l_t = \left(\frac{w_t}{\bar{w}}\right)^{\eta}, \tag{12}$$

where η and $\bar{w}$ are positive constants, and η is the Frisch elasticity of labor supply. When $\eta = 0$, the labor supply is inelastic at $l = 1$.

Using the labor demand equation (7), we can then infer the equilibrium labor as a function of aggregate capital, K_{t+1}:

$$l_{t+1} = \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r_{t+1}}{\bar{w}}\right)K_{t+1}\right]^{\frac{\eta}{\eta+1}}. \tag{13}$$

When firms are constrained, the aggregate stock of capital is limited by total saving, W_t, and so is equilibrium labor, preventing the equilibrium wage from reaching the first-best wage.

In equilibrium, l is less sensitive to r when η is low. This is because the equilibrium wage responds to the interest-rate-induced increase in labor demand, which mitigates the equilibrium increase in labor, and the more so as the elasticity is low. In the extreme case where $\eta = 0$, labor demand is inelastic and $l = 1$ in equilibrium. In this case, the increase in the equilibrium wage offsets the increase in r. At the opposite end of the spectrum, if η goes to infinity, labor supply is hyperelastic at the wage $w_{t+1} = \bar{w}$, and any increase in labor demand is satisfied, so

$$l_{t+1} = \frac{(1-\alpha)r_{t+1}K_{t+1}}{\alpha\bar{w}}.$$

1.4 The Net Demand for Bonds and Equilibrium on the World Bond Market

Entrepreneurs can lend or borrow at the world interest rate, r_t. We assume that $r_t < 1/\beta$, which ensures that credit constraints are binding in the steady state and around it.[6] The aggregate net demand for bonds, B_{t+1}, is equal to the net saving of the Emerging country. At each period t, there are two groups of entrepreneurs: those who invest and those who produce. As mentioned above, the saving of investing

6. This is true in our two-country economy as long as both countries have sufficiently strong credit constraints (ϕ and ϕ^* are low).

entrepreneurs is $A_{t+1} + K_{t+1}$. The saving of producing entrepreneurs is simply $-L_{t+1}$. Aggregate net saving is then equal to total saving, $A_{t+1} + K_{t+1} - L_{t+1}$, minus investment, K_{t+1}. Therefore, the aggregate net saving in the Emerging country is the aggregate net demand for bonds, which is $B_{t+1} = A_{t+1} - L_{t+1}$.

The description of the Developed economy is identical to the Emerging one. For a given world interest rate r_{t+1}, the Developed country has a net demand for bonds of $B^*_{t+1} = A^*_{t+1} - L^*_{t+1}$. The world interest rate has to be such that the world bond market clears:

$$B_{t+1} + B^*_{t+1} = 0 \; . \qquad (14)$$

1.5 An Asymmetric World Economy with Global Imbalances

We assume that the Emerging and Developed countries differ by their level of credit tightness, due to different levels of financial development, and by their level of technology. We assume $\phi^* > \phi$ and $Z^* > Z$. The asymmetry in ϕ has strong implications for the world equilibrium and for its reaction to shocks. In particular, it implies that the Emerging country will, in general, lend to the Developed country, that is, $B_{t+1} > 0$ and $B^*_{t+1} < 0$. Thus, the model is consistent with the pattern of global imbalances.

To understand why the country with a tighter borrowing constraint lends to the country with a looser borrowing constraint, it is key to understand the behavior of the two groups of entrepreneurs.[7] At each period t, one group of entrepreneurs is in the production period and borrows L_{t+1} (L^*_{t+1}) and the other group is in the investment period and accumulates liquid assets A_{t+1} (A^*_{t+1}). With a loose credit constraint in the Developed country, L^*_{t+1} can be large while the need for liquid assets A^*_{t+1} is small. Thus, $B^*_{t+1} < 0$. In the Emerging country, since the credit constraint is tight, L_{t+1} is small and the need for liquid assets A_{t+1} is large. Thus, $B_{t+1} > 0$.

The difference in credit tightness also affects the way the demand for bonds reacts to shocks. Consider an increase in growth in the Developed country. This increases output and relaxes the credit

7. For convenience, in this paper we assume that the constraint is always binding in both countries. Bacchetta and Benhima (2015) analyze the case where the constraint is never binding for the Developed country and may not always be binding for the Emerging country.

constraint (equation 4). This allows borrowing from producing entrepreneurs to increase. This effect dominates, and overall the country has a lower net demand for foreign bonds, that is, B^*_{t+1} becomes more negative. Now consider an increase in growth in the Emerging country. The impact on borrowing is small since ϕ is low. On the other hand, there is a stronger need to finance the labor input, so that A_{t+1} and thus B_{t+1} increase. This implies that an increase in growth increases the magnitude of global imbalances, whether this increase occurs in the Developed or in the Emerging country.[8]

2. Spillovers

In this model, the international spillover of shocks goes exclusively through the world interest rate. To have a clear understanding of spillovers, it is useful to analyze the impact of interest rate shocks. For this purpose, we first consider the Emerging country as a small open economy. We can then study the effect of a change in the world interest rate, both theoretically and numerically.

2.1 Three Spillover Channels

There are three potential channels for a change in r. First, as apparent in the labor demand equation (7), a lower r_{t+1} makes firms substitute capital for labor. This is the substitution channel. Second, according to the consolidated budget constraint (equation 11), a lower r_{t+1} makes the wage bill more costly, because it decreases the return of bonds that are used to finance it. This is the liquidity channel. Third, a lower interest rate increases the financing capacity of firms by relaxing the credit constraint. This is the collateral channel.

To study these channels, we analyze two extreme cases that are of particular interest: the case with an extreme borrowing constraint ($\phi = 0$) and the case with an inelastic labor supply ($\eta = 0$). We then simulate the behavior of an economy hit by a negative shock on the world interest rate, for these extreme cases and for intermediate cases.

8. Bacchetta and Benhima (2015) examine the dynamic impact of a growth acceleration in the Emerging country.

2.1.1 Extreme borrowing constraint

The case with $\phi = 0$ shuts down the collateral channel and enables us to focus on the substitution and liquidity channels. In that case, the consolidated budget constraint makes the capital level depend on wealth, W_t, in a straightforward way, according to equation (11). The resulting dynamics are summarized in the following proposition.

Proposition 1. If $\phi = 0$ and the credit constraint is binding, a negative shock on r_{t+1} has a negative effect on labor and output on impact, but no effect on capital. Capital, labor and output are negatively affected in subsequent periods when the interest rate shock is persistent.

Proof. The level of capital is inferred from equation (11) where $\phi = 0$. Labor is then determined by the equilibrium equation (13). Output is obtained by replacing K_{t+1} and l_{t+1}. Finally, $W_{t+1} = Y_{t+1}$, because $\phi = 0$. This gives

$$K_{t+1} = \alpha\beta^2 W_t \ ;$$

$$l_{t+1} = \left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r_{t+1}}{\bar{w}}\right)\alpha\beta^2 W_t\right]^{\frac{\eta}{\eta+1}} \ ;$$

$$Y_{t+1} = W_{t+1} = Z_{t+1}^{1-\alpha}\left[\left(\frac{1-\alpha}{\alpha}\right)\left(\frac{r_{t+1}}{\bar{w}}\right)\right]^{(1-\alpha)\eta/(\eta+1)}\left(\alpha\beta^2 W_t\right)^{\alpha+(1-\alpha)\eta/(\eta+1)} .$$

The impact of a decrease in r_{t+1} is then straightforward.

Whereas capital is not affected by r_{t+1} on impact, labor is negatively affected by a decrease in r_{t+1}, which then affects output negatively. This is the result of the combination of the substitution and liquidity channels. Through the liquidity channel, inputs are more costly, which decreases total inputs. Through the substitution channel, resources are reallocated within inputs toward capital at the expense of labor. All in all, the demand for capital stays unchanged, while the demand for labor drops.

The magnitude of the equilibrium effect of r_{t+1} on l_{t+1} depends on the Frisch elasticity of labor, η. In equilibrium, the decrease in labor demand depresses the wage, which mitigates the equilibrium effect of the interest rate on labor. In the case where labor supply is inelastic ($\eta = 0$), the decrease in the wage perfectly offsets the decrease in the interest rate, so labor stays constant at $l = 1$. In that extreme case, r_{t+1} has no effect on l_{t+1} and thus no effect on the economy. We now consider more generally the case of $\eta = 0$.

2.1.2 Inelastic labor supply

The case with $\eta = 0$ shuts down the substitution and liquidity channels and enables us to focus on the collateral channel. In that case, the following proposition applies.

Proposition 2. If $\eta = 0$ and the credit constraint is binding, then a negative shock on r_{t+1} has a positive effect on capital.

Proof. If $\eta = 0$ and the credit constraint is binding, then for a given W_t,

$$l_{t+1} = 1\,;$$

$$Y_{t+1} = Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}\,;$$

$$W_{t+1} = (1-\phi) Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}\,.$$

The consolidated budget constraint defines K_{t+1} implicitly as a function of W_t:

$$\left(\frac{K_{t+1}}{\alpha}\right) - \left(\frac{\phi Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}}{r_{t+1} r_{t+2}}\right) = \beta^2 W_t\,.$$

By differentiating the above equation, we find

$$\left(1 - \frac{\phi F_{Kt+1}}{r_{t+1} r_{t+2}}\right)\left(\frac{\partial K_{t+1}}{\partial r_{t+1}}\right) = -\left(\frac{\phi Z_{t+1}^{1-\alpha} K_{t+1}^{\alpha}}{r_{t+1}^2 r_{t+2}}\right).$$

Using equation (5), we can show that the first term in parentheses is positive as long as $\lambda_{t+1} > 0$, which implies that $\partial K_{t+1}/\partial r_{t+1} < 0$.

A decrease in r_{t+1} relaxes the credit constraint and allows firms to borrow more. It therefore has a positive effect on capital and hence on production. This is the collateral channel.

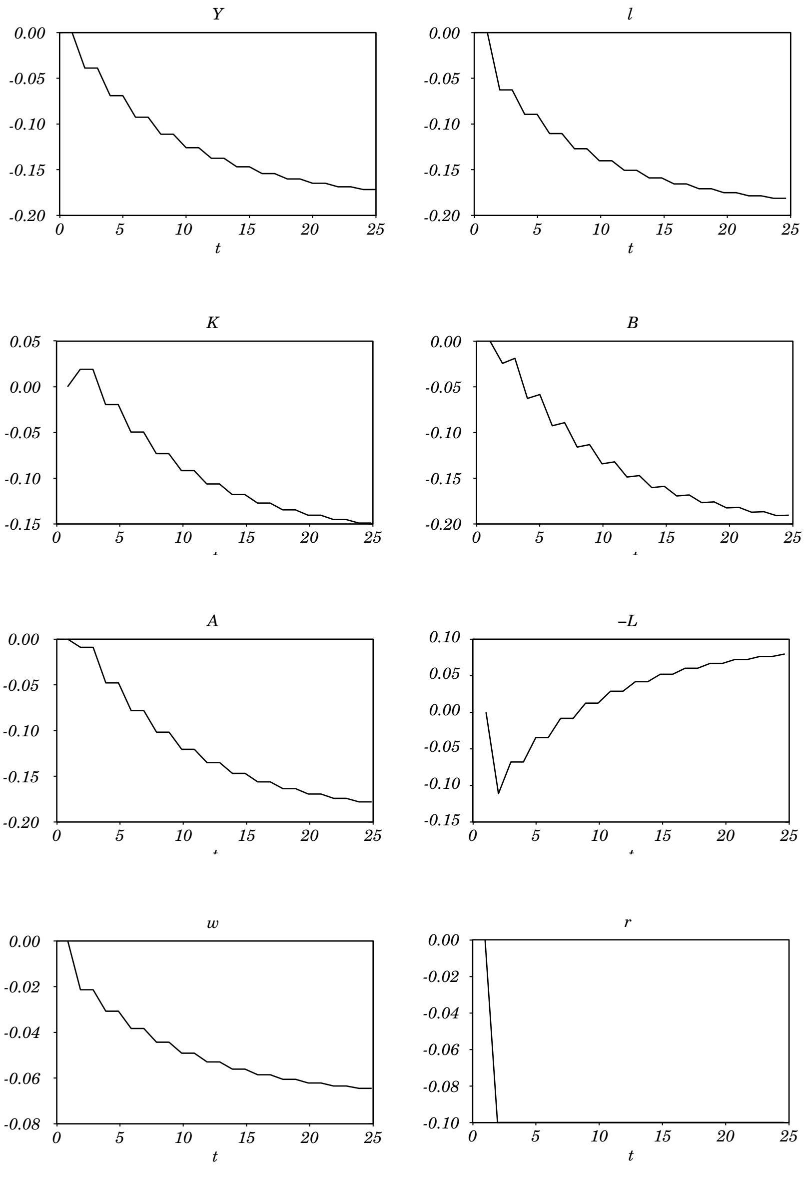
2.2 Numerical Analysis: Interest Rate Shocks

Here we simulate the effect of a permanent decrease in the world interest rate on the Emerging country for different values of ϕ and η. We first define a benchmark case with the following parameter values. The capital share α is set to 0.3, the discount factor β is set to 0.95, η to 3.0 and ϕ to 0.05. We normalize Z to 1.0 and $\bar{w}$ is set so that in the steady state $l = 1$. The steady-state interest rate is set at the same value as the one that holds in the two-country steady state.

We then look at the impact of a permanent 10 percent decrease in the interest rate, r. Figure 4 shows the evolution of output, labor, capital, gross bond positions, the net demand for bonds and wages. We observe a decline in output and labor, which indicates that the substitution and liquidity channels are at work; wages decline in line with labor. Capital increases on impact, to decline afterward. The dynamics of capital combine the results of Propositions 1 and 2: the initial increase represents a positive collateral effect, which is subsequently dominated by the negative liquidity channel. We also observe a decline in net bond holdings, B: as production decreases, the demand for liquid assets decreases. The evolution of B is actually determined by the decline in A. Borrowing L by producing firms initially increases due to the collateral effect, but then declines with the level of output. However, since L is small, it has little impact on B.

Figure 5 shows the impulse responses for deviations from the benchmark case. Panel A considers different levels of the credit constraint, measured by ϕ. We compare the benchmark value of $\phi = 0.05$ with a low value $\phi = 0$ and a higher value $\phi = 0.1$. A lower value of ϕ reduces the collateral effect and leads to a larger decline in output, while capital hardly increases on impact. The decline in bond holdings is also larger. In contrast, a higher value of ϕ gives a dominant role to the collateral channel. This leads to a sustained increase in capital and even to an increase in output. The decline in labor is much smaller. There is also a very strong decline in bond holdings. The reason is again that the collateral channel is stronger. A decrease in the interest rate leads to a stronger increase in borrowing and therefore to a decline in net bond holdings.

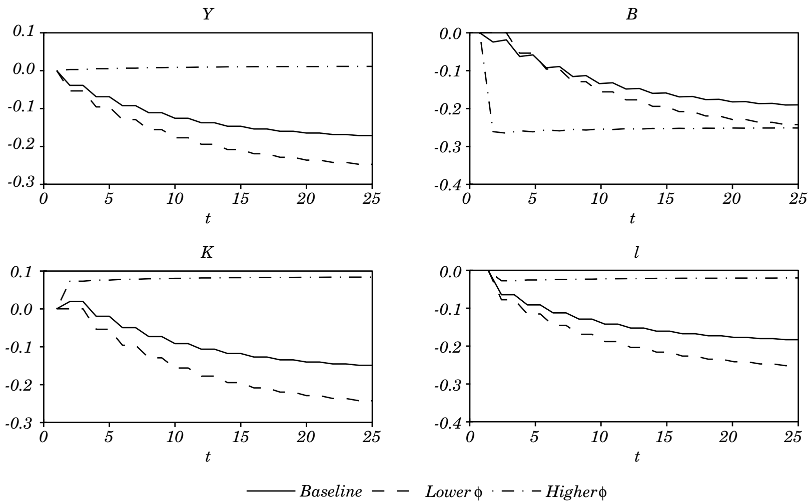
Figure 4. Negative Shock on *r*



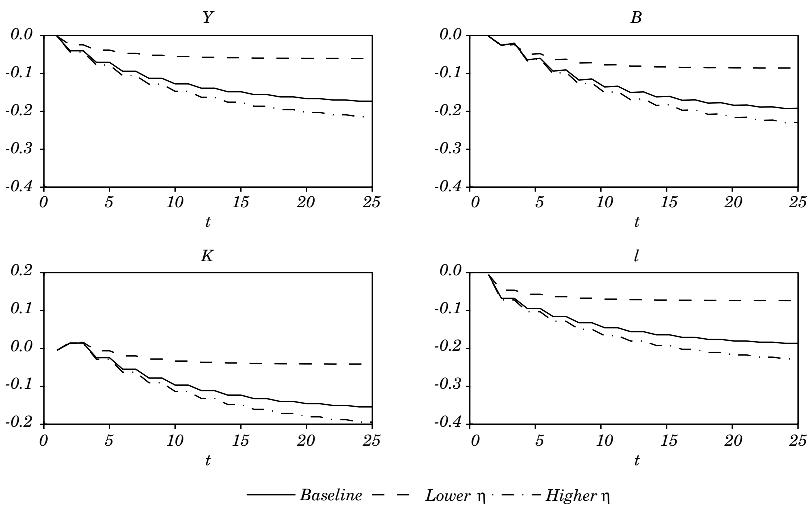
Note: Percentage deviation from steady state.
Source: Authors' elaboration.

Figure 5. Sensitivity Test: Role of ϕ and η
Yearly growth

Panel A: Role of ϕ



Panel B: Role of η



Note: Percentage deviation from steady state.
Source: Authors' elaboration.

Panel B of Figure 5 shows the impact of different levels of labor supply elasticity. We compare the benchmark value of $\eta = 3$ with a low value $\eta = 1$ and a high value $\eta = 4$. As suggested by Proposition 2, a higher elasticity reinforces the liquidity channel and therefore amplifies the decline in output, labor, capital and net bonds. A lower elasticity has the opposite effect.

3. Global Rebalancing

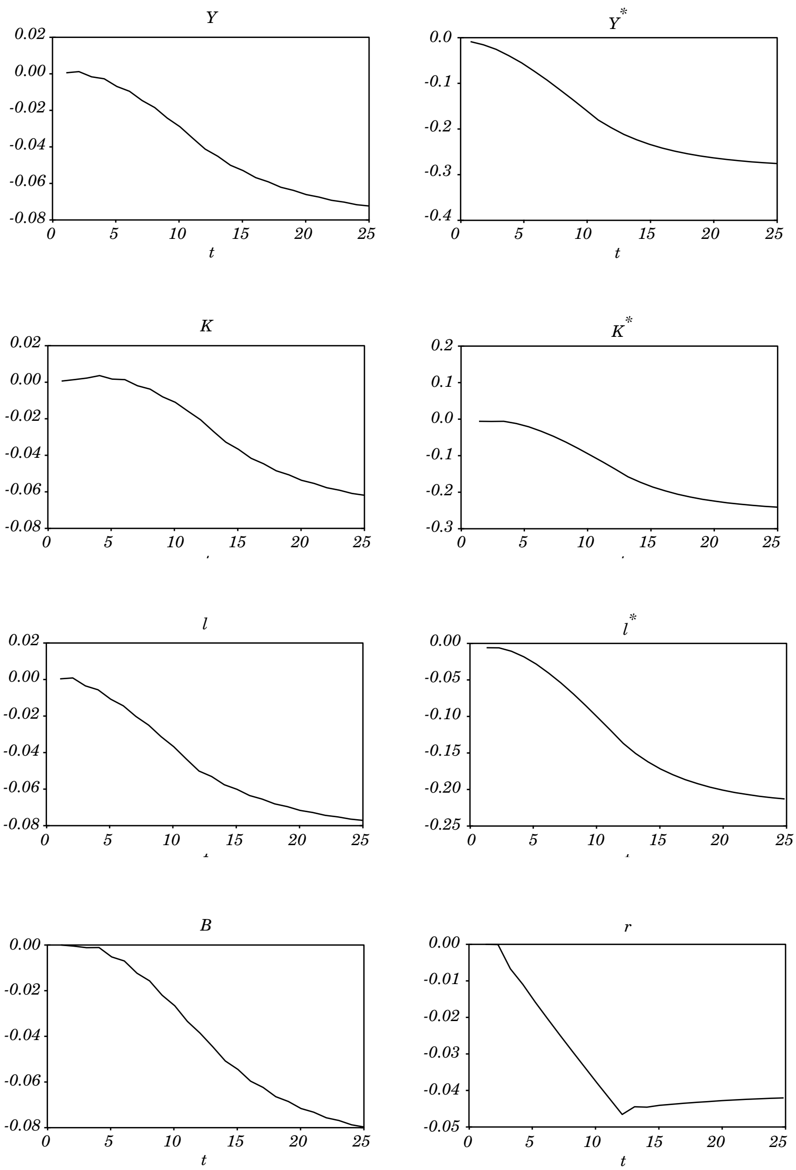
We now consider different scenarios leading to global rebalancing in the two-country model: a growth slowdown and a credit crunch in the Developed country and a growth slowdown in the Emerging country. We simulate the dynamic impact of these shocks in a benchmark version of the model. We set the parameters in the Emerging country as in the benchmark calibration described earlier. To generate heterogeneity in net foreign asset positions, we set $\phi^* = 0.3 > \phi$ in the Developed country. We also set $Z^* = 4Z$, and $\bar{w}^*$ is set so that $l^* = 1$ in the steady state. The other parameters are identical to the Emerging country. With this calibration, the Emerging country is a net lender ($B > 0$), and the Developed country is a net borrower ($B^* = -B < 0$).

3.1 Lower Growth and Credit Crunch in the Developed Country

We first examine the impact of a decline in productivity, Z^*, in the the Developed country. We assume that Z^* declines by 1 percent over ten periods.[9] The resulting dynamics are shown in figure 6. The impact of such a shock on the Developed country is relatively standard. The lower productivity naturally lowers output, but it also reduces borrowing from producing firms due to a tighter credit constraint (equation 4). This lowers capital and labor and further decreases output. Lower borrowing implies an improvement in the net asset position, B^* (declining debt), and a decline in the world interest rate.

9. For convenience, we do not consider steady-state growth in this paper. The gradual decline in Z^* implies a period of negative growth and has similar implications as a growth slowdown. See Bacchetta and Benhima (2015) for a full analysis with steady-state growth.

Figure 6. Negative Shock on *Z**



Note: Percentage deviation from steady state.
Source: Authors' elaboration.

The Emerging country is affected through the lower interest rate. The impact is naturally smaller than for the Developed country. Based on the analysis of section 2, we know that in the benchmark calibration, the substitution and liquidity channels dominate, so output and labor decline over time, while capital initially increases before declining. The decline in net bonds B matches the increase in B^*.

Figure 7 shows the impact of a permanent tightening of the credit constraint, that is, a 30 percent permanent decline in ϕ^* (from 0.30 to 0.21). Producing firms reduce their borrowing, so that net bond demand, B^*, increases (net debt decreases) and the world interest rate declines. Output and labor also decline, but capital increases. This somewhat surprising result is explained by a decline in the wage bill, which increases entrepreneurs cash flow to finance capital. The impact on the Emerging country is the same as with a decline in productivity, as the spillover goes through the decline in the world interest rate. However, in this case the impact is larger than in the Developed country.

To summarize, both the decline in growth and the credit crunch in the Developed country lead to rebalancing, with a decline in the world interest rate. Output declines in both countries.

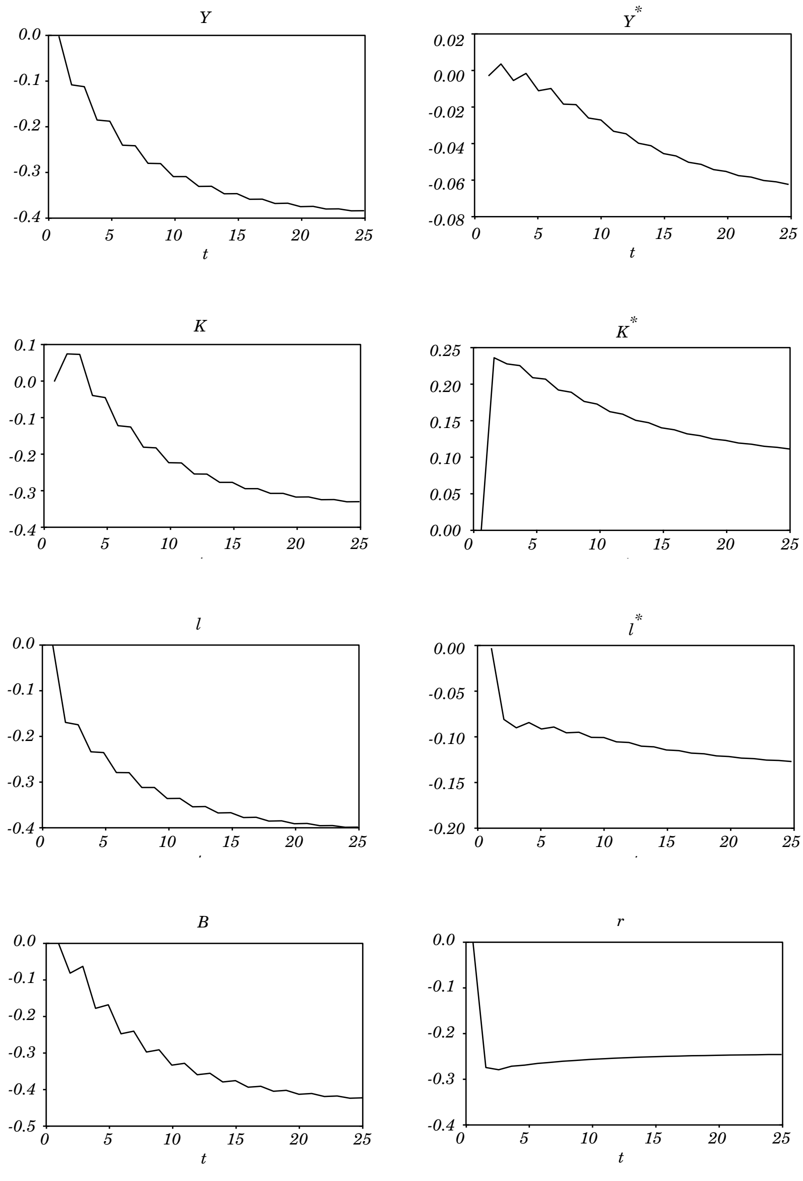
3.2 Lower Growth in the Emerging Country

Consider now a decline in productivity growth in the Emerging country. We assume that Z declines by 1 percent over ten periods. The dynamics are presented in figure 8. The decline in productivity growth reduces output, labor and capital in the Emerging country. This also leads to a decline in the net demand for bonds. The reason is that firms need to hold less liquidity in their production period, while their reduced borrowing in the investment period has a smaller impact. The reduced demand for bonds leads to an increase in the world interest rate.

The Developed country is affected negatively by the interest rate increase since the collateral effect dominates. The impact is smaller than in the Emerging country. Consequently, we also observe a decline in output, capital and labor, while the net foreign asset position improves.[10]

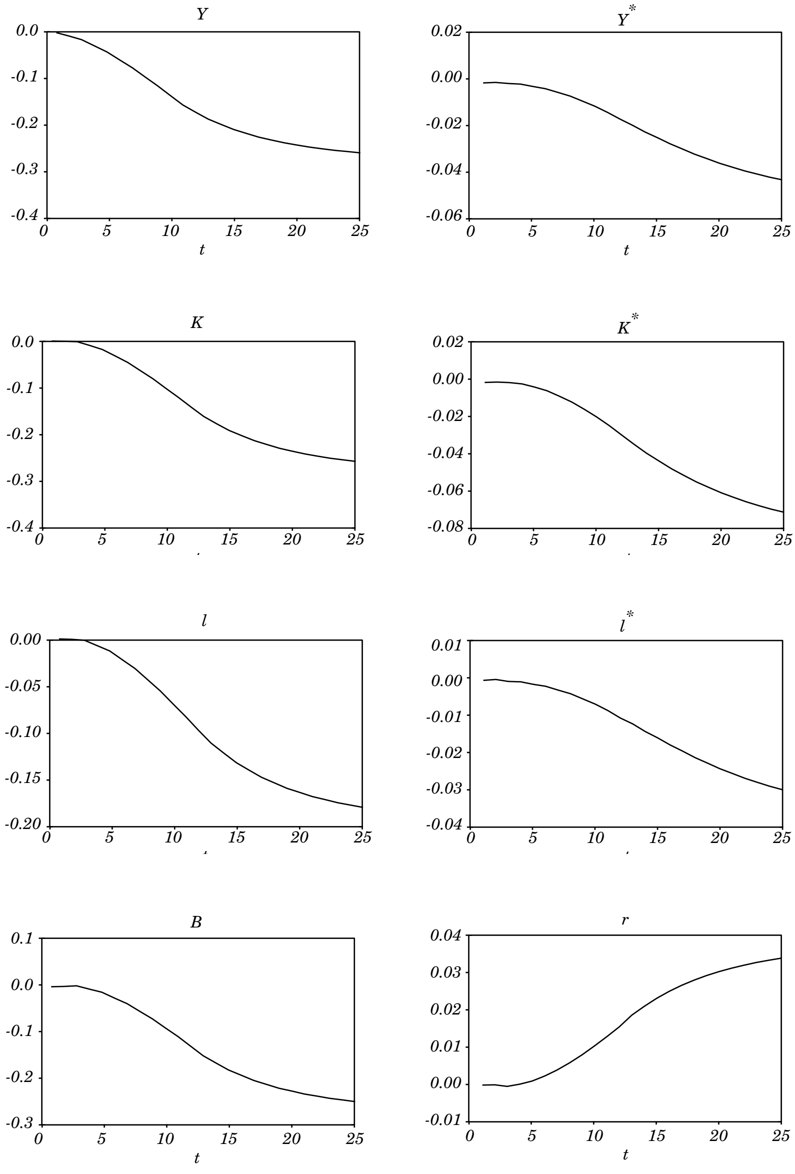
10.. The result would be similar if the Developed country was not constrained. Instead of a collateral channel, there would be a standard cost-of-funds channel and a higher interest rate would decrease the capital stock.

Figure 7. Negative Shock on ϕ



Note: Percentage deviation from steady state. Reduction of ϕ* by 30 percent.
Source: Authors' elaboration.

Figure 8. Negative Shock on *Z*



Note: Percentage deviation from steady state. Reduction of Z by 1% over 10 periods.
Source: Authors' elaboration.

3.3 International Comovements and the World Interest Rate

The results presented in this section show that a decline in growth, either in the Emerging country or in the Developed country, leads to a reduction in net foreign asset positions. Moreover, there is a positive output comovement, since a growth decline that starts in one country is transmitted to the other country. This positive comovement differs from the outcome of growth shocks in standard models. However, the channel of transmission is different if the shock occurs in the Emerging or the Developed country. The impact on the world interest rate is also of opposite sign: a negative growth shock in the Developed country decreases the interest rate, while a negative shock in the Emerging country increases it.

Growth shocks have a different impact on both the demand for bonds and the interest rate spillover to the other country. A negative growth shock in the Developed country increases the demand for bonds of this country by decreasing its borrowing. The resulting lower interest rate has a negative effect on the Emerging country since the liquidity and substitution effects dominate. In contrast, a negative growth shock in the Emerging country decreases the demand for bonds due to a lower need for corporate liquidity. Then, the higher world interest rate has a negative impact on the Developed economy since the collateral effect dominates.

4. Conclusion

Numerous factors determine global net capital flows. In this paper, we have focused on a specific aspect, namely, corporate saving and investment. By introducing realistic sources of asymmetry between an Emerging and a Developing economy, we have presented a model that is consistent with the stylized facts and has interesting implications in the context of global rebalancing. An alternative perspective would have been to focus on household saving and a demand for liquid assets emanating from credit-constrained consumers. For example, Bacchetta, Benhima and Kalantzis (2013) develop such a model based on the first model in Woodford (1990). Growth and credit shocks would have similar implications for total saving as in this paper when there are only consumers. However, there would be no impact on investment and output.

A more speculative question has to do with the medium-term perspectives for rebalancing. Our model predicts that a growth recovery would again increase global imbalances, so the rebalancing would only be a temporary phenomenon. However, this is a *ceteris paribus* prediction. Besides growth, there may be other factors that will change in future years. In particular, a reduction in financial restrictions in emerging markets (for example, financial liberalization in China) may decrease the need for high corporate saving and liquid asset holdings. This effect would clearly reduce global imbalances.

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Global Imbalances and External Adjustment After the Crisis

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Over five years have passed since the most intense phase of the global financial crisis. As has been widely documented, the pre-crisis period was characterized by increased dispersion in current account deficits and surpluses, facilitated by a benign global financial environment characterized by low risk aversion by borrowers and lenders as well as low volatility (see, amongst others, Lane, 2013). While the crisis was not triggered by an unraveling of global imbalances, it did lead to a drastic change in the global financial environment and a sharp compression of current account balances. But was this initial adjustment the result of cyclical factors, including the initial sharp decline in domestic demand in deficit countries such as the United States, the eurozone periphery, and several countries in Central and Eastern Europe, as well as initially declining commodity prices? Or has the external adjustment process been more protracted, with a stronger structural component?

In this paper we seek to address these questions by looking at both the adjustment of "global imbalances" post-crisis and cross-country evidence on the external adjustment process. For the first part, covered in section I, we illustrate how global current account imbalances have narrowed since the crisis, but how stock imbalances have instead continued to increase. Furthermore, we show that, while the adjustment process has a cyclical component (in the sense that

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output gaps for deficit countries were estimated to be larger than for surplus countries), global current account imbalances are projected to narrow further in the years ahead.

The second part of the paper presents cross-country evidence on current account adjustment after the crisis, documenting how the extent of adjustment is strongly correlated with measures of pre-crisis "excess imbalances." This part builds on previous work (Lane and Milesi-Ferretti, 2012) which focused on the process of adjustment in the two years following the financial crisis. We believe an extension is warranted for two reasons. First, the longer time period allows us to better incorporate the effects of the crisis in the eurozone. Second, and more generally, the longer time period elapsed since the crisis allows us to provide a medium-term analysis of adjustment, which should be less contaminated by purely-cyclical factors.

The paper is related to several strands of literature: on sudden stops and current account reversals (Calvo, 1998; Milesi-Ferretti and Razin, 2000; Calvo et al. 2004); causes and consequences of global imbalances (Obstfeld and Rogoff 2005, 2007; Blanchard and Milesi-Ferretti, 2010 and references therein; Klyuev and Kang, 2013); and the cross-country impact of the global financial crisis (Rose and Spiegel, 2010, 2012; Frankel and Saravelos, 2012; Lane and Milesi-Ferretti, 2012). Also in relation to these contributions, the longer post-crisis time period provides a clearer perspective on the medium-term dynamics of current account balances and output performance.

1. Global Imbalances after the Crisis

The decade preceding the global financial crisis was characterized by a sharp widening of global imbalances, which was underpinned by a spectacular increase in capital flows and the size of cross-border financial holdings, particularly for advanced economies. During and after the crisis, capital flows declined sharply and current account balances contracted. In this section we focus on trends in current account balances and net external positions, first at the global level, and then, more specifically, for Latin America.

1.1 Global trends

Figure 1 depicts the evolution of "global imbalances" –current account balances in the main countries/regions of the world. The classification of countries in groups follows Blanchard and

Milesi-Ferretti (2010). In particular, European countries (including those in the eurozone) with current account surpluses are grouped separately from those with current account deficits. As is well known, the pre-crisis period was associated by a widening U.S. current account deficit as well as growing current account deficits in the "eurozone periphery," the United Kingdom, and Central and Eastern Europe. At the same time, surpluses surged in emerging Asian countries (especially China), the group of major oil exporters, and a number of advanced economies in the eurozone and northern Europe. As the top panel of figure 1 shows, global imbalances peaked in 2007-08 and shrunk sharply in 2009, reflecting a global downturn but also sharply lowered oil prices and, after increasing in 2010 with the recovery in global output and oil prices, they have continued to shrink.

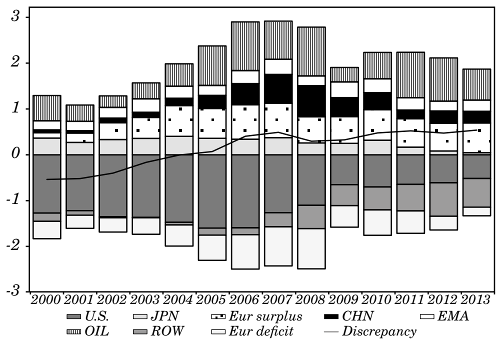
What was the country pattern of this adjustment? Among deficit countries, the U.S. deficit shrank by over 1 percent of world GDP during the period 2006-13 (0.7 percent between 2007 and 2013), and current account imbalances in "deficit Europe" shrank by 80 percent (about 0.7 percent of world GDP) between 2007 and 2013. In contrast, current account deficits in the "rest of the world" increased by some 0.3 percent of world GDP (reflecting primarily the deficits of Australia, Brazil, Canada, France, India, and Mexico).[1] Among surplus countries, Asian economies (China, Japan, as well as other East Asian economies) experienced the biggest decline relative to 2007 (0.8 percent of world GDP), while the surpluses in oil exporters declined modestly and those of other advanced European countries were broadly unchanged. Ancillary evidence on the narrowing of current account imbalances comes from figure 2. The figure depicts two measures of current account dispersion: one weighted by country size (the sum of the absolute value of current account balances, divided by world GDP) and the other unweighted (the median value of the current account to domestic GDP ratio). Both series show a decline in current account dispersion after the crisis, interrupting a trend starting in the early 1990s.

Does this imply that global imbalances are "over?" A look at international creditor and debtor positions (figure 3) suggests some caution. As the top panel shows, global creditor and debtor positions have not shrunk as a ratio of GDP—in fact, they have widened since 2007. As of 2012, there were four major "creditors" with roughly similar net foreign assets (to the order of $3 trillion): oil exporters,

1. France is not classified among the European deficit countries because it ran current account surpluses uninterruptedly between 1992 and 2004.

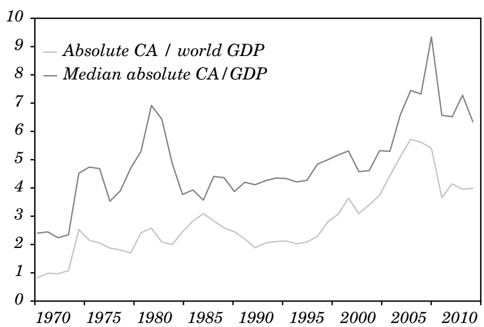
Japan, China and other East Asian economies, and European surplus countries. On the other side of the ledger, there were 3 major "debtors" with liabilities of over $4 trillion: the United States, European deficit countries, and the rest of the world. As is the case for current account balances, six countries (Australia, Brazil, Canada, France, India, and Mexico) account for the lion share of the rest of the world's liabilities. Despite the reduction in flow imbalances, creditor and debtor positions as a share of world GDP increased in absolute terms for all countries and regions depicted in figure 3.

Figure 1. Global Imbalances
(percent of world GDP)



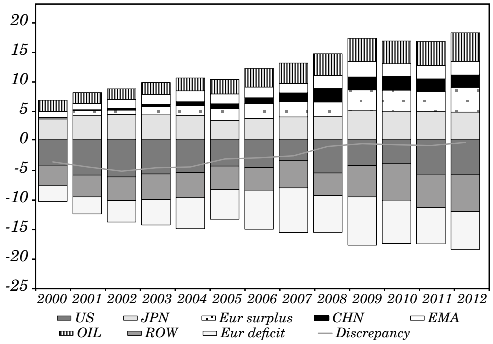
Note: See appendix for definition of country groups.
Source: Author's calculations based on Intenational Monetary Fund, World Economic Outlook database.

Figure 2. Global Dispersion of Current Account Balances
(1970-2012)



Note: Black line depicts the global sum of absolute values of CA balances divided by world GDP. Gray line depicts the median CA/GDP ratio in absolute terms.
Source: Author's calculations based on IMF, World Economic Outlook database.

Figure 3. Net Foreign Asset Positions
(in percent of world GDP)



Note: See appendix for definition of country groups.
Source: Lane and Milesi-Ferreti, External Wealth of Nations database.

Table 1 reports the positions for these same countries and regions scaled instead by domestic GDP: the only region where the absolute size of the position relative to GDP has shrunk since 2012, is East Asia (including China), also reflecting the rapid pace of GDP growth.

Figure 4 reports alternative measures of dispersion of creditor and debtor positions. Symmetrically with figure 2, the first measure is weighted by country size (the sum of the absolute value of net foreign asset positions, scaled by world GDP) and the second is unweighted (the median ratio of net foreign assets to domestic GDP). Both measures show a trend towards rising dispersion that was not interrupted by the crisis.[2]

What is the outlook for imbalances over the medium term? The top panel of figure 5 shows current account projections from the Spring 2014 edition of the IMF's World Economic Outlook (IMF, 2014). Current account imbalances have continued to shrink in 2013 and are projected to post a modest further decline over the medium term. Current WEO forecasts envisage some widening of surpluses in Asian economies in relation to world GDP (particularly China) over the next five years. However, this is more than offset by a projected shrinking surplus in advanced European countries, and especially oil exporters. On the

2. The sharp decline in the "unweighted" measure of stock imbalances between 2002 and 2006 reflects, primarily, the effect of debt forgiveness on the external positions of some highly indebted poor countries, primarily in Africa.

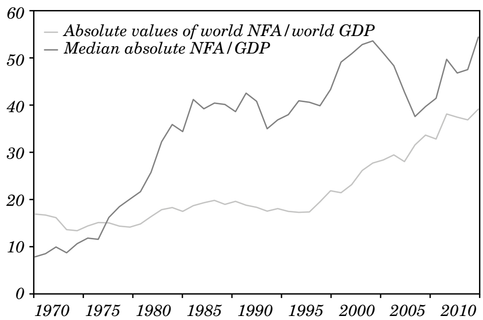
other side, the deficits of other European countries and the rest of the world are both expected to shrink over the next five years, with the U.S. deficit remaining broadly stable. Table 2 provides ancillary evidence on whether the reduction in current account imbalances reflects primarily cyclical or structural factors. It shows estimates of the size of the output gap (also from the World Economic Outlook database) for both surplus and deficit countries. The estimated output gap is negative for both deficit and surplus countries and larger for the former, which would suggest the presence of some cyclical narrowing of current account balances in 2012-13, but the difference in output gaps is relatively modest –as also noted by Klyuev and Kang (2013).

Table 1. Net External Position[1]
(ratio of domestic GDP)

	2007	*2012*
Oil exporters	50.3	55.7
East Asia	27.5	26.1
Europe surplus	22.4	44.3
Japan	50.1	56.8
United States	-14.4	-27.4
Europe deficit	-45.6	-51.7
Rest of the world	-23.5	-29.3

1. Net external position excludes gold holdings. See appendix for definition of country groups.
Source: Lane and Milesi-Ferretti, External Wealth of Nations database.

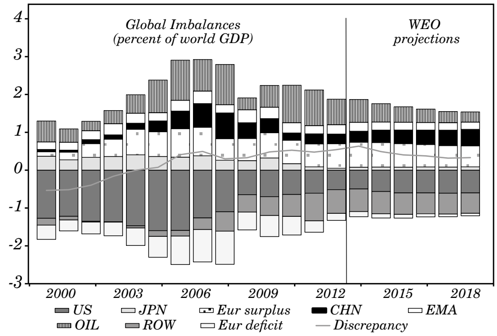
Figure 4. Dispersion of Net Foreign Asset Positions
Global dispersion of NFA positions



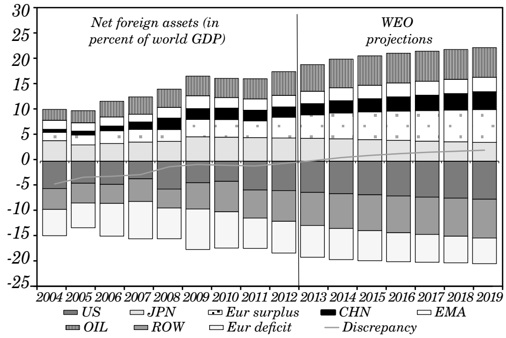
Source: Lane and Milesi-Ferreti, External Wealth of Nations database.

Figure 5. Global Imbalances: Projections

Current account



Net foreign assets



Note: See appendix for definition of country groups.
Source: Authors' calculations based on World Economic Outlook database and External Wealth of Nations database.

Predicting the evolution of net external positions is even more difficult than predicting current account balances, given potentially large valuation effects driven by difficult to predict exchange rate and asset price changes. With this caveat in mind, the bottom panel of figure 5 shows the evolution of stock imbalances by assuming that the change in the stock of net foreign assets equals the (projected) current account balance. Despite the retrenchment in current account balances, these data still point to a widening of net positions over time. In turn, this suggests that, absent a stabilizing configuration of valuation changes (for example, rising asset prices or appreciating exchange rates in surplus countries), a further compression of current account balances will be needed to keep positive and negative net external positions from getting larger in relation to world GDP.

Table 2. Net External Position
(ratio of domestic GDP)

	GDP (US$ billion)		*Output gap*	
	2012	*2013*	*2012*	*2013*
United States	16,245	16,800	-4.3	-4.1
European deficit countries	8,810	9,091	-2.5	-2.9
ROW	15,764	16,155	-0.3	-0.7
Total debtors	40,819	42,046	-2.4	-2.6
China	8,229	9,181	-3.1	-3.5
Emerging Asia	3,951	4,122	0.2	-0.1
European surplus countries	6,849	7,214	-0.5	-1.3
Japan	5,938	4,902	-3.1	-2.1
Oil exporters	6,310	6,503	0.9	0.6
Total creditors	31,276	31,922	-1.3	-1.5

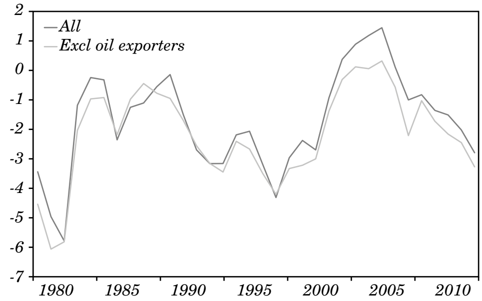
Note: Output gap measure available only for a subset of oil exporters (gap assumed to be zero for the others).
Source: International Monetary Fund, World Economic Outlook, April 2014.

1.2 Latin America

Figure 6 depicts the evolution of the current account balance for the Latin American and Caribbean region since 1980 (the cross-country sum of current account balances divided by the region's GDP). Focusing on the last 15 years, the regional current account balance improved steadily between 1998 and 2006, a year in which it reached a surplus of 1½ percent of regional GDP. Since then, the current account balance has deteriorated, also reflecting the pace of recovery in Latin America after the global financial crisis which more than offset the positive contribution coming from the terms of trade.

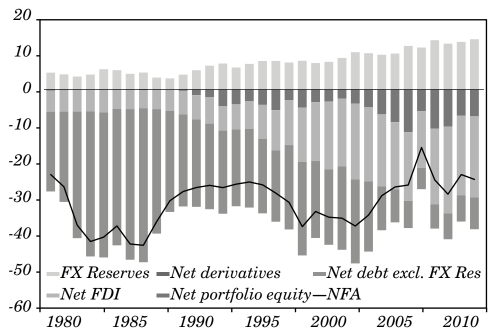
Figure 7 shows the evolution of the net foreign asset position and its composition. Focusing first on the net foreign asset position, we see a deterioration prior to, and in the aftermath of, the 1982 debt crisis, reflecting at first the large current account deficits preceding that crisis and then the combined effects of exchange rate depreciation (triggering adverse balance sheet effects given the "short FX" position of the region) as well as weak output. The position improved through the mid-1990s reflecting a combination of improved current account balances and debt reduction agreements; it experienced a second deterioration in the aftermath of the "Tequila crisis," and after remaining broadly stable in the late 1990s and early 2000s, it improved sharply until the global financial crisis –a point we will come back to shortly. It has since deteriorated.

Figure 6. Current Account Balances in Latin America
(ratio of GDP)



Note: Sum of current account balances divided by regional GDP. Oil exporters include Ecuador, Trinidad and Tobago, and Venezuela.
Source: IMF, World Economic Outlook, April 2014.

Figure 7. Latin America and the Caribbean: Net Foreign Assets and Their Composition, 1980-2012
(ratio of GDP)



Source: Lane and Milesi-Ferretti, External Wealth of Nations database.

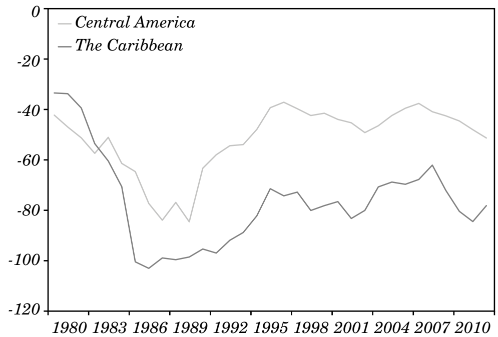
Changes in the composition of net foreign assets during the past three decades have been substantial. Specifically, the net debt position has improved steadily, from over -40 percent of GDP in 1987 to -6 percent of GDP in 2008, while at the same time the stock of foreign exchange reserves increased by some 10 percentage points of GDP. External finance for the region has increasingly taken the form of FDI and portfolio equity investment. These dramatic changes in the composition of the external portfolio help explain why during the recent crisis—unlike in previous crisis episodes—the external position of the region improved. This reflected to an important extent a change in the net position in foreign currency, which turned positive for the region with a decline in external debt and an increase in FDI and portfolio equity on the liability side, and the accumulation of reserves on the asset side. Also, the increase in liabilities whose value is tied to the outlook for the domestic economy (equity and FDI) played a role. In this new environment, the sharp depreciation of regional currencies, together with the decline in stock market valuations, reduced the value of foreign claims in the region.

The evidence shown so far reflects regional trends, and is hence heavily affected by dynamics in the largest economies (Brazil and Mexico). But there is of course significant heterogeneity in the region, including in terms of external sector developments. Figure 8 illustrates this point by showing the ratio of net foreign assets to GDP in Central American and Caribbean countries, which account for a relatively small share of aggregate regional GDP. For both regions the evolution of the external position is less favorable—specifically, they have experienced a steady deterioration in their net external position, to levels that for Caribbean countries are particularly high. Higher commodity prices are one obvious channel that affects different parts of Latin America and the Caribbean in asymmetric fashion, providing a boost to commodity exporters in South America but implying a deterioration in the terms of trade for commodity-importing countries in the Caribbean and Central America.

Looking to the future, WEO's current account projections envisage a further modest deterioration of the regional current account balance after its sharp worsening in 2013 (figure 9). In a global context, the regional current account deficit (excluding oil exporters) would constitute a rising fraction of the "rest of the world" deficit depicted in the lower panel of figure 1 (from 1/5 in 2012 to over 1/3 in 2018). A simple forward-looking projection based on 2012 net foreign asset positions, the 2013 current account balance, and WEO projections for current account balances and GDP for the period 2014-19 also suggests a further deterioration of the region's net foreign asset position (figure 8), by some 10 percentage points of GDP. The net external liabilities of the region account for about 1/3 of the net external liabilities of the "rest of the world" group, a ratio that remains broadly stable during the projection period as depicted in the lower panel of figure 5.

Figure 8. Net Foreign Asset Position, Central America and the Caribbean

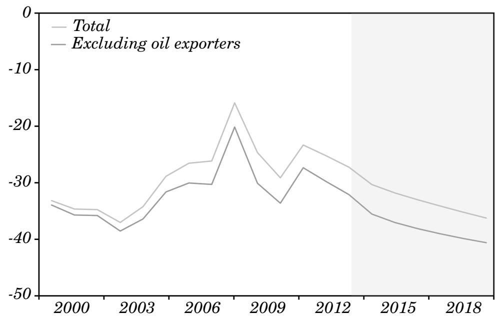
(percent of regional GDP)



Note: Sum of countries' net foreign asset position divided by regional GDP. Central America includes Costa Rica, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Nicaragua, and Panama. The Caribbean includes Antigua and Barbuda, Anguilla, Aruba, Dominica, Grenada, Guyana, Belize, Jamaica, Montserrat, Sint Maarten, St. Kitts and Nevis, St. Lucia, St. Vincent & Grenadines, Suriname, and Trinidad and Tobago.
Source: Lane and Milesi-Ferretti, External Wealth of Nations database.

Figure 9. Latin America and the Caribbean: Actual and Projected Net Foreign Asset Position

(percent of regional GDP)



Note: shaded area reports projections of the net foreign asset position (NFA) based on the current account projections reported in the Spring 2014 World Economic Outlook. The projections assume that NFA(t+1)=NFA(t)+CA(t+1), with all variables expressed in current U.S. dollars. Oil exporters include Ecuador, Trinidad and Tobago, and Venezuela.
Source: Authors' calculations based on External Wealth of Nations database and IMF, World Economic Outlook, April 2014.

2. Pre-Crisis Imbalances and External Adjustment

In this section, we examine the cross-country variation in external adjustment over the crisis period. We adopt this cross-sectional approach in order to establish whether a variety of pre-determined or fixed country characteristics have influenced the direction and scale of external adjustment. The focus on predetermined and fixed country characteristics limits endogeneity issues in interpreting the regression results. In particular, we investigate whether the current account adjustment that occurred during the crisis can be viewed as correcting "excessive" imbalances that may have emerged during the pre-crisis period. As outlined in Lane and Milesi-Ferretti (2012), the increase in the dispersion of current account balances may be attributed to an unusual and temporary configuration in the global financial environment in which risk appetite was high among both lenders and borrowers and interest rates were low. Once this phase was terminated, a compression in external imbalances was required.

Our empirical strategy is to capture the "excess" component in the pre-crisis imbalances by measuring the deviation of the current account balance from a level consistent with underlying medium-term fundamentals. To this end, following Lane and Milesi-Ferretti (2012) and a large empirical literature on this topic (e.g. Chinn and Prasad, 2003), we estimate the medium-term relation between current account balances and a set of macro-financial variables (demographic structure, level of output per capita, output growth rate, the fiscal balance, natural resource endowments, lagged net international investment position, financial center status, past experience of crisis episodes). The "excess" component of current account imbalances is derived as the deviation of the actual current account values from these estimated values. We will subsequently examine whether external adjustment during the crisis can be related to the size of this gap measure.

The current account "gap" is measured as the difference between the actual average current account balance during 2005-2008 (the final four-year interval in our pre-crisis sample) and the fitted value from the estimated regression[3]

$$CAGAP_{i,05-08} = CA_{i,05-08} - \widehat{CA}_{i,05-08}$$

3. Lane and Milesi-Ferretti (2012) report a host of robustness checks on the quality of the current account gap measure. These included additional regressors and examining alternative time windows in generating the gap estimates.

The country sample includes 64 advanced economies and emerging markets (listed in the appendix). In light of various idiosyncratic factors it excludes major oil exporters as well as countries with per capita income in 2007 below $1000 and very small countries (with GDP below $20 billion in 2007).[4]

Lane and Milesi-Ferretti (2012) show that the model captures much of the cross-country, cross-time variation in current account balances. For instance, there is a strong positive correlation (0.74) between the actual and model-implied values for the current account for the 2005-2008 period just prior to the onset of the global crisis. Still, there remains a substantial residual component and it is this "unexplained" component that we exploit as a proxy for "excessive" pre-crisis imbalances.

As a robustness test, we also calculated a measure of the current account gap using the more recent "External Balance Assessment" (EBA) methodology, described in IMF (2013). The EBA relies on a similar panel regression of current account balances, but covers a wider range of explanatory variables with a more explicit emphasis on policy variables. For the purpose of this paper, we construct the pre-crisis gap using the residuals from EBA panel regression, thereby side-stepping the issue of whether the policy variables during that period were at "appropriate" levels. The correlation between the residuals from EBA regression and the gap measure described earlier is extremely high. In the regression analysis, we use the *CAGAP* measure, since it is available for a larger sample of countries.[5]

We next turn to an examination of whether macroeconomic outcomes, during and following the global financial crisis, can be related to our measure of the current account gap. As a first step, we look at changes in the current account balance between the 2005-08 period and 2012. As the bivariate scatterplot of figure 10 highlights, the correlation of the current account gap with the subsequent change in the current account balance is clearly negative and very strong—those countries with the largest negative gaps (pre-crisis current account deficits in excess of the values indicated by the model specification) have experienced the biggest improvements in external balances over the crisis period, while those countries with

4. See Lane and Milesi-Ferretti (2012) for further details on the choice of sample.

5. We also ran the regressions using the *CAGAP-EBA* measure and obtained generally similar results.

the largest positive gaps (pre-crisis current account balances in excess of the values indicated by the model specification) have seen the largest declines in their current account to GDP ratio. Hence, the 2008-2012 period can be interpreted as a correction phase, in which the momentum has been towards the elimination of excessive external imbalances.

The pattern in figure 10 is very similar to the relation between the *CAGAP* measure and current account adjustment over 2008-2010 reported by Lane and Milesi-Ferretti (2012). In fact, there is a very high correlation (0.85) between the 2008-2010 change in the current account and the 2008-2012 change—the persistence of the improvement in the current account suggests that it cannot just be attributed to the acute disruption in international credit markets during the acute phase of the crisis (late 2008 through 2009).

We also perform regression analysis, with the change in the current account balance to GDP ratio between 2005-08 and 2012 ($\Delta CA_{i,0508-12}$) as the dependent variable. In addition to the pre-crisis current account gap; we include the pre-crisis (2007) stock of net foreign assets as a regressor. This allows us to check whether, holding pre-crisis "flow" imbalances constant, "stock" imbalances were also associated with large current account corrections. Accordingly, our baseline regression takes the following form

$$\Delta CA_{i,0508-12} = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,0407} + \varepsilon_i$$

where $NFA_{i,0407}$ is the average ratio of NFA to GDP during the period 2004-07.[6] We expect the improvement in the current account balance between 2005-08 and 2012 to be greatest for those countries with the largest negative current account gaps and—potentially—the largest net foreign liability positions.[7]

6. We also experimented with allowing for regional differences in adjustment behavior. In particular, there is no evidence that the adjustment experience of Latin American countries was different to that found for the wider sample.

7. As illustrated later in the paper, it makes no difference if we look at the change in the balance of goods and services rather than the change in the current account balance as the dependent variable.

In addition, we also want to investigate whether the exchange rate regime has influenced the nature of the adjustment process.[8] In particular, a baseline hypothesis is that a flexible exchange rate should facilitate external adjustment since nominal exchange rate movements may smoothly deliver required shifts in real exchange rates more than would be possible under a pegged exchange rate system (or inside a monetary union). We check this hypothesis in two ways. First, we run the baseline specification for sample splits. Specifically, in addition to the full sample of 64 countries, we split the sample between countries with de facto-pegged exchange rate regimes and non-pegging countries.[9] Furthermore, we also report variations within these sub-samples. Among the peggers, we drop the Baltic states from some specifications, given the dramatic changes in their current account balances. Among the non-peggers, we drop Iceland from some specifications, given the particularly large depreciation associated with the effective shut-down of the Icelandic krona market during its crisis. Second, we also run an expanded specification, in which the current account gap and net foreign asset position are interacted with an exchange rate regime dummy:

$$\Delta CA_{i,0508-12} = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,0407} + \phi PEG_i + \sigma CAGAP_{i,0508} * PEG_i + \lambda NFA_{i,0407} * PEG_i + \varepsilon_i$$

In addition to the analysis of current account adjustment, we also examine the underlying adjustment mechanisms. We focus on the cross-country variation in real exchange movements, relative demand and relative output. That is, we run regressions in the form

$$\Delta RER_{i,0508-12} = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,0407} + \varepsilon_i$$

$$\Delta DD_{i,0708-12} = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,0407} + \varepsilon_i$$

$$\Delta Y_{i,0708-12} = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,0407} + \varepsilon_i$$

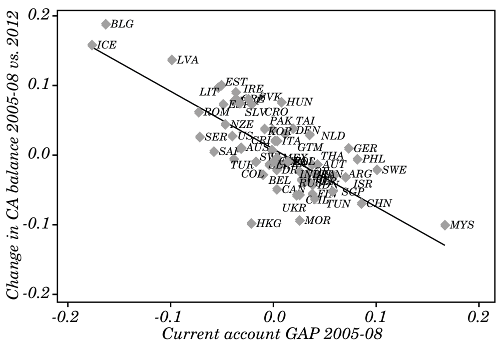
8. Rose (2014) examines whether there are differences across macroeconomic variables between different exchange rate regimes. However, his primary focus is on "unconditional" differences, whereas we examine the role of the exchange rate regime in conditioning the nature of the adjustment process as a function of the initial pre-crisis current account gap.

9. We employ the exchange rate regime classification system reported in Ghosh et al. (2011). We consider the individual members of the eurozone to be de facto peggers. Appendix C shows the list of peggers and non-peggers.

where $\Delta RER_{i,0508-12}$ is the log change in the real exchange rate between the 2005-08 average and 2012 (a positive movement is a real appreciation), $\Delta DD_{i,0708-12}$ is the log change in domestic demand between the 2007-08 average and 2012, and $\Delta Y_{i,0708-12}$ is the log change in relative output between the 2007-08 average and 2012.[10] We expect those countries with larger negative current account gaps to be under greater pressure to undergo real depreciation and/or experience a relative decline in domestic demand. Furthermore, in the presence of various nominal and real rigidities, a decline in domestic demand will map into a decline in domestic output. As in the current account regressions, we also control for the initial net foreign asset position.

As a first step, Figures 11 and 12 show scatter plots of these variables against the change in the current account balance (2012 value minus average value for 2005-08). In Figures 11a and 11b, we separately plot the change in the real exchange rate between 2005-08 and 2012 for the "non-peg" and "peg" samples, while Figures 12a and 12b show the 2005-08 to 2012 changes in domestic demand and output, respectively. Figures 11a and 11b show that for the non-peg sample, real exchange rates tended to depreciate in countries experiencing an improvement in the current account balance and vice-versa, but for the peg sample the relation has the opposite sign, suggesting that relative price changes did not help the adjustment process. However, in both Figures 12a and 12b, there is considerable heterogeneity around the bivariate regression line.

Figure 10. Current Account Adjustment and Current Account Gap

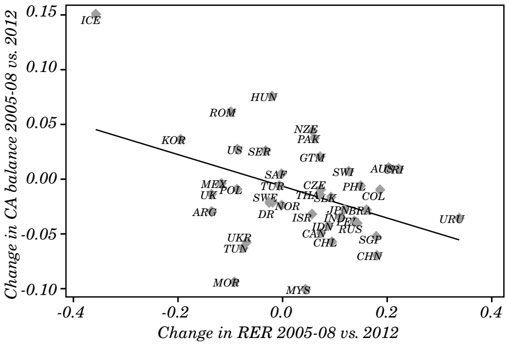


Note: Vertical axis is change in current account balance (2012 value minus average value for 2005-2008).
Source: Authors' calculations.

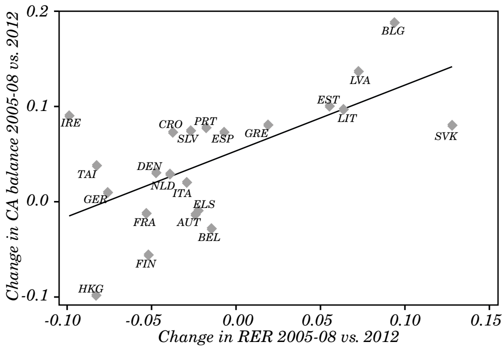
10. Given that output and demand are trending variables, we focus on a shorter pre-crisis period, but results for the 2005-08 pre-crisis period are analogous.

Figure 11. Real Exchange Rate and Current Account Balance Changes

A. No peg countries



B. Peg countries



Note: The horizontal axis measures the log change in real effective exchange rate between 2005-08 and 2012, while the vertical axis measures the change in the CA/GDP ratio between 2005-08 and 2012.
Source: Authors' calculations using data from the International Financial Statistics, IMF and Bank for International Settlements (BIS).

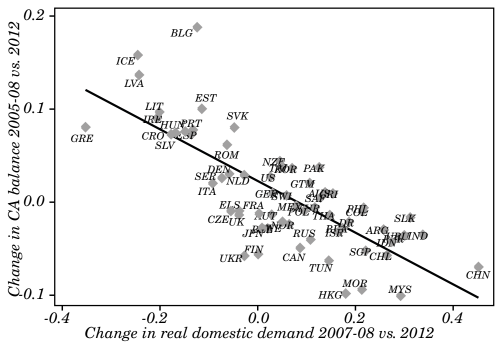
Figures 12a and 12b show very high bivariate correlations between the change in the current account and the changes in domestic demand and output. These strong covariation patterns show that current account improvements were typically associated with poorer macroeconomic outcomes (less positive or negative expenditure and output growth).

Figures 11-12 capture the contemporaneous comovements between the current account and the real exchange rate, domestic demand and output. Clearly, it is difficult to infer much about underlying causal mechanisms from such data, since these variables are jointly determined.

As outlined above, our regression analysis provides an alternative framework by examining the relation between pre-crisis imbalances and cross-country variation in adjustment patterns over 2008-2012. The regression results for current account adjustment are shown in table 3. Column (1) shows the full-sample baseline estimates. We split the sample between non-peggers and peggers in columns (2)-(3) and (4)-(5), with the latter two columns excluding extreme observations (Iceland among floaters and the Baltics among pegs). Finally, columns (6) and (7) present regressions for the whole sample with regressors interacted with an exchange regime dummy.

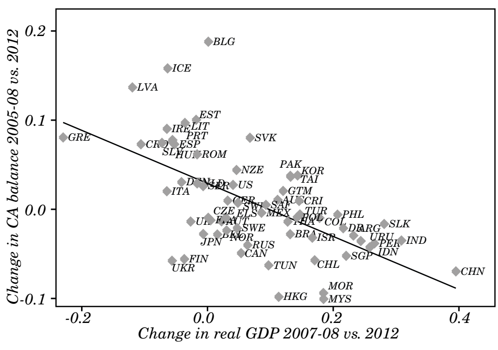
Figure 12. Change in Current Account Balance

A. Change in real domestic demand and change in current account balance



Note: The horizontal axis measures the log change in real domestic demand between 2007-08 and 2012, while the vertical axis measures the change in the CA/GDP ratio between 2005-08 and 2012.

B. Change in real GDP and change in current account balance



Note: The horizontal axis measures the log change in real GDP 2007-08 and 2012, while the vertical axis measures the change in the CA/GDP ratio between 2005-08 and 2012.
Source: Authors' calculations using data from World Economic Outlook Database, IMF, and World Development Indicators, World Bank.

Table 3. Current Account Adjustment between 2005-2008 and 2012

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
CA gap	-0.76***	-0.63***	-0.79***	-0.54***	-0.76***	-0.63***	-0.54***
	[-8.51]	[-6.46]	[-5.40]	[-6.71]	[-4.61]	[-6.38]	[-6.61]
CA gap*peg						-0.16	-0.22
						[-0.91]	[-1.25]
NFA/GDP 2004-07	-0.02*	-0.01	-0.04**	-0.01	-0.04**	-0.01	-0.01
	[-1.91]	[-1.07]	[-2.78]	[-0.97]	[-2.66]	[-1.06]	[-0.95]
NFA/GDP*peg						-0.03*	-0.03*
						[-1.95]	[-1.94]
Peg						0.03***	0.03***
						[2.94]	[3.12]
Constant	0.00	-0.01	0.02**	-0.01**	0.02**	-0.01	-0.01**
	[0.89]	[-1.44]	[2.52]	[-2.10]	[2.42]	[-1.42]	[-2.07]
Observations	64	42	22	41	19	64	60
R-squared	0.63	0.62	0.76	0.48	0.71	0.75	0.68
Countries	All	No Peg	Peg	No Peg; No ICE	Peg; No Baltics	All	All; No ICE; No Baltics

Note: Dependent variable is the change in current account to GDP between 2005-2008 (average) and 2012. Values in parentheses are t-statistics. ICE = Iceland. *** $p<0.01$, ** $p<0.05$, * $p<0.1$. OLS estimation with robust standard errors.

Table 4. Real Exchange Rate between 2005-2008 and 2012

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*
CA gap	0.46	0.74*	-0.62***	0.28	-0.53***	0.74*	0.28
	[1.29]	[1.74]	[-8.36]	[0.90]	[-4.44]	[1.72]	[0.88]
CA gap*peg						-1.36***	-0.81**
						[-3.12]	[-2.38]
NFA/GDP 2004-07	0.00	0.05***	-0.03***	0.04***	-0.03***	0.05***	0.04***
	[0.12]	[3.26]	[-4.44]	[3.26]	[-3.72]	[3.22]	[3.21]
NFA/GDP*peg						-0.08***	-0.07***
						[-4.81]	[-4.63]
Peg						-0.07***	-0.08***
						[-3.13]	[-3.88]
Constant	0.02	0.04*	-0.03***	0.05**	-0.03***	0.04*	0.05**
	[1.25]	[1.92]	[-3.56]	[2.60]	[-3.57]	[1.89]	[2.57]
Observations	64	42	22	41	19	64	60
R-squared	0.05	0.18	0.55	0.07	0.46	0.25	0.19
Countries	All	No Peg	Peg	No Peg; No ICE	Peg; No Baltics	All	All; No ICE; No Baltics

Note: Dependent variable is the change in real effective exchange rate between 2005-2008 (average) and 2012. Values in parentheses are t-statistics. ICE = Iceland. *** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

The gap measure is significant at the one percent level across all specifications. The estimated coefficient in column (1) suggests that over ¾ of the estimated pre-crisis current account gap was closed over the 2005-08 to 2012 period for the typical country in the sample. Furthermore, there is no statistically significant difference across exchange rate regimes in the relation between the gap measure and the scale of current account adjustment. These results hold even when extreme observations (Baltics, Iceland) are excluded in columns (4), (5) and (7). Relative to our previous work, the striking pattern in table 3 is that the scale of adjustment has increased relative to the (already sizable) correction during 2008-2010 (which was close to 0.6).

Table 3 also shows that those countries with more negative initial net foreign asset positions and operating under a pegged exchange rate regime underwent greater current account adjustment. While this result does not hold for the non-pegging sample, it does indicate that both *flow* and *stock* imbalances affected current account adjustment for the pegging sample. For robustness, we also ran regressions including both the current account gap and the actual current account balance for 2005-08 as right-hand-side variables. These clearly indicate that the former is the economically and statistically significant explanatory variable for subsequent current account changes.

The regression results for the real exchange rate are shown in table 4. They show a sizable difference in patterns depending on the exchange rate regime. For non-peggers, results suggest some link between pre-crisis imbalances and subsequent exchange rate adjustment, but this link is only robust for stock positions as opposed to the current account gap (whose statistical significance in column (2) vanishes when Iceland is excluded, as in column (4)). For the peg sample, the evidence suggests that, if anything, real exchange rates *appreciated* for countries with negative current account gaps and negative net external liabilities. The significance of the peg dummy indicates that peggers on average experienced more real depreciation –but that pattern is orthogonal to the scale of pre-crisis external imbalances.

Taken together, these findings do not provide much support to the notion that "expenditure switching" has been an important source of external adjustment over 2008-2012 –for excess deficit countries, the burden seems to have fallen mainly on "expenditure reduction." While Lane and Milesi-Ferretti (2012) found qualitatively-similar results for the 2008-2010 period, it is more surprising that real exchange rates have not played a supportive role over the longer 2008-2012 period, since the inhibiting forces of various nominal and real rigidities should be less powerful over a longer horizon. Arguably, alternative measures of real effective exchange rates (based on unit labor costs, instead of consumer price indices) show more real exchange rate adjustment among peggers—for example in deficit countries in the eurozone—but a broader cross-country comparison using these measures is hampered by more limited data availability.

We turn to an examination of relative domestic demand and relative output dynamics in table 5. The table underscores how pre-crisis current account gaps are strongly positively correlated with subsequent changes in domestic demand. Indeed it is striking that for the whole sample the current account gap and pre-crisis net foreign asset position help explain almost 40 percent of the cross-country variation in subsequent demand growth. Sample splits underscore how for non-peggers the current account gap plays an important role in explaining subsequent demand growth, while for peggers the initial net foreign asset position is instead the dominant factor. Not surprisingly, the link between pre-crisis imbalances and GDP growth is a bit weaker, but still important, and with the same difference in patterns between non-peggers and peggers. Robustness checks indicate that the current account gap—rather than the pre-crisis current account balance—is the relevant predictor of subsequent output and demand performance.

As further robustness checks, Lane and Milesi-Ferretti (2012) reported an array of alternative specifications and found these did not affect the main results. In particular, the pattern of results is robust in extended specifications that incorporate the initial fiscal position and projections of expected future growth or that allow for different coefficients between positive and negative current account gaps.

In Tables 6-8 and Figures 13-15 we explore in more detail some of the channels through which external adjustment can take place, focusing on policy interest rates, inflation, and the fiscal balance during the crisis.

Figure 13 shows the bivariate scatter of the change in the policy rate (average value for 2009-2012 minus the average value for 2005-2008) against the current account gap, in order to check whether those countries with negative pre-crisis current account gaps undertook larger reductions in the policy interest rate, consistent with the need to achieve a real depreciation.[11] The covariation pattern is positive –countries with negative current account gaps tended to have the largest policy rate reductions.

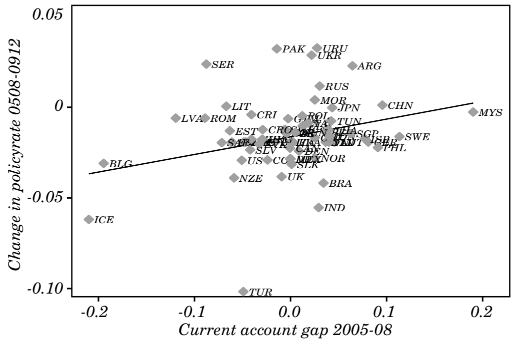
11. Serbia was excluded from the sample in table 6 as a large outlier.

Table 5. Change in Demand and Output between 2007-2008 and 2012

	(1)	(2)	(3)	(4)	(5)	(6)
	Domestic demand			Output		
CA gap	1.69***	1.51***	0.79*	0.98***	0.92***	0.15
	[6.45]	[4.96]	[2.08]	[4.50]	[3.84]	[0.58]
NFA/GDP 2004-07	0.04**	0.01	0.10***	0.02	0.00	0.07***
	[2.05]	[0.26]	[7.24]	[1.61]	[0.02]	[3.65]
Constant	0.06***	0.11***	-0.05***	0.07***	0.11***	-0.01
	[3.77]	[6.80]	[-4.00]	[5.97]	[7.63]	[-0.72]
Observations	64	42	22	64	42	22
R-squared	0.38	0.36	0.66	0.24	0.22	0.45
Countries	All	No Peg	Peg	All	No Peg	Peg

Note: Dependent variable in columns (1)-(3) is the change in total domestic demand between 2007-2008 and 2012; and change in real GDP between 2007-2008 and 2012 in columns (4)-(6). Values in parentheses are t-statistics. *** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

Figure 13. Policy Rate Adjustment and the Current Account Gap



Note: Vertical axis is change in policy interest rate (2009-2012 average value minus 2005-2008 average value). Sample excludes Serbia.
Source: Authors' calculations using data from International Financial Statistics, IMF and national sources.

Table 6. Policy Rates for 2005-2008 vs. 2009-2012

	(1)	(2)	(3)	(4)	(5)	(6)
CA gap	0.12***	0.18***	0.18***	0.01	0.14*	0.06**
	[2.75]	[2.93]	[2.88]	[0.22]	[1.78]	[2.22]
CA gap*peg		-0.17**				
		[-2.21]				
NFA/GDP 2004-07	0.00	0.00	0.00	-0.00	0.00	0.00
	[0.47]	[0.59]	[0.64]	[-0.17]	[0.59]	[0.61]
Peg		0.00				
		[0.25]				
Constant	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***	-0.02***
	[-7.68]	[-5.04]	[-5.01]	[-15.40]	[-4.27]	[-18.75]
Observations	63	63	41	22	40	19
R-squared	0.09	0.14	0.14	0.01	0.07	0.31
Countries	All	All	No Peg	Peg	No Peg; No ICE	Peg; No Baltics

Note: Dependent variable is the change in policy rate between the average for 2009-12 and average for 2005-08. Sample excludes Serbia. Values in parentheses are t-statistics. ICE = Iceland. *** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

Table 6 provides multivariate regression analysis. In particular, columns (1)-(4) indicate an important difference in the behavior of policy rates between the non-peg and peg samples. In particular, non-peggers with more negative current account gaps undertook larger cuts in policy interest rates during the crisis, whereas no similar pattern is found among the peggers. Given the strong relation between the current account gap and activity indicators (domestic demand and output) in table 5, it is not surprising that those countries with monetary policy autonomy (the non-peggers) opted to cut interest rates during the crisis, whereas this option was not available at the individual country level for the peggers.[12] Finally, column (6) of table 6 shows that the result for the peg sample is modified if the Baltics are excluded, with interest rate cuts also enjoyed by peggers with negative current account gaps. Since the eurozone member countries dominate

12. This is not necessarily true for peggers that maintain binding capital controls.

the non-Baltic peg sample, this result is explained by the cuts in ECB policy rates during the crisis since (on an unweighted basis) there are more eurozone member countries with negative current account gaps than positive current account gaps. Overall, the evidence in table 6 can help explain some of the results reported in table 4—namely, the "stabilizing" (albeit weak) link between pre-crisis imbalances and subsequent changes in the real exchange rate for non-peggers.

Table 7 reports regressions for the change in the inflation rate (average value for 2009-2012 minus the average value for 2005-2008), to see if those countries required to improve the external account in part achieved real depreciation through a lower domestic inflation rate. The bivariate scatter is presented in figure 14, which does suggest that this pattern is evident in the data. However, the regressions reported in table 7 show a significant relation between the current account gap and inflation for the pegging sample only (columns (4) and (6)). That peggers with more negative initial current account gaps experienced a reduction in inflation rates (relative to precrisis levels) in itself should contribute to real exchange rate adjustment.

Table 7. Inflation Adjustment

	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
CA gap	0.10*	0.03	0.03	0.26***	0.07	0.19***
	[1.86]	[0.66]	[0.72]	[3.89]	[1.42]	[3.35]
CA gap*peg		0.24***				
		[3.07]				
NFA/GDP 2004-07	0.01**	0.00	0.00	0.01	0.00	0.00
	[2.12]	[1.64]	[0.95]	[1.44]	[1.09]	[1.19]
Peg		0.00				
		[0.59]				
Constant	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***	-0.01***
	[-5.59]	[-3.71]	[-3.91]	[-3.93]	[-4.06]	[-3.74]
Observations	64	64	42	22	41	19
R-squared	0.10	0.17	0.02	0.59	0.03	0.54
Countries	All	All	No Peg	Peg	No Peg; No ICE	Peg; No Baltics

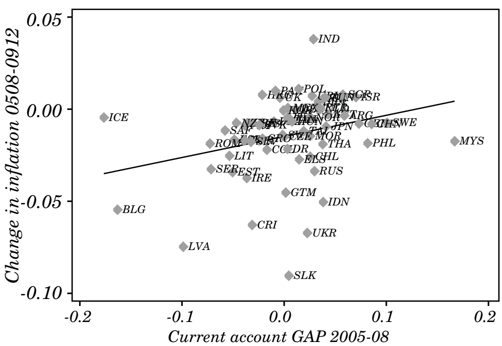
Note: Dependent variable refers to the change in inflation between the average for 2009-12 and average for 2005-08. Values in parentheses are t-statistics. ICE = Iceland. *** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

Table 8. Fiscal Adjustment

	(1)	(2)	(3)	(4)
Variables	*Change in structural fiscal balance, 2005-08 to 2012*			
CA gap	-0.04	0.02	-0.08	0.02
	[-0.71]	[0.38]	[-0.61]	[0.45]
CA gap * peg				-0.11
				[-0.76]
NFA/GDP 2004-07	-0.00	-0.00	-0.00	-0.00
	[-0.32]	[-0.21]	[-0.42]	[-0.45]
Peg				0.01
				[1.43]
Constant	-0.01***	-0.02***	-0.01	-0.02***
	[-3.39]	[-4.15]	[-0.79]	[-4.08]
Observations	62	40	22	62
R-squared	0.01	0.00	0.03	0.06
Countries	All	No Peg	Peg	All

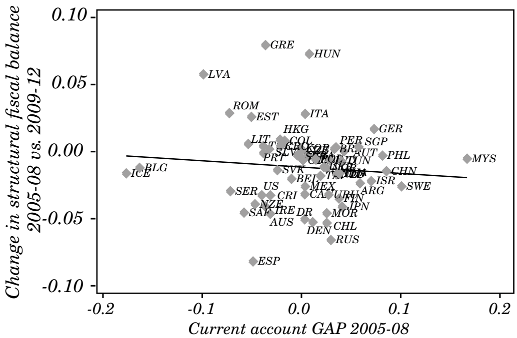
Note: Dependent variable is the change in general government structural balance as percent of potential GDP between 2005-2008 (average) and 2012). Sample excludes Pakistan and Sri Lanka for data availability reasons. Values in parentheses are t-statistics. *** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

Figure 14. Inflation Adjustment and the Current Account Gap



Note: Vertical axis is change in inflation rate (2009-2012 average value minus 2005-2008 average value).
Source: Authors' calculations using data from World Economic Outlook Database, IMF.

Figure 15. Fiscal Adjustment and the Current Account Gap



Note: Vertical axis is change in structural fiscal balance (2009-2012 average value minus 2005-2008 average value).
Source: Authors' calculations using data from World Economic Outlook Database and Fiscal Monitor Database, IMF.

However, the evidence in table 4 is that there is no systematic relation between the initial current account gap and the real exchange rate for this sample. For some countries, the positive contribution of the inflation term may have been offset by movements in the trade-weighted exchange rate; for other countries (e.g. the Baltics), the reduction in inflation during the crisis was from a high pre-crisis level, so that the net impact of the inflation differential *vis-à-vis* trading partners may have remained positive.

In table 8, we examine the relation between pre-crisis imbalances and adjustment in structural fiscal balances, in order to examine whether a tightening in the fiscal stance contributed to the closing of "excessive" current account deficits. We focus on the structural fiscal balance, since this should strip out the impact of cyclical factors on the overall fiscal balance. Figure 15 shows the bivariate scatter, which shows virtually no correlation between pre-crisis imbalances and subsequent changes in the structural fiscal balance. This is confirmed in the regression analysis in table 8—changes in the structural balance appear uncorrelated with both the pre-crisis current account gap and the pre-crisis net foreign asset position.

Next, we investigate whether stock-flow adjustments in net external positions over the period 2008-2012 were correlated with initial external imbalances.[13] As discussed in Lane and

13. That is, the contribution of non-flow factors to the change in the net international investment position between end-2007 and end-2012. Gourinchas and Rey (2014) provide a review of the literature on valuation effects and external adjustment.

Milesi-Ferretti (2001, 2007), the evolution of the net international investment position depends not only on the dynamics of the current account balance, but also on valuation effects and other adjustments to the international balance sheet. We are specifically interested in examining whether movements in exchange rates and asset prices have been facilitating external adjustment, with countries with excess deficits experiencing net valuation gains and vice versa. In this respect, it is important to note that while net valuation gains improve the external position and vice versa, these gains may actually reflect declines in domestic wealth—for example, a fall in domestic asset prices.

In terms of accounting, we can write

$$NFA_t = NFA_{t-1} - FA_t + X_t$$
$$FA_t = -(CA_t + KA_t + EO_t)$$

where *FA* is the financial account balance (equal to minus the sum of the current account balance, the capital account balance *KA*, and errors and omissions *EO*) and *X* is the sum of valuation effects and other adjustments

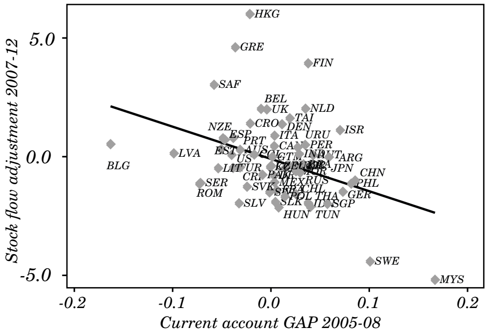
$$X_t = VAL_t + OTHER_t$$

Where *VAL* captures valuation effects related to exchange rate and asset price changes and the residual term *OTHER* captures other changes in the net foreign asset position due to reclassification, changes in coverage, etc. For most countries, it is not possible to separately capture the VAL and X terms, so we can only examine the overall *X* term. We also assume that errors and omissions primarily reflect mismeasured financial flows, and hence we use in our empirical analysis the term *SFA* defined as

$$SFA_t = NFA_t - NFA_{t-1} - (CA_t + KA_t)$$

Figure 16 summarizes the bivariate relation between the current account gap in 2005-08 and subsequent adjustments in the net external position not due to flows. The relation is positive –on average, countries with more negative current account gaps tended to experience net gains on their net external position.

Figure 16. Stock-Flow Adjustment and the Current Account Gap



Note: Vertical axis is cumulative stock-flow adjustment over 2008-2012. Sample excludes Iceland and Ireland.
Source: Authors' calculations using data from External Wealth of Nations Database, and International Financial Statistics, IMF.

Table 9. Net International Investment Position: Stock-Flow Adjustment 2008-2012

	(1)	(2)	(3)	(4)	(5)
CA gap	-1.62***	-1.85***	-1.69***	-0.49	0.24
	[-3.13]	[-3.11]	[-2.76]	[-0.69]	[0.34]
CA gap*peg		1.65*			
		[1.92]			
NFA/GDP 2004-07	0.08	0.07	0.01	0.13**	-0.01
	[1.39]	[1.32]	[0.42]	[2.37]	[-0.16]
Peg		0.13**			
		[2.61]			
Constant	0.01	-0.03	-0.04*	0.10**	0.07
	[0.23]	[-1.17]	[-1.93]	[2.33]	[1.49]
Observations	62	62	41	21	20
R-squared	0.22	0.36	0.30	0.22	0.00
Countries	All	All	No Peg	Peg	Peg No HK

Note: Dependent variable is the cumulative NIIP stock flow adjustment during 2008-2012.
Sample excludes Iceland and Ireland. HK = Hong Kong, POC. Values in parentheses are t-statistics.
*** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

This relation is further investigated in table 9, which shows the results for the various sample splits.[14] The evidence from columns (1)-(3) is that the *SFA* term has moved in a stabilizing direction for the non-pegging sample but not for the pegging sample. That is, those non-pegging countries with the most negative current account gaps have experienced more positive *SFA* terms, helping external adjustment (the international investment position improved relative to what net external borrowing would have suggested). Finally, while column (4) indicates the *SFA* term moves in a destabilizing direction *vis-à-vis* the initial net foreign asset position for the peg sample, column (5) shows that this result is not robust to the exclusion of Hong Kong (a major financial center).[15]

For non-peggers, the favorable valuation effects may in part reflect exchange rate depreciatio—to the extent that countries are "long" in foreign currency (having significant domestic-currency liabilities, such as portfolio equity and FDI, and foreign-currency assets), a depreciation will improve the net external position as a ratio of GDP. As shown in table 4, real exchange rate changes for non-peggers were positively correlated with the current account gap, implying, on average, a depreciation for countries with excess deficits. But valuation effects may also reflect changes in asset prices more generally. To the extent that markets revised their views downwards on the prospects of (previously rapidly growing) current account deficit countries, their stock market values and asset prices more generally would have underperformed during the crisis period relative to asset prices in countries with positive current account gaps. For peggers, the real exchange rate is actually negatively correlated with pre-crisis current account gaps, which in turn would imply that valuation effects would be "unfavorable" for countries with excess deficits. This can help explain the lack of evidence on a *stabilizing* pattern for valuation changes in peggers. But, more generally, this is an interesting area for future research, probing, in more detail, the underlying mechanisms at play.

We have also examined the adjustment pattern in financial flows. As in our earlier work, we find that shifts in net debt flows account for the lion share in financial account adjustment, and that these shifts are strongly correlated with the pre-crisis current account

14. The sample excludes Iceland and Ireland as extreme outliers. Lane (2012) analyses the behavior of the stock-flow adjustment term in Ireland during the crisis.

15. Measurement error is more likely to be a significant contributor to the SFA term for international financial centers, in view of the high ratios of gross foreign assets and liabilities to GDP.

gap (the results, not reported, are available from the authors). That debt flows experienced the largest shift is not too surprising, since the debt category also experienced the biggest surge in inflows to high-deficit countries during the pre-crisis period.

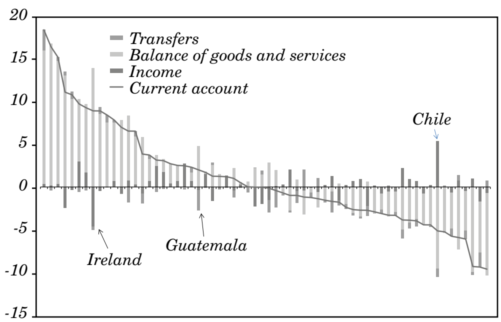
Finally, we analyze the components of the current account adjustment during the period 2005-08 to 2012. As shown in figure 17, the lion share of changes in current account balances during this period is accounted for by changes in the balance on goods and services. Changes in the income balance are virtually uncorrelated with changes in the current account, and change in the size of current account transfers are large for only a very few countries relying on remittances. In light of this evidence, we focus on the growth rate of export and import volumes in table 10. For this purpose, we employ the specifications:

$$\Delta \log(EXPVOL_{i,0708-12}) = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,2004-07} + \theta \Delta REER_{i,0508-12} + \sigma PEG_i + \varepsilon_i$$

$$\Delta \log(IMPVOL_{i,0708-12}) = \alpha + \beta CAGAP_{i,0508} + \gamma NFA_{i,2004-07} + \theta \Delta REER_{i,0508-12} + \sigma PEG_i + \varepsilon_i$$

where we consider the adjustment of trade volumes to the initial current account gap, the pre-crisis net foreign asset position, and the change in the real exchange rate over the sample period. We also run the regressions separately for our two exchange rate regime categories.

Figure 17. Decomposition of Changes in Current Account Balance, 2005-08 to 2012
(ratio of GDP)



Source: Authors' calculations based on World Economic Outlook, April 2014.

Table 10. Trade Adjustment

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	*(log) Export growth 2007-08 to 2012*			*(log) Import growth, 2007-08 to 2012*		
CA gap	-0.19**	-0.11	-0.05	0.33***	0.33**	0.60***
	[-2.49]	[-1.16]	[-0.26]	[3.09]	[2.26]	[3.14]
NFA/GDP 2004-07	0.00	-0.01	0.03**	0.01	-0.02***	0.06***
	[0.24]	[-1.02]	[2.22]	[0.99]	[-2.75]	[3.82]
Log change in REER (2005-08 to 2012)	0.07	0.05	0.52**	0.21***	0.26***	0.65***
	[1.30]	[0.90]	[2.50]	[3.82]	[3.85]	[3.27]
Peg	-0.02			-0.06***		
	[-1.31]			[-3.89]		
Constant	0.05***	0.05***	0.04***	0.05***	0.04***	0.01
	[5.99]	[5.12]	[3.98]	[6.07]	[5.94]	[1.05]
Observations	64	42	22	64	42	22
R-squared	0.08	0.04	0.31	0.50	0.46	0.44
Countries	All	No Peg	Peg	All	No Peg	Peg

Note: Values in parentheses are t-statistics. *** p<0.01, ** p<0.05, * p<0.1. OLS estimation with robust standard errors.

The trade adjustment patterns in table 10 show that countries with a more negative current account gap experienced both faster export growth and slower import growth. However, the scale of import adjustment is twice as large as the scale of export adjustment *vis-à-vis* the current account gap term, which is consistent with the "expenditure reduction" mechanism in narrowing an external deficit. More generally, the specification explains a sizable component of the cross-country variation in import growth, but a very modest share of export growth. There is a strong positive correlation between import growth and real exchange rate changes. Surprisingly, the correlation has the same sign for exports (countries with faster export growth experienced real appreciation) and is much larger and more significant for pegs. The economic and statistical significance of this result is driven by the Baltics, which (within the peg sample) experienced relatively fast export growth as well as a real appreciation.

Surprisingly, export performance post-crisis also appears to be very weakly correlated not just with pre-crisis imbalances but also with post-crisis output and import growth in trading partners, where the latter are identified on the basis of patterns of trade in goods.[16] Addressing this puzzle is an important topic for future research. One conjecture is that for several countries the geographical distribution of gross exports could be weakly correlated with trade links on the basis of value added in exports, reflecting the importance of value chains.

3. Conclusions

This paper has documented the significant narrowing of current account global imbalances following the financial crisis of 2008, with projections suggesting a further compression in current account imbalances in the coming years. So is this the end of global imbalances? The evidence is not clear-cut: despite this compression, stock imbalances have continued to expand, both in relation to domestic GDP and global GDP. As of the end of 2012, four major creditor groups (European surplus countries; emerging Asia including China; Japan; and oil exporters) held a roughly comparable stock of net foreign assets, with three debtor groups (European deficit countries; the United States; and the rest of the world) accounting for a similar absolute level of net external liabilities. Absent large valuation changes favoring debtor countries or a further compression of current account imbalances, stock positions may well widen further in coming years.

In relation to the cross-country evidence on current account adjustment after the crisis, it confirms the patterns obtained in our earlier work; namely, current account balances have generally compressed in a way that narrows the gaps that emerged during the pre-crisis period. Furthermore, pre-crisis current account gaps and pre-crisis net external positions help explain an important part of subsequent cross-country differences in demand growth. Real exchange rates have moved in a stabilizing direction only for countries without exchange rate pegs, and only to a modest extent.

16. Results available from the authors.

External adjustment has involved very costly declines in demand in high deficit countries, with dramatic output declines relative to pre-crisis forecasts.

We have subsequently explored whether monetary policy changes during the crisis period are correlated with the size of initial imbalances. The answer is yes for countries without an exchange rate peg, where those with excess deficits have cut interest rates by more, but not so for pegs, a sample dominated by eurozone countries where changes in the policy rate were of course common across surplus and deficit countries. Finally, we have provided some suggestive evidence that valuation changes have been in a *stabilizing* direction—but only for countries without an exchange rate peg. This preliminary evidence is consistent with the evidence on exchange rate changes relative to the pre-crisis period and also with the expected pattern of changes in asset prices, more generally.

We interpret this set of results as providing a new wave of evidence that the narrowing of large external imbalances can inflict considerable macroeconomic pain on deficit countries if it requires a sharp adjustment over a limited time horizon, especially (but not exclusively) for countries that lack monetary autonomy. From a global perspective, it reinforces the case to search for policy configurations that can make the adjustment process less costly (through some combination of less expenditure compression in deficit countries and faster demand growth in surplus countries). For individual countries, it also provides motivation for the examination of preventive policies that may curb excessive and persistent deficits.

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Appendix

A1. Country samples for global imbalances

EUR Surplus: Austria, Belgium, Denmark, Finland, Germany, Luxembourg, Netherlands, Sweden, and Switzerland;

EUR Deficit: Greece, Ireland, Italy, Portugal, Spain, United Kingdom, Albania, Bosnia and Herzegovina, Belarus, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kosovo, Latvia, Lithuania, Macedonia, Moldova, Montenegro, Poland, Romania, Serbia, Slovak Republic, Slovenia, Turkey, and Ukraine;

Emerging Asia (EMA): Hong Kong S.A.R. of China, Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan province of China, and Thailand;

Oil Exporters (OIL): Algeria, Angola, Azerbaijan, Bahrain, Republic of Congo, Ecuador, Equatorial Guinea, Gabon, Iran, Kazakhstan, Kuwait, Libya, Nigeria, Norway, Oman, Qatar, Russia, Saudi Arabia, Sudan, Syria, Trinidad and Tobago, United Arab Emirates, Venezuela, and Yemen;

Rest of the world (ROW): remaining countries.

A.2 Country sample for current account regressions

Argentina; Australia; Austria; Belgium; Brazil; Bulgaria; Canada; Chile; China, People's Rep. of; Hong Kong, China; Colombia; Costa Rica; Croatia; Czech Republic; Denmark; Dominican Republic; El Salvador; Estonia; Finland; France; Germany; Greece; Guatemala; Hungary; Iceland; India; Indonesia; Ireland; Israel; Italy; Japan; South Korea; Latvia; Lithuania; Malaysia; Mexico; Morocco; Netherlands; New Zealand; Norway; Pakistan; Peru; Philippines; Poland; Portugal; Romania; Russian Federation; Serbia, Republic of; Singapore; Slovak Republic; Slovenia; South Africa; Spain; Sri Lanka; Sweden; Switzerland; Taiwan Prov. of China; Thailand; Tunisia; Turkey; Ukraine; United Kingdom; United States; and Uruguay.

A3. Exchange Rate Regimes

Pegged: Austria; Belgium; Bulgaria; China, P.R.: Hong Kong; Croatia; Denmark; El Salvador; Estonia; Finland; France; Germany; Greece; Ireland; Italy; Latvia; Lithuania; Netherlands; Portugal; Slovak Republic; Slovenia; Spain; and Taiwan Province of China.

Non-Pegged: Argentina; Australia; Brazil; Canada; Chile; China,P.R.: Mainland; Colombia; Costa Rica; Czech Republic; Dominican Republic; Guatemala; Hungary; Iceland; India; Indonesia; Israel; Japan; South Korea; Malaysia; Mexico; Morocco; New Zealand; Norway; Pakistan; Peru; Philippines; Poland; Romania; Russian Federation; Serbia, Republic of; Singapore; South Africa; Sri Lanka; Sweden; Switzerland; Thailand; Tunisia; Turkey; Ukraine; United Kingdom; United States; and Uruguay.

Notes: "peg" refers to de facto exchange rate regime classification for the period 2005-08. Source: Ghosh et al. (2011) extended by the authors. "Baltics" include Estonia, Latvia, and Lithuania.

Saving Distortions, Undervalued Exchange Rates, and Protectionism

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Policies that distort domestic saving decisions have general equilibrium effects on trade flows and the real exchange rate. In particular, increasing domestic savings keeps the real exchange rate undervalued, depressing imports and increasing exports. However, there are important differences between saving distortions and standard protectionist trade policies like tariffs. We use a simple two-period model to illustrate these differences by comparing a saving subsidy, which keeps the exchange rate undervalued, and a temporary import tariff. Both policies reduce current imports. However, the first policy entails short-run welfare losses for the domestic country and short-run welfare gains for its trading partners; the second policy has opposite welfare effects.

There is a wide range of policy choices in emerging economies that affect the net saving rate of the country. All these policy choices have side effects on the trade balance and on the real exchange rate. Some policies are more directly oriented at affecting the exchange rate. For example, increased savings by the official sector in the form of reserves accumulation may be directly oriented at keeping the exchange rate low, but many other policy decisions are not primarily geared towards the exchange rate, and yet have general equilibrium effects on it. For

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example, a decision to put a better social insurance system in place will affect the precautionary savings of domestic households and thus affect the domestic saving rate. In this paper, we look at the trade implications of this broad class of policies, putting them under the general heading of "saving distortions," leaving aside the specifics of each policy and focusing on the general equilibrium channel for which these policies affect trade and international relative prices.

The objective of this paper is to clarify the differences between these policies and traditional protectionist policies like tariffs that differentially affect imported and exported goods. In particular, in the public debate, a common claim is that policies that keep the exchange rate undervalued are analogous to protectionist policies because they discourage the imports of foreign goods and encourage exports by the country that puts them in place. For example, Fred Bergsten commented on China's exchange rate policy in 2010 saying, "Such currency manipulation is a blatant form of protectionism. It subsidizes all Chinese exports 25 to 40 percent. It places the equivalent of a 25 to 40 percent tariff on all Chinese imports, sharply discouraging purchases from other countries."[1]

Here we use a simple model to argue that the analogy between exchange rate policy and trade policy can be misleading. In particular, we focus on comparing a saving subsidy and a tariff. The main difference is that, in a benchmark neoclassical framework, the terms-of-trade effects associated to a saving distortion favor a country's trading partner in the short run, while the terms-of-trade effects associated with a tariff increase domestic welfare at the expense of foreign welfare. The intuition behind this difference is as follows: A tariff reduces the relative demand for foreign goods, which worsens foreign terms of trade and welfare. The tariff discourages purchases of foreign goods by introducing a wedge so the tax-inclusive price of the foreign good goes up for the individual consumer, but the country as a whole faces a *lower* international price. In contrast, a subsidy on savings acts like a transfer to foreigners in the first period, which, given home bias, increases the relative demand for foreign goods as in the classic transfer problem of Keynes (1929). This increases the price of the foreign good for domestic consumers and discourages purchases of foreign goods. But now there is no wedge between the price perceived by individual consumers and the price faced by the country as a whole. So an increase in the price of the foreign good

1. See Bergsten (2010) for a more detailed discussion of this comment in section 4.

is just a worsening of the domestic terms of trade, leading to lower welfare. The opposite effects take place in future periods, when foreigners pay back home.

The analysis of the relative price effects of saving distortions builds on Costinot, Lorenzoni and Werning (2014). Here, we focus on a simple two period setting and add the possibility of good-specific taxes or subsidies so we can compare saving distortions and protectionist policies.

1. A Model

Consider a two period model. There are two countries, domestic and foreign, and two goods, good , produced in the domestic country, and good , produced in the foreign country. For ease of exposition, we make specific functional form assumptions on preferences. The preferences of the domestic consumer are represented by the utility function

$$U(C_1) + \beta U(C_2)$$

where $U(C) = C^{1-\gamma}/(1-\gamma)$. The consumption index C_t is a Cobb-Douglas composite of consumption of good 1 and 2 according to

$$C_t = c_{1t}^{\alpha} c_{2t}^{1-\alpha} .$$

The preferences of the foreign consumer are analogous, but with a discount factor β^* possibly different from β and with the role of the two goods reversed, so the consumption index is

$$C_t^* = \left(c_{1t}^*\right)^{1-\alpha} \left(c_{2t}^*\right)^{\alpha} .$$

We assume that $\alpha > 1/2$ to capture home bias in consumption.

The budget constraint of the domestic consumer is

$$p_{11}c_{11} + p_{21}c_{21} + q\left(p_{12}c_{12} + p_{22}c_{22}\right) = a_{01} + p_{11}y_{11} + q\left(a_{02} + p_{12}y_{12}\right), \qquad (1)$$

where y_{11} and y_{12} are endowments of good 1 produced in the two periods, p_{jt} is the price of good j at time t, and q is the price of a one period bond (related to the interest rate r by the equation $q=1/(1+r)$). The domestic country starts with an initial foreign asset position given by the vector (a_{01}, a_{02}), where a_{0t} are financial claims in terms of the numeraire, to be paid at date t. Since there are no real assets the net foreign asset position of the foreign consumer is $a^*_{0t} = a_{0t}$.

The budget constraint for the foreign consumer is analogous. Given the preferences above the price indices for the domestic and foreign consumer are given by

$$P_t = (1-\alpha)^{-(1-\alpha)}\alpha^{-\alpha}p_{1t}^{\alpha}p_{2t}^{1-\alpha}, \tag{2}$$

and

$$P_t^* = (1-\alpha)^{-(1-\alpha)}\alpha^{-\alpha}p_{1t}^{1-\alpha}p_{2t}^{\alpha}. \tag{3}$$

We use world total output as the numeraire. Since world output is equal to world consumption in each period, we have

$$P_tC_t + P_t^*C_t^* = 1.$$

We define the fraction of world spending realized by domestic consumers:

$$x_t \equiv P_tC_t.$$

We will consider the effect of introducing a small distortion, starting at a competitive equilibrium. So let us first derive some necessary equilibrium conditions.

For a given value of x_t it is easy to characterize the equilibrium in the two goods markets in period t. Given Cobb-Douglas preferences, domestic consumers allocate a fraction α of their spending to the domestic good, while foreigners allocate a fraction $1-\alpha$. So, by market clearing, the domestic good price satisfies

$$p_{1t}y_{1t} = \alpha x_t + (1-\alpha)(1-x_t), \tag{4}$$

and the foreign good price satisfies

$$p_{2t}y_{2t} = (1-\alpha)x_t + \alpha(1-x_t). \tag{5}$$

Intertemporal optimality conditions determine the values of x_1 and x_2 in equilibrium. In particular, the Euler equation for the domestic and foreign consumers are, respectively,

$$U'(C_1) = \beta(1+r)\frac{P_1}{P_2}U'(C_2), \tag{6}$$

where $C_t = x_t/P_t$, and

$$U'(C_1^*) = \beta^*(1+r)\frac{P_1^*}{P_2^*}U'(C_2^*), \tag{7}$$

where $C_t^* = (1-x_t)/P_t^*$. Notice that the real interest rates faced by the two consumers are different because they consume different consumption baskets.

Equations (2) to (7) will be all we need to analyze the effect of intertemporal policies on domestic and foreign welfare.

2. Effects of a Saving Distortion

2.1 The Policy

We want to study the effects of a small distortion in favor of saving introduced by country 1. We want to distinguish the effects of this inter-temporal disortion among the effects of an intra-temporal distortion that affects the two goods differentially. So we assume that the government of country 1 cannot impose good-specific taxes or subsidies, but can only introduce a tax/subsidy on total savings that distorts the choice of C_1 and C_2. To be specific, the government introduces a proportional subsidy τ to net lending in period 1, which is financed by lump-sum taxation.[2] This means that the domestic consumer faces the budget constraint

$$p_{11}c_{11} + p_{21}c_{21} + \frac{q}{1+\tau}(p_{12}c_{12} + p_{22}c_{22}) = a_{01} + p_{11}y_{11} + \frac{q}{1+\tau}(a_{02} + p_{12}y_{12}) - \frac{T}{1+\tau}.$$

2. τ is a saving subsidy if $p_{11}c_{11} + p_{21}c_{21} < a_0 + p_{11}y_{11}$ and a borrowing tax if $p_{11}c_{11} + p_{21}c_{21} > a_0 + p_{11}y_{11}$.

Notice that the tax τ does not change the equilibrium conditions (4) and (5). It also does not affect the Euler equation and the intertemporal budget constraint of the foreign consumer. In particular the latter can be written as

$$1-x_1+q\left(1-x_2\right)=a_{01}^*+p_{21}y_{21}+q\left(a_{02}^*+p_{22}y_{22}\right). \tag{8}$$

Therefore, a convenient way to analyze the effects of the tax is to choose a pair of spending levels x_1 and x_2 such that (8) is satisfied, taking into account that the prices q, p_{21} and p_{22} depend on the choice of x_1 and x_2. Then we can show that there exists a tax τ that implements a competitive equilibrium with spending levels x_1, x_2.[3]

Differentiating (8) we get

$$-dx_1-qdx_2=y_{21}dp_{21}+qy_{22}dp_{22}+\left(a_{02}^*+p_{22}y_{22}-\left(1-x_2\right)\right)dq. \tag{9}$$

Recall that the price p_{2t} only depends on the spending level x_t. Then, using conditions (4) and (5) to express dp_{21} and dp_{22} in terms of dx_1 and dx_2, we can rewrite (9) as

$$2\left(1-\alpha\right)dx_1+2\left(1-\alpha\right)qdx_2=\left(1-x_2-a_{02}^*-p_{22}y_{22}\right)dq. \tag{10}$$

To simplify the analysis we restrict attention, from now on, to economies that feature no borrowing or lending at the undistorted competitive equilibrium, that is, $x_1 = a_{01} + p_{11}y_{11}$. In the appendix we show how to choose the economy's primitive parameters so that this property holds. Zero borrowing implies that small changes in the interest rate (i.e., in the bond price q), have no redistribution effects on domestic and foreign consumers. With this assumption, we are muting the interest rate channel that is the focus of section 3 of Costinot, Lorenzoni and Werning (2014), and focusing on the effects of inter-temporal distortions on intra-temporal relative prices, i.e., the relative price of the domestic good in terms of the foreign good at time t.

Assuming zero borrowing in equilibrium implies $1-x_2=a_{02}^*+p_{22}y_{22}$, so equation (10) yields

$$\frac{dx_2}{dx_1}=-\frac{1}{q}. \tag{11}$$

3. A similar approach is developed in section 4 of Costinot, Lorenzoni and Werning (2014) to analize optimal policy.

Near the competitive equilibrium, the locus of feasible pairs of spending levels x_1, x_2 have a slope equal to the equilibrium interest rate. In other words, if we introduce a saving subsidy that decreases by ε domestic spending in t =1, this increases domestic spending by $(1 + r)$ ε in t =2.

2.2 Welfare Effects

We can now look at the effect of the policy described on the welfare of domestic and foreign consumers. The total change in welfare for domestic consumers is given by

$$\frac{dW}{dx_1} = U'(C_1)\frac{dC_1}{dx_1} + \beta U'(C_2)\frac{dC_2}{dx_2}\frac{dx_2}{dx_1}.$$

Using $C_t = x_t / P_t$ and equation (11) we can rewrite the expression on the right-hand side as

$$\frac{dW}{dx_1} = \frac{U'(C_1)}{P_1}\left[1 - \frac{dP_1}{dx_1}C_1\right] - \frac{\beta}{q}\frac{U'(C_2)}{P_2}\left[1 - \frac{dP_2}{dx_2}C_2\right].$$

The interpretation is straightforward. The direct effect of an intertemporal shift in spending is given by the two terms equal to in the bracketed expressions. The remaining terms have to do with the effects of the spending shift on the relative prices of the two goods.

Since we start at an undistorted competitive equilibrium, the domestic consumer's Euler equation implies that the two direct effects cancel out, so we are left with

$$\frac{dW}{dx_1} = \frac{U'(C_1)}{P_1}\left[\frac{dP_2}{dx_2}C_2 - \frac{dP_1}{dx_1}C_1\right]. \tag{12}$$

In the appendix we prove that $dP_t / dx_t > 0$. This result follows from the assumption of home bias in consumption ($\alpha > 1/2$): an increase in domestic spending increases the demand for the domestic good relatively more than the demand for the foreign good. This raises the price of the domestic good and reduces the price of the foreign good. Since the domestic consumption basket contains relatively more of the home good, the net effect is an increase in the domestic price index. We can then use equation (12) to interpret the welfare effect of a saving subsidy. A saving subsidy reduces domestic spending at date 1 and increases it at date 2. The domestic consumer gains if the current reduction in the price of the domestic consumption basket, weighted by the current consumption level, more than offsets the future increase in the same variable. The following result shows that depending on the model parameters, a saving subsidy can either increase or decrease domestic welfare. The proof is in the appendix.

Proposition 1 *Suppose at the undistorted competitive equilibrium there is zero borrowing. A small saving subsidy increases domestic welfare if* $x_2 < x_1 \leq 1/2$ *or* $1/2 \leq x_1 < x_2$. *It decreases domestic welfare if* $x_1 < x_2 \leq 1/2$ *or* $1/2 \leq x_2 < x_1$.

While the total welfare effect of a saving subsidy can go in either direction, the short-run effects are unambiguous. The effect of a saving subsidy is always to decrease current utility, since dx_1<0 and

$$\frac{dU_1}{dx_1} = \frac{U^{'(C_1)}}{P_1}\left[1 - \frac{dP_1}{dx_1}C_1\right]dx_1 > 0.$$

The inequality is proved in the appendix, but the intuition is very simple: reducing current spending reduces current utility. The effect is mitigated but never overturned by the fact that the domestic consumption basket gets cheaper. Notice that we are moving on the Pareto frontier within each period, so a reduction in domestic utility corresponds to an increase in foreign utility. We then get the following result.

Claim 2 *In the short run, foreign consumers always gain from a saving subsidy imposed by the domestic country.*

It is also possible to decompose the welfare effects in a different manner, looking at the redistribution generated by term-of-trade adjustments. The envelope theorem implies that the total change in welfare for the domestic consumer can also be computed as follows:

$$\frac{dW}{dx_1} = \frac{U'(C_1)}{P_1}\left[\left(y_{11} - c_{11}\right)\frac{dp_{11}}{dx_1} - c_{21}\frac{dp_{21}}{dx_1} + q\left(y_{12} - c_{12}\right)\frac{dp_{12}}{dx_1}\right.$$
$$\left.-q\frac{dp_{22}}{dx_1}c_{22} + \left(a_{02} + p_{12}y_{12} - x_2\right)\frac{dq}{dx_1}\right]$$

In an equilibrium with zero borrowing the last term inside the square brackets is zero, so the change in welfare is purely due to the changes in relative prices of the two goods in the two periods. Equations (4) and (5) imply that $dp_{11}/dx_1>0$ and $dp_{21}/dx_1>0$, as an increase in domestic spending shifts world demand towards the domestic good. Moreover, the same decomposition can be done for the foreign consumer, leading to the same exact expressions, but with the opposite sign. We then have the following result.

Claim 3 *A saving subsidy generates short-run changes in the static terms of trade that increase the utility of the foreign consumer and reduce the utility of the domestic consumer.*

The interpretation is also straightforward. A temporary reduction in domestic spending leads to a worsening of domestic terms of trade, so domestic consumers sell domestic goods at a lower price and purchase foreign goods at a higher price. Notice that this leads domestic consumers to buy less foreign goods for two reasons: because they are more expensive and because domestic consumers are spending less overall. This reduction in imports suggests a similarity with a tariff, but, as we shall see in a moment, the analogy is misleading.

3. Comparison with a Tariff

Consider now a different policy experiment. Suppose we start at an equilibrium with zero borrowing, as we have done so far. Suppose at $t=1$ the domestic country imposes an ad valorem tariff on foreign goods μ and, at the same time, introduces an intertemporal tax τ that ensures that we stay at zero borrowing. Then the effects of the tariff can be analyzed exactly as in a static model. The tariff now distorts the share of domestic spending going to the two goods. The fraction spent on domestic goods is now

$$\frac{\alpha(1+\mu)}{\alpha(1+\mu)+1-\alpha}.$$

Market clearing in the domestic good market yields

$$p_{11}y_{11}=\frac{\alpha(1+\mu)}{\alpha(1+\mu)+1-\alpha}\left(a_{01}+p_{11}y_{11}\right)+(1-\alpha)\left(1-p_{11}y_{11}-a_{01}\right),$$

where we are using the fact that the economy is kept at zero borrowing so $x_1 = a_{01} + p_{11} y_{11}$. Differentiating shows that a tariff increases the price of the domestic good

$$\frac{dp_{11}}{d\mu} > 0.$$

Similarly we can show that $dp_{21}/d\mu < 0$.

Given the way we have designed the policy, it only affects the allocation and welfare in period 1. Moreover, an envelope argument implies

$$\frac{dW}{d\mu} = \frac{U'(C_1)}{P_1}\left[(y_{11} - c_{11})\frac{dp_{11}}{d\mu} - c_{21}\frac{dp_{21}}{d\mu}\right].$$

So a tariff always increases the welfare of the country imposing it and always reduces the welfare of the trading partner. By construction, the welfare gain is only showing in the short run.

We can now clearly see the difference between the two policy experiments considered. The immediate effect of a saving subsidy is to worsen the terms of trade of the country imposing it. A saving subsidy can only yield benefits in the future, when the country will be spending more and increasing its terms of trade. A tariff, on the other hand, always improves the terms of trade of the country imposing it and that is what makes it desirable.

A source of confusion comes from the fact that under both policies domestic consumers are encouraged to shift their spending from foreign goods to domestic goods. Namely, the ratio

$$\frac{c_{21}}{c_{11}}$$

goes down under both policies. However, under a saving subsidy this ratio is decreasing only because, in general equilibrium, the foreign good is getting relatively more expensive. The condition of equality between marginal rate of substitution and relative price,

$$\frac{\alpha}{1-\alpha}\frac{c_{21}}{c_{11}} = \frac{p_{11}}{p_{21}},$$

holds undistorted under a saving subsidy. Under a tariff, instead, the foreign good is only perceived to be more expensive because of the tariff and the condition above is replaced by

$$\frac{\alpha}{1-\alpha}\frac{c_{21}}{c_{11}}=\frac{p_{11}}{(1+\mu)p_{21}}.$$

The price cum tariff of the foreign good $(1+\mu)p_{21}/p_{11}$ has gone up, but the world price p_{21}/p_{11} has gone down, that is what is benefitting the domestic consumer. Consumers are buying less of good 2 only because they have to pay the tariff on top of the world price. But the country as a whole is paying less for good 2.

4. Neutrality Results and Equivalence Results

Now consider a policy of imposing both an import tariff and an export subsidy in period 1, of equal size, in percentage terms. Suppose the intertemporal effects of the policy are muted by imposing a saving tax, as we did in the case of a tariff alone. Then the effect of the policy is completely neutral. The import tariff makes foreign goods more expensive in terms of the numeraire, the export subsidy makes the domestic good more expensive. Their relative price is unchanged. This is simply a consequence of Lerner's symmetry theorem (Lerner, 1936), with the two interventions exactly canceling each other. Neutrality also follows if the tariff and subsidy are permanent, i.e., if they are equal in the two periods.

If the intertemporal effects are not neutralized, a temporary import tariff plus export subsidy are equivalent to a saving subsidy since they introduce an equal wedge on both period-1 goods for domestic consumers. The general equilibrium effect of the policy is to make domestic goods cheaper in period 1 and, as we saw above, it has detrimental welfare effects in the short run. Notice that there is no mechanical relation between the size of the tariff plus subsidy, and the size of the exchange rate devaluation achieved with this policy. To see this in an extreme case notice that if $\alpha=1/2$ the effect on relative prices is completely absent.

We can now go back to the remark by Bergsten (2010), cited in the introduction. Under the right *ceteris paribus* assumptions, the remark is mechanically true. For example, for a domestic firm competing with imported goods, who faces given prices of domestic inputs in domestic currency and given prices of competing imports in foreign currency, a tariff or an exchange rate devaluation are equivalent. However, once the exchange rate is determined in equilibrium, one has to specify what policy instruments are used to achieve the exchange rate devaluation and to make assumptions on the adjustment of domestic and foreign prices. In a simple neoclassical environment with flexible prices, in which the exchange rate is manipulated solely via saving distortions, this leads to very different conclusions.

5. Concluding Remarks

This paper leaves aside an important open question: what is the rationale for policies that distort the saving rate of a country? Proposition 1 provides a potential rationale by which the country imposes a distortion because it will reap welfare gains in the long run, while its exchange rate appreciates. Since this channel seems poorly understood and rarely made in policy circles, it's important to consider alternative explanations.

One possibility is that an increase in the saving rate may be simply the side effect of policies of precautionary reserve accumulation. Another possibility is that the real devaluation and expansion of the export sector generated by a high-saving policy are an explicit objective of the policy maker. From a terms-of-trade point of view, the argument in this paper shows that the real devaluation, per se, leads to welfare losses in the short run. However, it is possible that the policy is beneficial in terms of social welfare because it internalizes some externality associated to an expansion of the export sector. Maybe export volumes affect learning-by-doing and other forms of knowledge accumulation. This is the argument pursued in Rodrick (2008). On the other hand, it is also possible that these policies are simply not maximizing social welfare, but responding to political-economy pressures.

Finally, a depressed economy may like to devalue its currency to boost external demand. However, that does not seem to make a case for distortions that increase domestic savings, given that these distortions are likely to be overall contractionary in a depressed economy. Discussing these channels requires a richer monetary model with price stickiness where exchange rate policy is achieved with different instruments.[4] In any event, it is useful to separate medium-run considerations that apply to countries that keep their exchange rate undervalued over long periods of time, from short-run considerations related to volatile capital flows and cyclical shocks, where nominal rigidities are more likely to play an important role.

A better understanding of the rationale behind high-saving policies is clearly needed to assess their overall welfare consequences, both on the countries imposing them and on their trading partner. This paper only provides a clarification of a basic difference in the terms-of-trade implications of these policies relative to traditional protectionist tools.

4. Stager and Sykes (2010) analyze the effect of nominal undervaluation achieved by monetary policy in a sticky price environment. Farhi and Wering (2013) analyze the role of capital controls in responding to volatile capital flows in sticky-price models.

Appendix

Derivations for section 2.2

First, we prove the following inequalities

$$0 < \frac{dP_t}{dx_t} C_t < 1,$$

which are stated in section 2.2. Derive the equilibrium prices p_{1t} and p_{2t} from (4) and (5) and substitute in the domestic CPI (2) to get

$$P_t = \alpha^{-\alpha} (1-\alpha)^{-(1-\alpha)} \left(\frac{\alpha x_t + (1-\alpha)(1-x_t)}{y_{1t}} \right)^{\alpha} \left(\frac{(1-\alpha) x_t + \alpha (1-x_t)}{y_{2t}} \right)^{1-\alpha}.$$

Differentiating this expression and rearranging gives

$$\frac{1}{P_t} \frac{dP_t}{dx_t} = \alpha \frac{2\alpha - 1}{\alpha x_t + (1-\alpha)(1-x_t)} - (1-\alpha) \frac{2\alpha - 1}{(1-\alpha) x_t + \alpha (1-x_t)}. \tag{13}$$

It is easy to check that $\alpha > 1/2$ implies $dP_t / dx_t > 0$. Moreover

$$\frac{dP_t}{dx_t} C_t = \frac{x_t}{P_t} \frac{dP_t}{dx_t} < (2\alpha - 1) \frac{\alpha x_t}{\alpha x_t + (1-\alpha)(1-x_t)} < 1,$$

where the last inequality follows since the two factors before the inequality are both smaller than 1.

Proof of Proposition 1

Define the function

$$f(x) \equiv \alpha \frac{x}{\alpha x + (1-\alpha)(1-x)} - (1-\alpha) \frac{x}{(1-\alpha) x + \alpha (1-x)}.$$

A saving subsidy reduces x_1, so it leads to a welfare gain iff $dW/dx_1 < 0$. By equation (12), this happens iff

$$\frac{x_1}{P_1} \frac{dP_1}{dx_1} > \frac{x_2}{P_2} \frac{dP_2}{dx_2},$$

that is, iff $f(x_1) > f(x_2)$. It can be shown that the function f is increasing in [0,1/2] and decreasing in [1/2,1]. The two cases in the Proposition follow.

Constructing examples

Examples of competitive equilibria with $x_1 > x_2$ and $x_1 < x_2$ can be constructed by reverse engineering. Zero borrowing in equilibrium requires

$$1 - x_2 = p_{22} y_{22} = (1 - \alpha) x_2 + \alpha (1 - x_2),$$

which implies $x_2 = 1/2$. Choose a value for $x_1 \neq 1/2$ and choose a bond price q. Find the levels of $p_{1t,} p_{2t,} P_{t,} P_t^*$ using equations (2) to (5). Then consumption levels are obtained from $C_t = x_t / P_t$ and $C_t^* = (1 - x_t) / P_t^*$. Choose the discount factors β and β* to satisfy the Euler equations (6) and (7) (choosing q small enough ensures that both discount factors are smaller than 1). Finally, choose the initial net asset position a_0 so that the domestic budget (1) constraint holds. The foreign budget constraint holds by Walras' Law.

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Domestic Financial Frictions and the Transmission of Foreign Shocks in Chile

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In the early 90's a literature emerged emphasizing the role of external factors in explaining business cycle fluctuations in emerging countries. In particular, changes in the terms of trade and world interest rates are generally viewed as the main external factors affecting these economies.[1] Additionally, part of this literature has also highlighted the role of financial frictions in explaining the propagation of external shocks where these frictions arise in the relationship between foreign lenders and domestic borrowers. The role of country premia,[2] the possibility of sovereign default,[3] and financial dollarization[4] are some of the propagation mechanisms

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1. Early contributions to this literature are Calvo et al. (1993) and Hoffmaister and Roldos (1997), while Izquierdo et al. (2008) and Osterholm and Zettelmeyer (2008) are some more recent examples focusing on Latin America.

2. See, for instance, Neumeyer and Perri (2005), Uribe and Yue (2008), and Mendoza (2011).

3. For example, Arellano (2008), Yue (2010), and Mendoza and Yue (2012).

4. For instance, Cespedes et al. (2004), Devereux et al. (2006), and Gertler et al. (2007).

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that have been highlighted by this literature. All these features generate a wedge between foreign and domestic interest rates. Given the number of financial and currency crises, as well as episodes of sovereign default, that have affected the emerging world in the 80's and 90's, it is not hard to see the relevance of these arguments.

In contrast, the role of *domestic* financial frictions in propagating shocks emanating from the rest of the world has not been as deeply analyzed.[5] Such analysis might be of interest because for many emerging countries, including some in Latin America, the financial situation with the rest of the world seems to have changed in the last decade relative to the last quarter of the 20th century. For instance, most countries seem to have controlled the fiscal situation (some governments are even net foreign lenders), dollarization has been drastically reduced, country premia have not displayed the high levels they used to show years ago, and fixed exchange rate regimes (that greatly exacerbated the influence of foreign shocks) have been replaced by either managed floats or, in some cases, flexible inflation targeting frameworks. From that perspective, it might be argued that financial frictions between foreign and domestic agents are likely less relevant than they used to be. However, financial frictions between domestic agents—a factor that has been emphasized in the recent macroeconomic literature for developed countries—can still play an important role in explaining how foreign shocks affect emerging countries. In other words, while the spread between domestic and foreign interest rates could be small, it might still be the case that domestic spreads play a relevant role. And while we do not argue that frictions between domestic and foreign agents are irrelevant, the lack of studies tackling the role of domestic frictions in emerging countries motivates analysis of this issue.

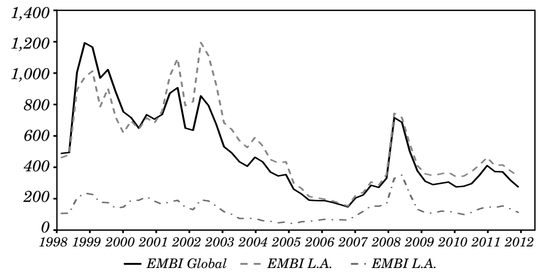
The goal of this paper is to assess the importance of domestic financial frictions in propagating external shocks in Chile. The Chilean economy has most of the characteristics of the 21th-century emerging countries that we mentioned above. Its fiscal situation is quite strong, particularly since the structural-balance rule that was introduced in 2001. Indeed, the Chilean government has a positive net external investment position, which in particular implies that

5. Some exceptions are Edwards and Vegh (1997) or Mandelman (2010) who consider how imperfections in the banking sector (e.g., monopolistic competition) propagate foreign shocks. More recently, Christiano et al. (2011) include a financial accelerator channel for the intermediation of domestic credit, but they do not focus on analyzing how this friction affects the propagation of external shocks.

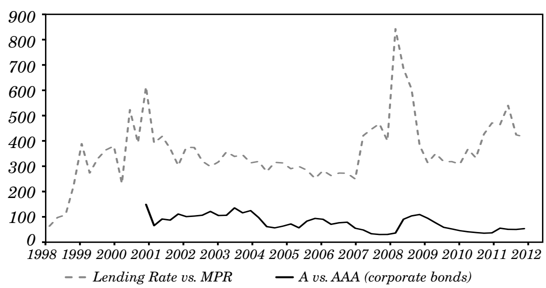
the country premium is generally quite small. For instance, as shown in figure 1 (panel A), the JP Morgan EMBI index for Chile has been significantly lower than both its world and its Latin American counterparts. Moreover, financial dollarization is almost nil in Chile. Still, the lending-deposit spread in domestic currency and the corporate bond premia are sizable, as can be seen in figure 1 (panel B). For instance, the average spread between 90-day bank lending and deposit rates between 2001 and 2012 was 380 basis points, and the average spread between A and AAA corporate bonds yields in that same period was 120 basis points. We take this evidence as an indication that domestic financial frictions might be a relevant propagation channel.

Figure 1. Selected Spreads (a.b.p)

A. External spreads



B. Domestic spreads



Sources: Bloomberg and the Central Bank of Chile.

To perform the analysis we develop a dynamic stochastic general equilibrium (DSGE) model of a small open economy featuring two types of domestic financial frictions. On one hand, there is a friction between depositors and banks that induces a spread between lending and deposit rates. We model this friction as a moral hazard problem following the work of Gertler and Karadi (2011) (GK for short).[6] On the other hand, there is a spread between the lending rate and the return to capital (known as the external finance premium) that originates in a costly state verification problem, following Bernanke et al. (1999) (BGG for short). The model also features loans to finance working capital, although there are no informational asymmetries in this lending relationship. We estimate the model with quarterly Chilean data from 2001 to 2012, including both macro and financial variables, using Bayesian techniques. The estimated model is used to understand the role that domestic financial frictions play in the propagation of shocks to world commodity prices, foreign inflation, external demand, and world interest rates.

In the estimated model, foreign shocks have a non-trivial role as driving forces for some macro variables such as GDP, consumption, the trade balance and the country premium, particularly the shocks to commodity prices and to foreign inflation. In contrast, they have a more limited role in explaining fluctuations of other variables such as inflation, the monetary policy rate, and the real exchange rate.

When we assess the role of domestic financial frictions, we find that the latter are quite relevant in propagating foreign shocks. In particular, the analysis suggests that the behavior of the real exchange rate and its interaction with financial frictions is key to understanding how foreign shocks are propagated. For instance, when the economy is hit by a contractionary foreign shock, the real exchange rate tends to depreciate. In turn, because the home good is fully tradable in our model, the real depreciation improves (relative to a model with no financial frictions) the financial position of these firms, leading to a reduction in the premium they face. Thus, the negative effect on investment might be ameliorated in the presence of financial frictions.

However, another relevant channel in place, particularly for the propagation of commodity price shocks, is the presence of working

6. The Gertler and Karadi framework has become quite popular in recent macroeconomic literature, particularly for the analysis of unconventional monetary policies (see, for instance, Gertler and Kiyotaki, 2011; Gertler and Karadi, 2013; Dedola et al., 2013; Kirchner and van Wijnbergen, 2012; Rannenberg, 2012).

capital loans, and its interaction with financial frictions. As we mentioned in our model, firms need to finance part of their operating costs (working capital) with loans, although there are no frictions in this lending activity. However, banks also have the possibility to lend to entrepreneurs that are subject to frictions. Thus, whenever the financial situation of these entrepreneurs worsens and the interest rate that banks charge them rises, it would also increase the rate that firms pay for working capital financing. Thus, while there are some loans that are not subject to frictions, in our model these loans are still affected by others that do face financial constraints. This channel is not present in models that just include a BGG-type financial friction, for instance, Christiano et al. (2011), and it arises in our framework from the interaction of both types of frictions (GK and BGG).

Our study makes several contributions to the related literature. First, to the best of our knowledge, we are the first to set up a model combining banks, as in Gertler and Karadi (2011), with entrepreneurs, as in Bernanke et al. (1999), in a small open economy framework.[7] In addition, we are the first to estimate a model featuring banks as in Gertler and Karadi (2011) for a small open economy.[8] Finally, while several studies use estimated DSGE models to assess the role of financial frictions between domestic and foreign agents in propagating external shocks,[9] we are among the few that assess the role of domestic financial frictions.

The rest of the paper is organized as follows. Section 1 presents the model. Section 2 describes the parametrization and estimation strategy, while section 3 addresses the role of financial frictions in propagating foreign shocks. Finally, section 4 concludes and discusses some possible relevant extensions.

1. The Model

Our model shares many features with those in the literature of small open economy DSGE models, particularly those used at

7. Rannenberg (2013) combines these two features but in a closed economy setup, using a calibrated model.

8. Some examples of estimations in closed-economy frameworks with these types of banks are Villa (2013), Villa and Yang (2013), and Areosa and Coelho (2013).

9. For instance, Tovar (2006) and Fernández and Gulan (2012)

central banks.[10] The non-financial part of our framework is one of a small open economy with nominal and real rigidities. Domestic goods are produced with capital and labor, there is habit formation in consumption, there are adjustment costs in investment and capital utilization. Firms face a Calvo-pricing problem with partial indexation, and there is imperfect exchange rate pass-through into import prices in the short run due to local-currency price stickiness. In addition, households face a Calvo-type problem in setting wages, assuming also partial indexation to past inflation. We also assume that firms need to pay a fraction of their operating costs (working capital) in advance, which they finance with loans from banks. The economy also exports an exogenous endowment of a commodity good.

On top of that setup, we add two kinds of domestic financial frictions. On one hand, there are banks that intermediate credit from households to entrepreneurs (to finance capital accumulation) and to firms (for working capital), and that are subject to a moral hazard problem along the lines of Gertler and Karadi (2011). On the other hand, capital accumulation by entrepreneurs is risky and subject to a costly state verification problem as in Bernanke et al. (1999), making the return on the loans obtained by banks state-contingent, as every period, a fraction of the entrepreneurs will default on their loans.

The model features several exogenous sources of fluctuations: shocks to preferences, technology (neutral and investment-specific), commodity production, government expenditures, monetary policy, foreign demand, foreign inflation, foreign interest rates, the international price of the commodity good, and two financial shocks. International driving forces will be the focus of our analysis.

In the main part of the paper, we describe and set up the problems faced by each agent, leaving the list of the relevant equilibrium conditions and the computation of the steady state for the appendix.

1.1 Households

There is a continuum of infinitely lived households of mass one that have identical asset endowments and identical preferences that depend on consumption of a final good (C_t) and hours worked

10. Our base model (without financial frictions) is a simplified version of the model by Medina and Soto (2007), which is the DSGE model used for policy analysis and forecasting at the Central Bank of Chile. Given the simplifications that we make, the model is closer to that in Adolfson et al. (2007).

(h_t) in each period (t= 0,1,2,...).[11] Households save and borrow by purchasing domestic currency denominated government bonds (B_t) and by trading foreign currency bonds (B_t^*) with foreign agents, both being non-state-contingent assets. They can also deposit resources at banks (D_t). Expected discounted utility of a representative household is given by

$$E_t \sum_{s=0}^{\infty} \beta^s v_{t+s} \left[\log\left(C_{t+s} - \varsigma C_{t+s-1}\right) - \kappa \frac{h_{t+s}^{1+\phi}}{1+\phi} \right], \tag{1}$$

where v_t is an exogenous preference shock.

Following Schmitt-Grohé and Uribe (2006a, 2006b), labor decisions are made by a central authority, a union, which monopolistically supplies labor to a continuum of labor markets indexed by [$i \in$ 0,1]. Households are indifferent between working in any of these markets. In each market, the union faces a demand for labor given by $h_t(i) = \left[W_t^n(i) / W_t^n \right]^{-\varepsilon_W} h_t^d$, where $W_t^n(i)$ denotes the nominal wage charged by the union in market i, W_t^n is an aggregate hourly wage index that satisfies $\left(W_t^n\right)^{1-\varepsilon_W} = \int_0^1 W_t^n(i)^{1-\varepsilon_W} di$, and h_t^d denotes aggregate labor demand by firms. The union takes W_t^n and h_t^d as given and, once wages are set, it satisfies all labor demand. Wage setting is subject to a Calvo-type problem, whereby each period the household (or union) can set its nominal wage optimally in a fraction $1-\theta_w$ of randomly chosen labor markets, and in the remaining markets, the past wage rate is indexed to a weighted product of past and steady state CPI inflation with weights $\vartheta_w \in 0,1]$ and $1-\vartheta_w$, respectively.

Let r_t and r_t^* denote the gross real returns on B_{t-1} and B_{t-1}^*, respectively. The real interest rate on deposits, by a non-arbitrage condition, will also equal r_t. Further, let W_t denote the real hourly wage rate, let rer_t be the real exchange rate (i.e., the price of foreign consumption goods in terms of domestic consumption goods), let T_t denote real lump-sum tax payments to the government and let Σ_t

11. Throughout, uppercase letters denote variables containing a unit root in equilibrium (either due to technology or due to long-run inflation) while lowercase letters indicate variables with no unit root. Real variables are constructed using the domestic consumption good as the numeraire. In the appendix we describe how each variable is transformed to achieve stationarity in equilibrium. Variables without time subscripts denote non-stochastic steady state values in the stationary model.

collect real dividend income from the ownership of firms. The period-by-period budget constraint of the household is then given by

$$C_t + B_t + rer_t B_t^* + D_t + T_t = \int_0^1 W_t(i) h_t(i) di + r_t B_{t-1} + rer_t r_t^* B_{t-1}^* + r_t D_{t-1} + \Sigma_t \quad (2)$$

The household chooses C_t, h_t, $W_t^n(i)$, B_t, B_t^* and D_t to maximize (1) subject to (2) and labor demand by firms, taking prices, interest rates and aggregate variables as given. The nominal interest rates are implicitly defined as

$$r_t = R_{t-1}\pi_t^{-1}, \quad r_t^* = R_{t-1}^* \xi_{t-1} \left(\pi_t^*\right)^{-1},$$

where π_t and π_t^* denote the gross inflation rates of the domestic and foreign consumption-based price indices P_t and P_t^*, respectively. The variable ξ_t denotes a country premium given by[12]

$$\xi_t \equiv \bar{\xi} \exp\left[-\psi \frac{rer_t B_t^* / A_{t-1} - rer \times \bar{b}^*}{rer \times \bar{b}^*} + \frac{\zeta_t - \zeta}{\zeta} \right],$$

where ζ_t is an exogenous shock to the country premium.[13] The foreign nominal interest rate R_t^* evolves exogenously, and the domestic central bank sets R_t.

1.2 Production and Pricing

The supply side of the economy is composed of a set of monopolistically competitive firms producing different varieties of a home good with labor and capital services as inputs, a set of monopolistically competitive importing firms, and three groups of perfectly competitive aggregators: one packing different varieties of the home good into a composite home good, one packing imported varieties into a composite foreign good, and a final group that bundles (with different combinations) the composite home and foreign goods to create a final good that will be purchased by household consumption (Y_t^C), capital goods producers (l_t) and the government (G_t). All of these firms are owned by domestic households. In addition, there is a set of competitive firms producing a homogeneous commodity good

12. See, for instance, Schmitt-Grohé and Uribe (2003) and Adolfson et al. (2007).

13. The variable A_t (with $a_t \equiv A_t / A_{t-1}$) is a non-stationary technology disturbance, see below.

that is exported abroad. A proportion of those commodity-exporting firms is owned by the government and the remaining proportion is owned by foreign agents. The total mass of firms in each sector is normalized to one. We denote production/supply with the letter y and inputs/demand with x.

Final Goods

The final consumption good that generates utility for households, the final investment good that is used to increase the stock of capital, and expenditures by the government are produced with different technologies combining composite home and foreign goods. The three production functions are, respectively,

$$Y_t^C = \left[(1-o_C)^{\frac{1}{\eta_C}} (X_t^{C,H})^{\frac{\eta_C - 1}{\eta_C}} + o_C^{\frac{1}{\eta_C}} (X_t^{C,F})^{\frac{\eta_C - 1}{\eta_C}} \right]^{\frac{\eta_C}{\eta_C - 1}}, \tag{3}$$

$$I_t = \left[(1-o_I)^{\frac{1}{\eta_I}} (X_t^{I,H})^{\frac{\eta_I - 1}{\eta_I}} + o_I^{\frac{1}{\eta_I}} (X_t^{I,F})^{\frac{\eta_I - 1}{\eta_I}} \right]^{\frac{\eta_I}{\eta_I - 1}}, \tag{4}$$

$$G_t = \left[(1-o_G)^{\frac{1}{\eta_G}} (X_t^{G,H})^{\frac{\eta_G - 1}{\eta_G}} + o_G^{\frac{1}{\eta_G}} (X_t^{G,F})^{\frac{\eta_G - 1}{\eta_G}} \right]^{\frac{\eta_G}{\eta_G - 1}}, \tag{5}$$

where $X_t^{C,H}$, $X_t^{I,H}$ and $X_t^{G,H}$ denote the demands of home composite goods by each representative firm, while $X_t^{C,F}$, $X_t^{I,F}$ and $X_t^{G,F}$ are the demands of foreign composite goods.[14] Each representative firm is competitive and takes input prices (p_t^H and p_t^F, measured in terms of the final consumption good) as well as selling prices (respectively, 1, p_t^I and p_t^G, in terms of the final consumption good) as given.

Home Composite Goods

A representative home composite goods firm demands home goods of all varieties indexed by $j \in [0,1]$ in amounts $X_t^H(j)$ and combines them according to the technology

14. Y_t^C will generally differ from C_t as we assume that utilization and monitoring costs are paid in final consumption units.

$$Y_t^H = \left[\int_0^1 X_t^H(j)^{\frac{\varepsilon_H - 1}{\varepsilon_H}} dj \right]^{\frac{\varepsilon_H}{\varepsilon_H - 1}}.$$

Let $p_t^H(j)$ denote the price of the good of variety j in terms of the home composite good. The profit maximization problem yields the following demand for the variety j:

$$X_t^H(j) = p_t^H(j)^{-\varepsilon_H} Y_t^H. \tag{6}$$

Home Goods of Variety *j*

Each home variety j is produced according to the technology

$$Y_t^H(j) = z_t K_t^d(j)^{\alpha} [A_t h_t^d(j)]^{1-\alpha}, \tag{7}$$

where z_t is an exogenous stationary technology shock, while A_t (with $a_t \equiv A_t / A_{t-1}$) is a non-stationary technology disturbance, both common to all varieties. $K_t^d(j)$ denotes the demand for capital services by firm $p_t^H(j)$ while $h_t^d(j)$ denotes this firm's demand for labor. Additionally, we assume that a fraction α_L^{WC} of the operating costs need to be financed with an intra-temporal loan (i.e., $L_t^{WC} = \alpha_L^{WC}[W_t h_t(j) + r_t^K K_t^d(j)]$), with a non-state contingent nominal rate of $R_t^{L,WC}$ (with $r_t^{L,WC} \equiv R_{t-1}^{L,WC} / \pi_t$). The firm producing variety j has monopoly power but produces to satisfy the demand constraint given by (6). As the price setting decision is independent of the optimal choice of the factor inputs, the problem of firm j can also be represented in two stages. In the first stage, the firm hires labor and rents capital to minimize production costs subject to the technology constraint (7). Thus, the firm's real marginal costs in units of the final domestic good is given by

$$mc_t^H(j) = \frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} \frac{(r_t^K)^{\alpha} W_t^{1-\alpha} [1 + \alpha_L^{WC}(R_t^{L,WC} - 1)]}{p_t^H z_t (A_t)^{1-\alpha}}, \tag{8}$$

which, given the assumptions, is the same for all varieties j.

In the second stage of firm j's problem, given nominal marginal costs, the firm chooses its price $P_t^H(j)$ to maximize profits. In setting prices, the firm faces a Calvo-type problem, whereby each period the firm can change its price optimally with probability $1-\theta_h$, and if it cannot change its price, it indexes its previous price according to a weighted product of past inflation of home composite goods prices and steady state CPI inflation with weights $\vartheta_H \in 0,1]$ and $1-\vartheta_H$.[15]

Foreign Composite Goods

A representative foreign composite goods firm demands foreign goods of all varieties $j \in 0,1]$ in amounts $X_t^F(j)$ and combines them according to the technology

$$Y_t^F = \left[\int_0^1 X_t^F(j)^{\frac{\varepsilon_F - 1}{\varepsilon_F}} dj \right]^{\frac{\varepsilon_F}{\varepsilon_F - 1}}.$$

Let $p_t^F(j)$ denote the price of the good of variety j in terms of the foreign composite good. Thus, the input demand functions are

$$X_t^F(j) = p_t^F(j)^{-\varepsilon_F} Y_t^F. \qquad (9)$$

Foreign Goods of Variety

Importers buy an amount M_t of a homogenous foreign good at the price P_t^{F*} in the world market and convert this good into varieties $Y_t^F(j)$ that are sold domestically, where $M_t = \int_0^1 Y_t^F(j)dj$. The firm producing variety j has monopoly power but satisfies the demand constraint given by (9). As it takes one unit of the foreign good to produce one unit of variety j, nominal marginal costs in terms of composite goods prices are

$$P_t^F mc_t^F(j) = P_t^F mc_t^F = S_t P_t^{F*}. \qquad (10)$$

Given marginal costs, the firm producing variety j chooses its price $P_t^F(j)$ to maximize profits. In setting prices, the firm faces a Calvo-type problem, whereby each period the firm can change its price optimally with probability $1-\theta_F$, and if it cannot change its price, it indexes its previous price according to a weighted product of past inflation of foreign composite goods prices and steady state CPI inflation with weights $\vartheta_F \in 0,1]$ and $1-\vartheta_F$. In this way, the model features delayed pass-through from international to domestic prices.

15. This indexation scheme eliminates the distortion generated by price dispersion up to a first-order expansion.

Commodities

A representative commodity producing firm produces a quantity of a commodity good Y_t^{Co} in each period. Commodity production evolves according to an exogenous process, and it is co-integrated with the non-stationary TFP process. The entire production is sold abroad at a given international price P_t^{Co*}. The real foreign and domestic prices are denoted as P_t^{Co*} and P_t^{Co}, respectively, where P_t^{Co*} is assumed to evolve exogenously. The real domestic currency income generated in the commodity sector is therefore equal to $P_t^{Co}Y_t^{Co}$. The government receives a share $\chi \in 0,1]$ of this income and the remaining share goes to foreign agents.

1.3 Capital Accumulation

Entrepreneurs

Entrepreneurs manage the economy's stock of capital (K_t). Following Bernanke et al. (1999), entrepreneurs have two distinctive features in this setup. On one hand, they have a technology available to transform new capital produced by capital-goods producers (described below) into productive capital that can be used by firms. In particular, if at t they buy K_t units of new capital, the amount of productive capital available to rent to firms in $t+1$ is $\omega_{(t+1)}^e K_t$. The variable $\omega_t^e > 0$ is the source of heterogeneity among entrepreneurs and it is distributed in the cross section with a c.d.f. $F(\omega_t^e;\sigma_{\omega,t-1})$, and p.d.f. $f(\omega_t^e;\sigma_{\omega,t-1})$, such that $E(\omega_t^e)=1$. The variable $\sigma_{\omega,t}$ denotes the time-varying cross-sectional standard deviation of entrepreneurs' productivity, which is known in advance,[16] and is assumed to follow an exogenous process, as in, for instance, Christiano et al. (2010, 2014). On the other hand, entrepreneurs have finite lifetimes (we describe this in more detail below) and when they exit the market they transfer all their remaining wealth to households.

In each period, after the idiosyncratic productivity shock is realized, entrepreneurs rent capital services (which for each individual

16. That is, at the time the financial contract is signed, everybody knows the distribution from which individual productivity will be drawn next period.

entrepreneur $u_t \omega_t^e K_{t-1}$, where u_t denotes capital utilization)[17] to home goods producing firms, at a rental rate (in real terms) r_t^K. They face a utilization cost per unit of capital, which in real terms is given by

$$\phi(u_t) = \frac{r^K}{\phi_u}\{\exp[\phi_u(u_t - 1)] - 1\},$$

where r^K is the steady state value of the rental rate of capital services, and ϕ_u governs the importance of these utilization costs.[18] After non-depreciated capital is returned, they sell it to capital goods producers at a real price q_t. Afterwards, they buy new capital $(q_t K_t)$.

We assume that purchases of new capital have to be financed by loans from intermediaries. However, due to an informational asymmetry (see below) entrepreneurs will not be able to obtain loans to cover the whole operation. This will create the incentives for entrepreneurs to accumulate net worth N_t^e so that they can use it to finance part of the capital purchases. Thus, we have

$$q_t K_t = N_t^e + L_t^K,$$

where L_t^K is the loan obtained from banks in real terms. We assume that the loan contract signed at t is nominal and it specifies a non-contingent interest rate $R_t^{L,e}$ (with $r_t^{L,e} \equiv R_{t-1}^{L,e} / \pi_t$). The fact that entrepreneurs have finite lifetimes prevents them from accumulating net worth beyond a point at which they can self-finance the operation.

The informational asymmetry takes the form of a costly-state-verification problem, as in BGG. In particular, we assume that ω_t^e is only revealed to the entrepreneur ex-post (i.e., after loan contracts have been signed) and can only be observed by a third party after paying a monitoring cost, equivalent to a fraction μ^e of the total revenues generated by the project. Thus, at the time entrepreneurs have to repay the loan they can choose to either pay it (plus the specified interest) or to default, in which case the intermediary will pay the monitoring cost and seize all entrepreneurial assets.

17. We are abusing the notation here, as u_t, ω_t^e and K_{t-1} should have an index identifying the individual entrepreneur. However, as we assume that entrepreneurs are identical ex-ante, and that $E(\omega_t^e)$=1, in equilibrium the aggregate capital service unit will be given by $u_t K_{t-1}$.

18. Note that the choice of u_t is intra-periodic, so it does not depend on financing conditions.

Following BGG, the optimal debt contract specifies a cut-off value $\bar{\omega}^e_{t+1}$ such that if $\omega^e_{t+1} \geq \bar{\omega}^e_{t+1}$ the borrower pays $\bar{\omega}^e_{t+1}[r^K_{t+1}u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]K_t$ units of final consumption goods to the lender and keeps $(\omega^e_{t+1} - \bar{\omega}^e_{t+1})[r^K_{t+1}u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]K_t$, while if $\omega^e_{t+1} < \bar{\omega}^e_{t+1}$ the borrower receives nothing (defaults) and the lender obtains $(1-\mu^e)\omega^e_{t+1}[r^K_{t+1}u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]K_t$. Therefore, under the assumption of a competitive the lending market, the mapping between the cut-off value and the interest rate on the loan R^{Le}_t satisfies

$$R^{L,e}_t = \bar{\omega}^e_{t+1}[r^K_{t+1}u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]\frac{K_t}{L^K_t}\pi_{t+1}, \tag{11}$$

where the right-hand side is the return obtained by the bank for each unit of money lent from an entrepreneur that pays back the loan. As we assume that entrepreneurs bear all the risk (as in BGG), this condition is assumed to hold state by state.

While R^{Le}_t denotes the interest rate of a loan signed at , the ex-post return for the intermediary for each unit lent at t (which we denote by $R^{L,K}_{t+1}$, with $r^{(L,K)}_t \equiv R^{(L,K)}_t / \pi_t$) is not equal to R^{Le}_t for two reasons: not all loans will be repaid and, from those entrepreneurs who default, the intermediary receives their assets net of monitoring costs. This in particular implies that, while the interest rate on the loan is known at the time the contract is signed, the return obtained by the intermediary is instead state-contingent, for it depends on the aggregate conditions that determine whether entrepreneurs default or not. Therefore, for the intermediary to be willing to lend it must be the case that

$$L^K_t r^{L,K}_{t+1} \leq g(\bar{\omega}^e_{t+1};\sigma_{\omega,t})[r^K_{t+1}u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]K_t, \tag{12}$$

where the terms in brackets on the right-hand side of (12) are the average (across entrepreneurs) revenue obtained at t+1 if the amount of capital purchases at t was K_t, and with

$$g(\bar{\omega}^e_t;\sigma_{\omega,t-1}) \equiv \bar{\omega}^e_t[1 - F(\bar{\omega}^e_t;\sigma_{\omega,t-1})] + (1-\mu^e)\int_0^{\bar{\omega}^e_t} \omega^e f(\omega^e;\sigma_{\omega,t-1})\mathrm{d}\omega^e.$$

The first term on the right-hand side is the share of total revenues that the intermediary obtains from those who pay back the loan, while the second is the value of the assets seized from defaulting entrepreneurs, net of monitoring costs. As we will see below, the banks' problem defines a non-arbitrage condition that relates the *expected value* of $R^{L,K}_{t+1}$ with other interest rates relevant for banks. Thus, (12) is the participation constraint for the banks to be willing to lend.[19] As before, this condition holds state-by-state under the assumption that entrepreneurs bear all the risk.

From the entrepreneurs' viewpoint, the expected profits for the project of purchasing K_t units of capital equals

$$E_t\left\{[r^K_{t+1}u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]K_t h(\bar{\omega}^e_{t+1};\sigma_{\omega,t})\right\}, \tag{13}$$

where

$$h(\bar{\omega}^e_t;\sigma_{\omega,t-1}) \equiv \int_{\bar{\omega}^e_t}^{\infty} \omega^e f(\omega^e;\sigma_{\omega,t-1})d\omega^e - \bar{\omega}^e_t[1 - F(\bar{\omega}^e_t;\sigma_{\omega,t-1})]. \tag{14}$$

The first term on the right-hand side of (14) is the expected share of average revenue that entrepreneurs obtain given their productivity. The second term is the expected repayment. Both are conditional on not defaulting (i.e., $\bar{\omega}^e_t \geq \omega^e_t$). Defining $lev^e_t \equiv \frac{q_t K_t}{N^e_t}$, and given the revelation principle, the optimal debt contract specifies a value for lev^e_t and a state-contingent $\bar{\omega}^e_{t+1}$ such that (13) is maximized subject

19. A technical note: As we have stated the model, it turns out that whether this constraint holds state-by-state or in expectations (as in, for instance, Rannenberg, 2013) is (up to first order) irrelevant for the characterization of the optimal contract (in equilibrium it will hold without expectations anyway, as in Rannenberg, 2013). What is key to allow the BGG model to merge within the Gertler and Karadi framework is the assumption that the loan rate $r^{L,e}_t$ is not contingent on the aggregate state, and if this is not the case the equilibrium is indeterminate. The intuition for this result is as follows. In the original BGG model, if the participation constraint for the lender holds state-by-state, the nature of $r^{L,e}_t$ is irrelevant. This is so because, as the required return $r^{L,K}_{t+1}$ is determined elsewhere, the participation constraint pins down the current value of $\bar{\omega}^e_{t+1}$ and then the other optimality condition of the optimal contract (see below) pins down the external finance premium (in fact, given such a setup is the usual way the BGG model is implemented an equation like (11) is generally omitted as an equilibrium condition). However, if in the original BGG model the participation constraint for the lender holds in expectations, we do require $r^{L,e}_t$ to be non-contingent. In such a case, it is precisely equation (11) that pins down $\bar{\omega}^e_{t+1}$, while the participation constraint alone just determines (up to first order) $E_t\{\bar{\omega}^e_{t+1}\}$.

In our setup the reason why we need $r^{L,e}_t$ to be non-contingent is because $r^{L,K}_{t+1}$ is not determined by any other equilibrium condition (the intermediary's problem just pins down $E_t\{r^{L,K}_{t+1}\}$). Thus, in our framework, equation (11) pins down $\bar{\omega}^e_{t+1}$ and, given that value, (12) determines $r^{L,K}_{t+1}$. Under the other alternative, the equilibrium is indeterminate because only equation (12) displays both $r^{L,K}_{t+1}$ and $\bar{\omega}^e_{t+1}$, and there is no other equation that determines one of these.

to (12) being satisfied with equality for every possible aggregate state at $t+1$. As shown in the appendix, the optimality condition for this contract can be written as follows:

$$E_t\left\{\frac{[r_{t+1}^K u_{t+1} - \phi(u_{t+1}) + (1-\delta)q_{t+1}]}{q_t}\left[\frac{h'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})g(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}{g'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})} - h(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})\right]\right\} = E_t\left\{r_{t+1}^{L,K}\frac{h'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}{g'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}\right\}, \quad (15)$$

The ratio $E_t\left\{\frac{\left[r_{t+1}^K u_{t+1} - \phi(u_{(t+1)}) + (1-\delta)q_{(t+1)}\right]}{q_t}\right\} / E_t\left\{r_{t+1}^{L,K}\right\}$ is known as the external finance premium which, as shown by BGG, is (up to first order) an increasing function of entrepreneurs' leverage lev_t^e.

Finally, average entrepreneurs' net worth evolves over time as follows. The average return an entrepreneur gets after repaying its loan at t is given by $[r_t^K u_t - \phi(u_t) + (1-\delta)q_t]K_{t-1}h(\bar{\omega}_t^e;\sigma_{\omega,t-1})$. We assume that only a fraction of entrepreneurs survives every period, and an equivalent fraction enters the market with an initial capital injection from households equal to $\frac{\iota^e}{1-\upsilon}n^e A_{t-1}$, with $\iota^e > 0$ (i.e., a fraction $\frac{\iota^e}{1-\upsilon}$ of balanced-growth-path net worth).[20] Thus, we have

$$N_t^e = \upsilon\left\{[r_t^K u_t - \phi(u_t) + (1-\delta)q_t]K_{t-1}h(\bar{\omega}_t^e;\sigma_{\omega,t-1})\right\} + \iota^e n^e A_{t-1}.$$

Capital Goods

Capital goods producers operate the technology that allows to increase the economy-wide stock of capital. In each period, they purchase the stock of depreciated capital from entrepreneurs and combine it with investment goods (which they buy at a price P_t^I) to produce new productive capital. The newly produced capital is then sold back to the entrepreneurs and any profits are transferred to the households. A representative capital producer's technology is given by

$$K_t = (1-\delta)K_{t-1} + [1 - \text{“}\left(I_t / I_{t-1}\right)]\varpi_t I_t,$$

20. Entrepreneurs that leave that market transfer their remaining resources to households.

where I_t denotes investment expenditures in terms of the final good as a materials input and

$$\Gamma\left(\frac{I_t}{I_{t-1}}\right)=\frac{\gamma}{2}\left(\frac{I_t}{I_{t-1}}-\bar{a}\right)^2$$

are convex investment adjustment costs. The variable ϖ_t is an investment shock that captures changes in the efficiency of the investment process (see, for instance, Justiniano et al., 2011).

1.4 Banks

We assume the presence of competitive financial intermediaries (banks) that take deposits from households and combine them with their own net worth to produce loans to both firms and to entrepreneurs. Following Gertler and Karadi (2011), the relationship between households and banks is characterized by a moral hazard problem that gives rise to a premium between lending and deposit rates.

The balance sheet of a representative financial intermediary at the end of period t is given by

$$L_t^{WC} + L_t^K = D_t + N_t,$$

where D_t denote deposits by domestic households at this intermediary, L_t^{WC} and L_t^K denote the intermediary's stock of loans to, respectively, home goods producing firms and entrepreneurs, and N_t denotes the intermediary's net worth (all in real terms of domestic units). The latter evolves over time as the difference between earnings on assets, and interest payments on liabilities:

$$N_{t+1}= r_{t+1}^{L,WC} L_t^{WC} + r_{t+1}^{L,K} L_t^K - r_{t+1} D_t = (r_{t+1}^{L,WC} - r_{t+1}) L_t^{WC} + (r_{t+1}^{L,K} - r_{t+1}) L_t^K + r_{t+1} N_t \qquad (16)$$

where $r_t^{L,WC}$ and $r_t^{L,K}$ denote the real gross returns on both types of loans.[21/22]

21. These real rates relate to their nominal counterparts in a similar way as the real domestic deposit rate r_t defined above.

22. We assume that, while loans to working capital are intra-periodic, firms repay loans after banks' choices in period t have been made, which is the same as assuming that the return from this loan is received in the next period as in (16). This is in line with the assumption of working capital loans in the related literature without banks (e.g., Christiano et al. 2014).

Financial intermediaries have finite lifetimes. At the beginning of period $t+1$, after financial payouts have been made, the intermediary continues operating with probability ω and exits the intermediary sector with probability $1-\omega$, in which case it transfers its retained capital to the household which owns that intermediary. Thus, the intermediary's objective in period t is to maximize expected terminal wealth (V_t), which is given by

$$V_t \equiv E_t \sum_{s=0}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1} N_{t+s+1},$$

where $\Xi_{t,t+s}$ is the households' stochastic discount factor for real payoffs.

Further, following Gertler and Karadi (2011), a costly enforcement problem constrains the ability of intermediaries to obtain funds from depositors. In particular, at the beginning of period t, before financial payouts are made, the intermediary can divert an exogenous fraction μ_t of total assets (L_t). The depositors can then force the intermediary into bankruptcy and recover the remaining assets, but it is too costly for the depositors to recover the funds that the intermediary diverted. Accordingly, for the depositors to be willing to supply funds to the intermediary, the incentive constraint

$$V_t \geq \mu_t (L_t^{WC} + L_t^{K}) \tag{17}$$

must be satisfied. That is, the opportunity cost to the intermediary of diverting assets (i.e., to continue operating and obtaining the value V_t) cannot be smaller than the gain from diverting assets. As can be seen, shocks that increase μ_t will make this constraint tighter, making the financial problem more severe.

Using the method of undetermined coefficients, V_t can be expressed as follows (see the appendix):

$$V_t = \rho_t^{L,WC} L_t^{WC} + \rho_t^{L,K} L_t^{K} + \rho_t^{N} N_t, \tag{18}$$

where

$$\rho_t^{L,WC} = \beta E_t \left\{ \Xi_{t,t+1} \left[(1-\omega)(r_{t+1}^{L,WC} - r_{t+1}) + \omega \frac{L_{t+1}^{WC}}{L_t^{WC}} \rho_{t+1}^{L,WC} \right] \right\},$$

$$\rho_t^{L,K} = \beta E_t \left\{ \Xi_{t,t+1} \left[(1-\omega)(r_{t+1}^{L,K} - r_{t+1}) + \omega \frac{L_{t+1}^{K}}{L_t^{K}} \rho_{t+1}^{L,K} \right] \right\},$$

$$\rho_t^{N} = \beta E_t \left\{ \Xi_{t,t+1} \left[(1-\omega) r_{t+1} + \omega \frac{N_{t+1}}{N_t} \rho_{t+1}^{N} \right] \right\}$$

Holding the other variables constant, $P_t^{L,WC}$ and $P_t^{L,K}$ are the expected discounted marginal gain of an additional unit of each type of loan, while P_t^N is the expected discounted marginal gain, and additional unit, of net worth.

The intermediary maximizes (18) subject to (17) taking N_t as given. The first-order conditions to this problem are as follows:

$$L_t^{WC} : (1 + \varrho_t)\rho_t^{L,WC} - \mu_t \varrho_t = 0,$$
$$L_t^{K} : (1 + \varrho_t)\rho_t^{L,K} - \mu_t \grave{u}_t = 0,$$
$$\varrho_t : \rho_t^{L,WC} L_t^{WC} + \rho_t^{L,K} L_t^{K} + \rho_t^{N} N_t - \mu_t (L_t^{WC} + L_t^{K}) \geq 0,$$

where $\varrho_t \geq 0$ is the multiplier associated with the incentive constraint. The second condition holds with equality if $\varrho_t > 0$, otherwise it holds with strict inequality. Notice that the optimality conditions for each type of loan implies that $\rho_t^{L,WC} = \rho_t^{L,K} \equiv \rho_t^L$. In other words, as the incentive constraint is symmetric for both types of loans, banks need to be indifferent ex-ante between lending one unit to firms or to entrepreneurs. However, the arbitrage condition is simply not that the expected return of both loans are ex-ante identical (not even up to first order), because the marginal value for each type of loan depends on the growth rate of each of these loans. In addition, either of the conditions for the choice of loans imply that

$$\varrho_t = \frac{\rho_t^L}{\mu_t - \rho_t^L},$$

such that the constraint is strictly positive if $\mu_t > \rho_t^L$. That is, the incentive constraint holds with equality if the marginal gain to the financial intermediary from diverting assets and going bankrupt (μ_t) is larger than the marginal gain from expanding assets by one unit of deposits (i.e., holding net worth constant) and continuing to operate (ρ_t^L). We assume that this is the case in a local neighborhood of the non-stochastic steady state. The condition for $\grave{u}_t$ holding with equality implies that

$$L_t \equiv L_t^{WC} + L_t^{K} = lev_t N_t,$$

where

$$lev_t \equiv \frac{\rho_t^N}{\mu_t - \rho_t^L} \qquad (19)$$

denotes the intermediary's leverage ratio. As indicated by (19), higher marginal gains from increasing assets P_t^L support a higher leverage ratio in the optimum, the same is true for the higher marginal gains of net worth P_t^N, while a larger fraction of divertable funds μ_t lowers the leverage ratio.

The aggregate evolution of net worth follows from the assumption that a fraction $1-\omega$ of intermediaries exits the sector in every period and an equal number enters. Each intermediary exiting the sector at the end of period $t-1$ transfers their remaining net worth $(\tilde{N}_{e,t} \equiv (r_t^{L,WC} - r_t)L_{t-1}^{WC} + (r_t^{L,K} - r_t)L_{t-1}^{K} + r_t N_{t-1})$ to households. At the same time, households transfer starting capital equal to $\tilde{N}_{n,t} \equiv \frac{\iota}{1-\omega} nA_{t-1}$ to each new intermediary; with $\iota > 0$ (i.e., the transfer equals a fraction $\frac{\iota}{1-\omega}$ of balanced-growth-path net worth). Aggregate net worth then evolves as follows:

$$N_t = \omega\tilde{N}_{e,t} + (1-\omega)\tilde{N}_{n,t} = \omega\left[(r_t^{L,WC} - r_t)L_{t-1}^{WC} + (r_t^{L,K} - r_t)L_{t-1}^{K} + r_t N_{t-1}\right] + \iota n A_{t-1}.$$

Finally, we define the average lending-deposit spread as

$$spr_t = \frac{(R_t^{L,WC} L_t^{WC} + R_t^{L,e} L_t^{K})}{L_t}\frac{1}{R_t}. \tag{20}$$

i.e., the average of both contractual loan rates, weighted by the size of each loan on total loans, relative to the deposit rate. This measure would be the data counterpart of the spread we will use for the estimation.

1.5 Fiscal and Monetary Policy

The government consumes an exogenous stream of final goods (G_t), levies lump-sum taxes, issues one-period bonds and receives a share χ of the income generated in the commodity sector. We assume for simplicity that the public asset position is completely denominated in domestic currency. Hence, the government satisfies the following period-by-period constraint:

$$p_t^G G_t + r_t B_{t-1} = T_t + B_t + \chi p_t^{Co} Y_t^{Co}.$$

Monetary policy is carried out according to a Taylor rule of the form

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\alpha_\pi} \left(\frac{Y_t / Y_{t-1}}{a_{t-1}}\right)^{\alpha_y}\right]^{1-\rho_R} \exp(\varepsilon_t^R),$$

where $\bar{\pi}$ is target inflation and ε_t^R is an i.i.d. Gaussian shock that captures deviations from the rule.

1.6 The Rest of the World

Foreign agents demand home composite goods and buy the domestic commodity production. There are no transaction costs or other barriers to trade. The structure of the foreign economy is identical to the domestic economy, but the domestic economy is assumed to be small relative to the foreign economy. The latter implies that the foreign producer price level P_t^{F*} is identical to the foreign consumption-based price index P_t^*. Further, let P_t^{H*} denote the price of home composite goods expressed in foreign currency. Given full tradability and competitive export pricing, the law of one price holds separately for home composite goods and the commodity good, i.e., $P_t^H = S_t P_t^{H*}$ and $P_t^{Co} = S_t P_t^{Co*}$. That is, domestic and foreign prices of both goods are identical when expressed in the same currency. Due to local currency pricing, a weak form of the law of one price holds for foreign composite goods according to (10). Therefore, the real exchange rate rer_t satisfies

$$rer_t = \frac{S_t P_t^*}{P_t} = \frac{S_t P_t^{F*}}{P_t} = \frac{P_t^F mc_t^F}{P_t} = p_t^F mc_t^F,$$

and the commodity price in terms of domestic consumption goods is given by

$$p_t^{Co} = \frac{P_t^{Co}}{P_t} = \frac{S_t P_t^{Co*}}{P_t} = \frac{S_t P_t^*}{P_t} p_t^{Co*} = rer_t\, p_t^{Co*}.$$

We also have the relation $rer_t / rer_{t-1} = \pi_t^S \pi_t^* / \pi_t$, where π_t^* denotes foreign inflation and $\pi_t^S = S_t / S_{t-1}$. Further, foreign demand for the home composite good X_t^{H*} is given by the schedule

$$X_t^{H*} = o^* \left(\frac{P_t^{H*}}{P_t^*} \right)^{-\eta^*} Y_t^*,$$

where Y_t^* denotes foreign aggregate demand. Both Y_t^* and π_t^* evolve exogenously.

1.7 Aggregation and Market Clearing

Taking into account the market clearing conditions for all the different markets, we can define the trade balance in units of final goods as

$$TB_t = p_t^H X_t^{H*} + rer_t p_t^{Co*} Y_t^{Co} - rer_t M_t. \tag{21}$$

Further, we define real GDP as follows:

$$Y_t \equiv C_t + I_t + G_t + X_t^{H*} + Y_t^{Co} - M_t.$$

Then, the GDP deflator (p_t^Y, expressed as a relative price in terms of the final consumption good) is implicitly defined as

$$p_t^Y Y_t = C_t + p_t^I I_t + p_t^G G_t + TB_t.$$

Finally, we can show that the net foreign asset position evolves according to

$$rer_t B_t^* = rer_t r_t^* B_{t-1}^* + TB_t - (1-\chi) rer_t p_t^{Co*} Y_t^{Co}.$$

1.8 Driving Forces

The exogenous processes in the model are ν_t, ϖ_t, z_t, a_t, ζ_t, R_t^*, π_t^*, P_t^{Co*}, y_t^{Co}, y_t^*, g_t, μ_t and $\sigma_{\omega,t}$. For each of them, we assume a process of the form

$$\log\left(x_t / \bar{x}\right) = \rho_x \log\left(x_{t-1} / \bar{x}\right) + \varepsilon_t^x, \qquad \rho_x \in 0,1), \qquad \bar{x} > 0,$$

for $x = \left\{ \upsilon, \varpi, z, a, \zeta, R^*, \pi^*, p^{Co*}, y^{Co}, y^*, g, \mu, \sigma_\omega \right\}$, where the ε_t^x are i.i.d. Gaussian shocks.

1.9 Alternative Versions of the Model

In addition to this complete model, for comparison purposes we will also consider three alternative versions. The Base model is one in which there are no financial frictions (i.e., with no banks and where entrepreneurs do not face idiosyncratic shocks), and households lend directly to both firms and entrepreneurs. The GK model features banks following Gertler and Karadi (2011) as we have described, but entrepreneurs face no financial frictions.[23] The BGG model is one with entrepreneurs facing the costly-state-verification problem we have detailed above, but where they obtain funds directly from households. Finally, the full model we have described will be labeled as GK+BGG.

2. Parametrization

Our empirical strategy combines both calibrated and estimated parameters. The calibrated parameters and targeted steady state values are presented in table 1. The parameters not related with financial frictions that are endogenously determined in steady state are: β, π^*, k, o^*, $\bar{g}$, $\bar{b}^*$ and $\bar{y}^{Co}$. For most of the calibrated parameters, we draw from related studies using Chilean data, as indicated in the table. The parameters that deserve additional explanation are those related with financial frictions: $\bar{\mu}$ (the steady state value of the fraction of divertible funds), ω (the fraction of surviving banks), ι (the capital injection for new banks), μ^e (bankruptcy costs), υ (the fraction of surviving entrepreneurs), ι^e (the capital injection for new entrepreneurs), and σ_ω (the steady state value of entrepreneurs' dispersion).

23. In this version of the model, we force the share of total capital purchases financed by loans to be the same as in the model with BGG entrepreneurs. Moreover, following Gertler and Karadi (2011), we assume in this version of the model that loans to entrepreneurs are state-contingent.

Table 1. Calibrated Parameters

Param.	*Description*	*Value*	*Source*
σ	Risk aversion	1	Medina and Soto (2007)
ϕ	Frisch elasticity	1	Adolfson et al. (2008)
a	Capital share in production	0.33	Medina and Soto (2007)
δ	Capital depreciation	0.06/4	Medina and Soto (2007)
ε_H	E.o.S. domestic aggregate	11	Medina and Soto (2007)
ε_F	E.o.S. imported aggregate	11	Medina and Soto (2007)
o_C	Share F of in Y^C	0.26	Input-ouput matrix (2008-2012)
o_I	Share of F in I	0.36	Input-ouput matrix (2008-2012)
o_G	Share of F in G	0	Normalization
χ	Government share in commodity sector	0.61	Average (1987-2012)
s^{tb}	Trade balance to GDP in SS	4%	Average (1987-2012)
s^{g}	Gov. exp. to GDP in SS	11%	Average (1987-2012)
s^{Co}	Commodity prod. to GDP in SS	10%	Average (1987-2012)
$\bar{\pi}$	Inflation in SS	3%	Inflation Target in Chile
p^H	Relative price of H in SS	1	Normalization
h	Hours in SS	0.3	Normalization
$\bar{a}$	Long-run growth	2.50%	4.5% GDP - 2% labor force grth. (avg. 01-12)
R	MPR in SS.	5.80%	Fuentes and Gredig (2008)
R^*	Foreign rate in SS	4.50%	Fuentes and Gredig (2008)
ξ	Country premium in SS	140bp	EMBI Chile (avg. 01-12)
lev	Leverage financial sector	9	Own calculation (see text)
$spread$	90 days lending-borrowing spread	380bp	Loan rate vs. MP rate (avg. 01-12)
ι	Injection for new bankers	0.002	Gertler and Karadi (2011)
μ_e	Bankruptcy cost	0.12	Christiano et al. (2010)
υ	Survival rate of entrepreneurs	0.97	Bernanke et al. (1999)
rp	Entrepreneurs' external finance premium	120bp	Spread A vs. AAA, corp. bonds (avg. 01-12)
lev^e	Entrepreneurs' leverage	2.05	For the non-financial corp. sector (avg. 01-12)

Table 1. (continued)

Param.	*Description*	*Value*	*Source*
$\rho_{y^{Co}}$	Auto corr. y^{Co}	0.4794	Own estimation
ρ_g	Auto corr. g	0.6973	Own estimation
ρ_{R^*}	Auto corr. R^*	0.9614	Own estimation
ρ_{y^*}	Auto corr. y^*	0.8665	Own estimation
ρ_{π^*}	Auto corr. π^*	0.3643	Own estimation
$\rho_{p^{Co*}}$	Auto corr. p^{Co*}	0.962	Own estimation
$\sigma_{y^{Co}}$	St. dev. shock to y^{Co}	0.0293	Own estimation
σ_g	St. dev. shock to g	0.0145	Own estimation
σ_{R^*}	St. dev. shock to R^*	0.0011	Own estimation
σ_{y^*}	St. dev. shock to y^*	0.0062	Own estimation
σ_{π^*}	St. dev. shock to π^*	0.0273	Own estimation
$\sigma_{p^{Co*}}$	St. dev. shock to p^{Co*}	0.1413	Own estimation

Note: All rates and spreads are annualized figures.

We target the following averages for financial variables. We set the spread between the interest rate on entrepreneurs ($R^{L,e}$) and the deposit rate (R) to 380 basis points, which corresponds to the average spread between 90-day loans and the monetary policy rate.[24, 25] We further set the bank leverage ratio to 9. This statistic is not easy to calibrate, for banks' balance sheets are more complicated in the data than in the model. Consolidated data from the banking system in Chile implies an average leverage ratio of around 13 between 2001 and 2012, but on the assets side of the balance sheet there are other types of assets that are not loans. To pick the value that we used, we compute an average ratio of the stock of loans to total consolidated assets of the banking system of 66% and adjusted the observed average leverage of the banking system by this percentage (i.e., 9 ≈ 13 x 0.66). For the entrepreneurs' problem, we choose a steady state leverage of 2.05, which corresponds to the average leverage between

24. All the rates and spread figures are presented here in annualized terms, although in the mod el they are included on a quarterly basis.

25. We match this spread instead of the one defined in (20) because the computation of the steady state simplifies significantly with this choice. At the posterior mode, the difference between these two spreads is less than 3 annualized basis points.

2001 and 2012 for the largest Chilean firms.[26] In addition, we also calibrate the external finance premium in steady state (rp), for which we choose a value of 120 basis points, which corresponds to the average between the A vs. AAA corporate-bond spread and the BBA vs. AAA spread, for the sample from 2001 to 2012.[27] Finally, as the steady state for both financial problems imposes less restriction than parameters, we normalize $\iota = 0.002$ (as in Gertler and Karadi, 2011), $\upsilon = 0.97$ (the value used by BGG) and $\mu^e = 0.12$ (in the range used by Christiano et al., 2010, for the U.S. and the EU). Thus, the parameters $\bar{\mu}$, ω, ι^e and σ_ω are endogenously set in steady state to match these targets.

We also calibrate the parameters characterizing those exogenous processes for which we have a data counterpart. In particular, for g we use linearly-detrended real government expenditures, for y^{Co} we use linearly-detrended real mining production, for R^* we use the Libor rate, for y^* we use linearly-detrended real GDP of commercial partners, for π^* we use CPI inflation (in dollars) for commercial partners, and for p^{Co*} we use international copper price deflated by the same price index we used to construct π^*.[28]

The other parameters of the model were estimated using Bayesian techniques, solving the model with a log-linear approximation around the non-stochastic steady state. The list of these parameters and the priors are described in columns one to four of table 2.[29] We use the following variables (all from 2001Q3 to 2012Q4): the growth rates of real GDP, private consumption and investment, the CPI inflation rate, the monetary policy rate, the multilateral real exchange rate, the growth rate of real wages, the EMBI Chile (a proxy for ξ_t), the spread between the 90-day loan rate and the monetary policy rate (as a counterpart of spr_t), and the growth rate of total loans in the banking system.[30] We also include the variables used to estimate the exogenous processes previously described in the set of

26. This average is computed by consolidating balance sheet data compiled by the SVS (the stock market authority in Chile). On average, this includes the largest 300 firms in the country.

27. Here we follow Christiano et al. (2010) who use the spread on corporate bonds of different credit ratings as a proxy for the premium paid by riskier firms.

28. The data source for all Chilean-related data is the Central Bank of Chile, while the other variables are obtained from Bloomberg.

29. The prior means were set to represent the estimates of related papers for the Chilean economy (e.g., Medina and Soto, 2007).

30. Results do not significantly change if the growth rate of commercial loans is only used instead.

observables.[31] Overall, the model is estimated with 16 variables. Our estimation strategy also includes i.i.d. measurement errors for all the observables. For all the variables except for the real exchange rate, the variance of this measurement error was set to 10% of the variance of the corresponding observables. For the real exchange rate this variance was estimated.[32]

Table 2 displays the posterior mode and standard deviation of the estimated parameters in the last two columns. For many parameters the posterior mode is similar to related studies for Chile, so we only comment here on some relevant highlights. First, we can see that the estimated value for ψ (the elasticity of the country premium with respect to external debt to GDP) is quite small. While the model does not include any detailed financial friction between domestic and foreign agents, the fact that this parameter is so small can be seen as evidence on the conjecture that we described in the introduction that, at least for the case of Chile, financial frictions with foreign agents may not be a relevant transmission mechanism.

We can also see that the utilization cost parameter (ϕ_u) is significantly different from zero, which highlights the relevance of this channel to account for the data. In addition, the posterior mode indicates that the share of working capital that needs to be financed is close to 55%. As a consequence, we expect that this channel will play a relevant role in the propagation of shocks.

Finally, while the focus of this paper would be on the role of foreign driving forces, it is worth highlighting other exogenous processes that play a relevant role according to the estimation. In particular, the shocks to the marginal efficiency of investment (ω_t) and to entrepreneurs' risk ($\sigma_{\omega,t}$) are estimated to have large variances and to be quite persistent. Together, they explain more than 50% of the variance of GDP, and are also the main driving forces behind other variables such as consumption, inflation and, particularly, investment.

31. While the parameters of these exogenous processes were calibrated, including these variables in the data set is informative for the inference of the innovations associated with these exogenous processes.

32. Similar to other papers estimating this type of model (e.g., Adolfson et al., 2007), the model cannot adequately match the variance of the real exchange rate, which motivates estimating its measurement error variance.

Table 2. Estimated Parameters, Prior and Posterior Mode

			Prior		*Posterior mode*	
Param.	*Description*	*Dist.*	*Mean*	*St. Dev.*	*Mode*	*St. Dev.*
ς	Habits	beta	0.7	0.1	0.69	0.09
ψ	Country premium elasticity	invg	0.01		0.007	0.002
η^C	E.o.S. $X^{C,H}$ and $X^{C,F}$	invg	1.5	0.25	1.24	0.15
η^I	E.o.S. $X^{I,H}$ and $X^{I,F}$	invg	1.5	0.25	1.35	0.19
η^*	Demand elasticity for exports	invg	0.4	0.3	0.95	0.19
γ	Inv. Adj. Cost	norm	4	1.5	4.68	1.14
θ_W	Calvo prob. Wages	beta	0.75	0.1	0.96	0.02
ϑ_W	Indexation past infl. Wages	beta	0.5	0.15	0.46	0.11
θ_H	Calvo prob. H	beta	0.75	0.1	0.82	0.02
ϑ_H	Indexation past infl. H	beta	0.5	0.15	0.10	0.04
θ_F	Calvo prob. F	beta	0.75	0.1	0.95	0.02
ϑ_F	Indexation past infl. F	beta	0.5	0.15	0.48	0.20
ρ_R	MPR Rule R_{t-1}	beta	0.75	0.1	0.77	0.03
α_π	MPR Rule π_t	norm	1.5	0.1	1.49	0.09
α_y	MPR Rule growth	norm	0.13	0.05	0.14	0.05
ϕ_u	Utilization Cost	norm	1	0.5	1.51	0.42
α_L^{WC}	Share of working capital	norm	0.7	0.25	0.55	0.09
ρ_v	AC. Pref. shock	beta	0.75	0.1	0.76	0.09
ρ_u	AC. Inv. shock	beta	0.75	0.1	1.00	0.00
ρ_z	AC. Temporary TFP shock	beta	0.75	0.1	0.86	0.04
ρ_a	AC. Permanent TFP shock	beta	0.38	0.1	0.44	0.10
ρ_ζ	AC. Country premium shock	beta	0.75	0.1	0.90	0.05
ρ_μ	AC. μ_t	beta	0.75	0.1	0.71	0.09
ρ_{σ_ω}	AC. $\sigma_{\omega,t}$	beta	0.75	0.1	0.93	0.02
σ_v	St. Dev. Pref. shock	invg	0.01		0.019	0.008
σ_u	St. Dev. Inv. shock	invg	0.01		0.138	0.019
σ_z	St. Dev. Temporary TFP shock	invg	0.01		0.017	0.003
σ_a	St. Dev. Permanent TFP shock	invg	0.01		0.003	0.0004
σ_ζ	St. Dev. Country premium shock	invg	0.003		0.001	0.0001
σ_R	St. Dev. MPR shock	invg	0.003		0.002	0.0003
σ_μ	St. Dev. μ_t	invg	0.01		0.010	0.004
σ_{σ_ω}	St. Dev. $\sigma_{\omega,t}$	invg	0.01		0.164	0.054
$\sigma_{me_{RER}}$	St. Dev. M.E. RER	norm	2.7	0.5	3.50	0.36

Source: Authors' elaboration.

3. The Role of External Shocks

Using the estimated model, we now assess how the presence of financial frictions affects the propagation of foreign shocks. In the model, there are four exogenous external variables: the world interest rate (R_t^*), the international relative price of commodities (p_t^{Co*}), world inflation (π_t^*), and world output (y_t^*). We begin by analyzing the contribution of each of these external variables to explain the unconditional variance of the domestic observables both in the full model (GK+BGG) as well as in the other alternative versions that shut down one financial friction at a time, as displayed in table 3.

Table 3. Variance Decomposition

Variable	R^*	p^{Co*}	π^*	y^*	*Sum*	R^*	p^{Co*}	π^*	y^*	*Sum*
	A. GK+BGG					*B. GK*				
ΔGDP	4	2	11	1	18	2	1	5	0	9
ΔC	5	11	4	0	19	1	3	1	0	5
ΔI	1	2	0	0	3	1	1	0	0	2
TB/GDP	7	34	9	0	50	8	47	11	0	67
π	2	3	1	0	6	1	1	0	0	2
R	3	4	1	0	7	1	1	0	0	2
rer	2	3	1	0	5	1	2	1	0	5
ξ	1	15	11	0	26	1	16	11	0	28
$spread$	1	2	4	0	8	0	0	0	0	0
ΔL	2	3	1	0	6	0	0	0	0	0
	C. BGG					*D. Base*				
ΔGDP	2	1	6	0	9	4	2	9	1	16
ΔC	6	16	4	0	26	1	3	1	0	4
ΔI	0	1	0	0	1	1	1	0	0	3
TB/GDP	8	45	11	0	64	7	26	7	0	40
π	4	5	2	0	11	1	1	0	0	2
R	4	5	2	0	11	1	1	0	0	2
rer	2	3	1	0	6	1	1	0	0	2
ξ	1	22	14	0	38	1	6	5	0	12
$spread$	0	0	0	0	0					
ΔL	0	1	0	0	1					

Source: Authors' elaboration.

We can see that in the estimated model (panel A) external shocks explain an important fraction of the variance of some macro variables, in particular the trade balance, GDP, consumption and the country premium, while these shocks are less important for other variables such as inflation, the policy rate, and the real exchange rate. Of the four foreign shocks, the price of commodities seems to be the most relevant on average, followed by foreign inflation and the world interest rate, while foreign output plays a negligible role.

When this decomposition is applied to the model featuring no financial frictions (panel D) we can see that the relative importance of external shocks in explaining these domestic variables decreases significantly. The largest decrease can be noted in the case of commodity price shocks, which play a much smaller role in the Base model for consumption, the trade balance, and the country premium. Foreign inflation also plays a relatively smaller role in the Base model.

The comparison with the other two alternative models that feature only one financial friction (panels B and C) sheds light on which of the two frictions might be behind the differences found between the GK+BGG and the Base model. In particular, it seems that the BGG frictions are relatively more relevant to explain how foreign shocks propagate to consumption, inflation, and the policy rate. On the other hand, both frictions appear to be relevant to explain the role of foreign shocks in the GK+BGG model for the trade balance and the country premium.

To better understand how financial frictions alter the propagation of the foreign shocks, we analyze the impulse responses generated by these disturbances under the four different versions of the model. Figure 2 displays the responses obtained after an increase in the world price of commodities. Qualitatively, this shock generates a positive wealth effect (which is quite large given the estimated persistence for this shock) that raises consumption. In turn, by increasing the demand for domestic goods, the rise in desired consumption raises the marginal product of capital, also expanding investment. The increase in absorption leads to a real appreciation. In the Base model with no financial frictions, inflation experiences a minor drop, led by a reduction in the domestic price of imported goods due to the real appreciation. Consequently, the policy rate drops mildly.

Figure 2. Impulse Responses to a Commodity Price Shock

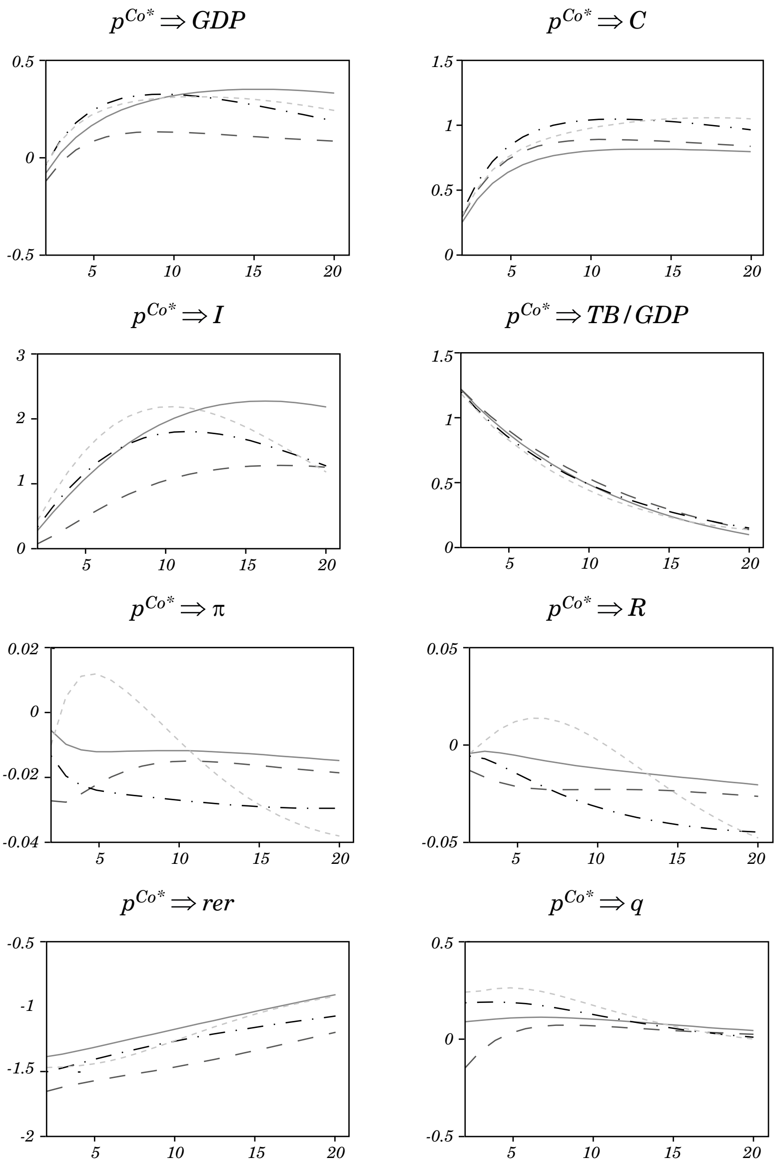
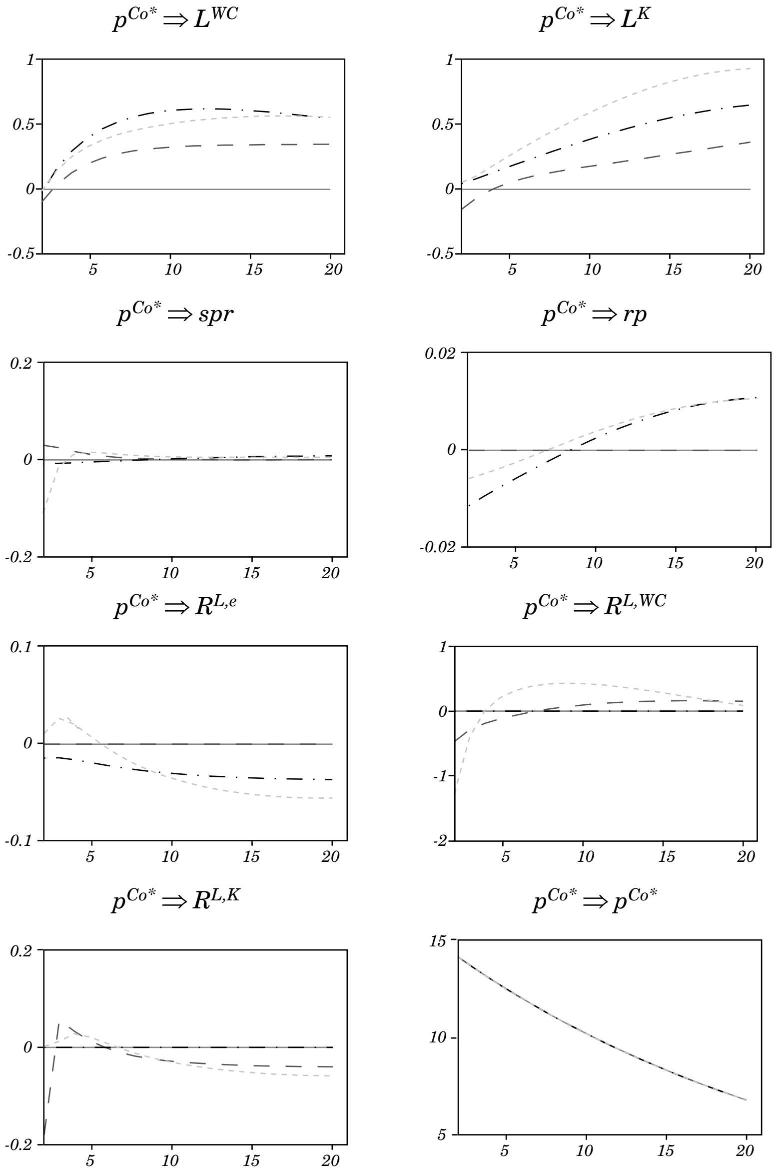


Figure 2. (continued)



Note: The solid lines are from the Base model, the dashed-grey lines correspond to the GK model, the dash-dotted black lines are from the BGG model, and the dash-short light grey lines represent the GK-BGG model. Responses where computed at the posterior mode estimated with the GK+BGG model, and correspond to one-standard-deviation innovations. The variables included in the graph are GDP, consumption, investment, the trade-balance-to-GDP ratio, CPI inflation, the monetary policy rate, the real exchange rate, the price of capital, loans to working capital and to entrepreneurs, the bank spread, the external finance premium, the nominal interest rates on entrepreneurs loans and on working capital loans, the (ex-post) nonimal return on loans to entrepreneurs, and the variable being shocked. Responses of all variables are expressed as percentage deviations from their respective steady state values.

In models with only one financial friction, the rise in investment is relatively milder than in the Base model, particularly for the GK model. While the price of capital tends to rise after the shock (except in the GK model) the persistent real appreciation induces a drop in the marginal product of capital (equal to the rental rate), because home firms produce tradable goods. In equilibrium, and given the estimated parameters, the second effect dominates and thus the return on capital for entrepreneurs falls, reducing the value of assets for either entrepreneurs (in the BGG model) and financial intermediaries (in the GK model). Moreover, this effect seems to be reinforced in general equilibrium, as the *rer* appreciates by more in both models. Overall, financial conditions become more restrictive. In the GK model, this can be seen by a rise in the spread, while in the BGG model we can see that the external finance premium, while dropping in the first periods, it is expected to rise in the medium term. Quantitatively, this seems to be more important for the GK model than for the BGG framework.

Consumption, on the other hand, increases by more in both the GK and the BGG models. This can be attributed in part to the larger reduction in the policy rate that is produced in the presence of financial frictions.

When we consider the GK+BGG model that features both frictions, there is an additional channel in place that makes investment more responsive to the increase in commodity prices. In this model, the bank's problem implies that the interest rate charged on working-capital loans is affected by the expected return on loans to entrepreneurs,[33] which in turn is affected by financial frictions as well.[34] Thus, as financial conditions are expected to be tighter in the future for the reasons we already described, the interest rate on working capital loans is also expected to rise by more than in the other models. Moreover, there is also a rise in the demand for working capital loans as domestic production is increasing. This expected rise in the cost to finance working capital increases the expected real marginal cost faced by firms and, as inflation in Home goods is forward looking, this tends to increase inflation *ceteris paribus*. In the figure, we can see that inflation is actually expected to rise in

33. Recall that from the Banks optimization problem, $\rho_t^{L,WC} = \rho_t^{L,K}$, which is the appropriate indifference conditions between the expected return on both types of loans.

34. In the other two models this interaction is not present. In the BGG model, where there are no banks, the interest rate on working capital loans equals the monetary policy rate. In the GK model, the rate on working capital loans is related to the expected return on capital, but in such a model this return on capital is not subject to frictions.

the first periods after the shock. In turn, given the presence of price rigidities, this provides an additional increase in investment, as the marginal product of capital is expected to increase (which can also be observed in the rise of the real price of capital q).

In terms of the role of foreign inflation shocks, figure 3 shows the effects generated by an increase in this variable. This shock affects the economy through two channels. First, it generates a positive wealth effect because exports will rise *ceteris paribus,* as the demand for exports of home goods depends negatively on foreign inflation. Second, the shock raises, *ceteris paribus*, the marginal cost of imports, generating upward pressure on imported inflation. As can be seen from the figure, the positive wealth effect generates an expansion in consumption and investment. In turn, the economy experiences a real appreciation that, in equilibrium, counteracts the direct effect on inflation from the rise in foreign prices, and inflation is reduced. Moreover, the trade balance deteriorates due to the real appreciation. The latter seems to dominate over the increase in domestic absorption in the first periods, leading to a fall in GDP; although, this effect is reversed after a few quarters and GDP rises afterwards.

The presence of financial frictions reduces the impact of this shock on investment while increasing the response of consumption. This can be attributed to the same exchange rate channel that we mentioned before: the real appreciation worsens the return on assets for entrepreneurs, leading to more restrictive financial conditions. The working capital channel that we highlighted in the case of commodity price shocks is not present because, as production of home goods falls as we already mentioned, the demand for working capital loans is reduced. Thus, while from the banks perspective they would like to raise the interest rate on working capital loans due to the increase in the required interest rate for entrepreneurs (i.e., the supply for working capital loans is reduced), in equilibrium, the contraction in the demand for working capital loans dominates and the interest rate on these loans falls.

Figure 3. Impulse Responses to a Foreign Inflation Shock

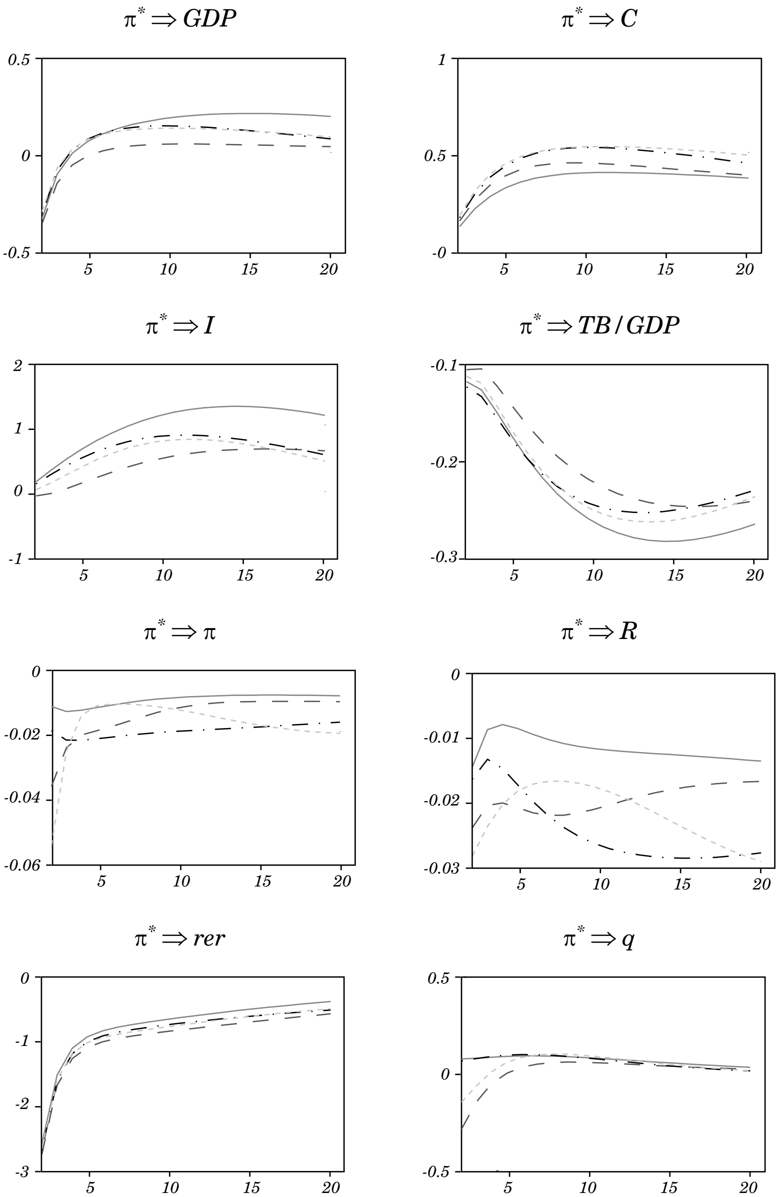
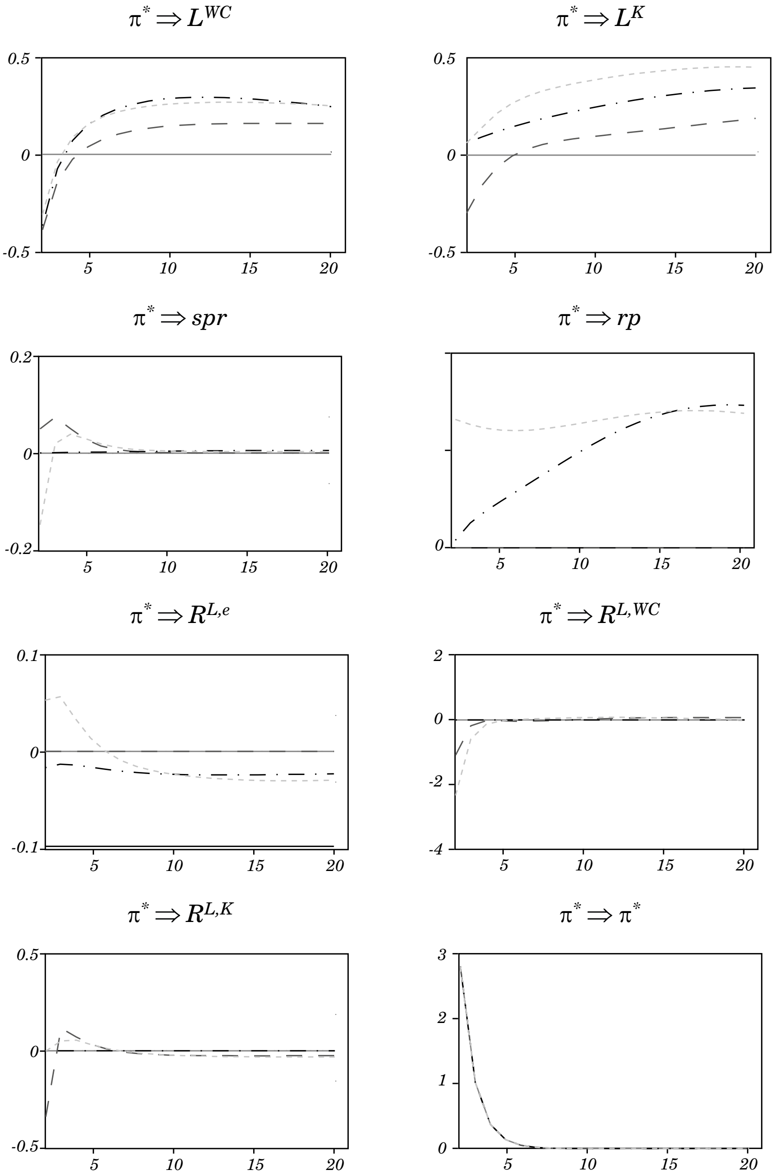


Figure 3. (continued)



Note: See figure 2.

Figure 4 displays the responses to an increase in the world interest rate. Regardless of the presence of financial frictions, this shock is contractionary for both consumption and investment. This happens because it reduces consumption through both a negative wealth effect and through an intertemporal substitution effect. It also contracts investment because it increases the real interest rate. This drop in aggregate absorption generates a real depreciation, which in turn raises aggregate inflation due to the increase in the domestic price of foreign goods. As a consequence, the policy rate rises. Moreover, the trade balance improves and the country premium increases. In the first periods, output increases as the trade balance effect dominates, but after 3 quarters, the output effect turns negative.

The presence of financial frictions dampens the response of investment to this shock. While the price of capital tends to fall after the shock, the persistent real depreciation induces an increase in the marginal product of capital (equal to the rental rate) because home firms produce tradable goods (i.e., the same exchange rate channel mentioned above). In equilibrium, and given the estimated parameters, the second effect dominates and thus the return on capital for entrepreneurs increases, which improves the value of assets for both entrepreneurs and financial intermediaries. Therefore, financial constraints are relaxed after this shock (the external finance premium is reduced) and therefore the negative effect on investment is ameliorated in the presence of financial frictions. Consumption, on the other hand, drops by more in the presence of financial frictions. This is the result of the larger increase in the policy rate that is produced in the presence of financial frictions.

We finish the analysis by computing the historical decomposition of consumption and investment growth to assess the role of the four external shocks in explaining the observed macroeconomic fluctuations over the sample period. This exercise complements the previous analysis as it allows to study the importance of these shocks at different points in time, while the previous analysis was only unconditional. In particular, we want to explore if the inclusion of domestic financial frictions changes the role that external shocks had during the 2008-2009 recession triggered by the financial crisis in the U.S.

Figure 4. Impulse Responses to a World Interest Rate Shock

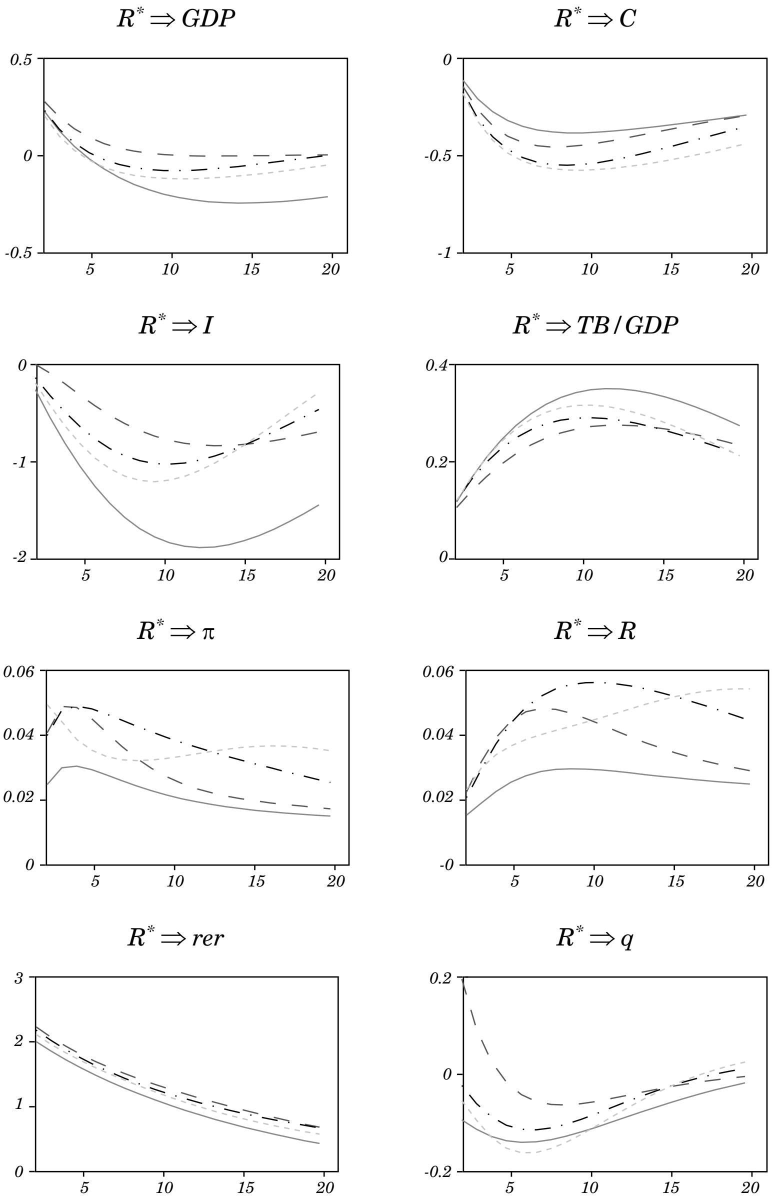
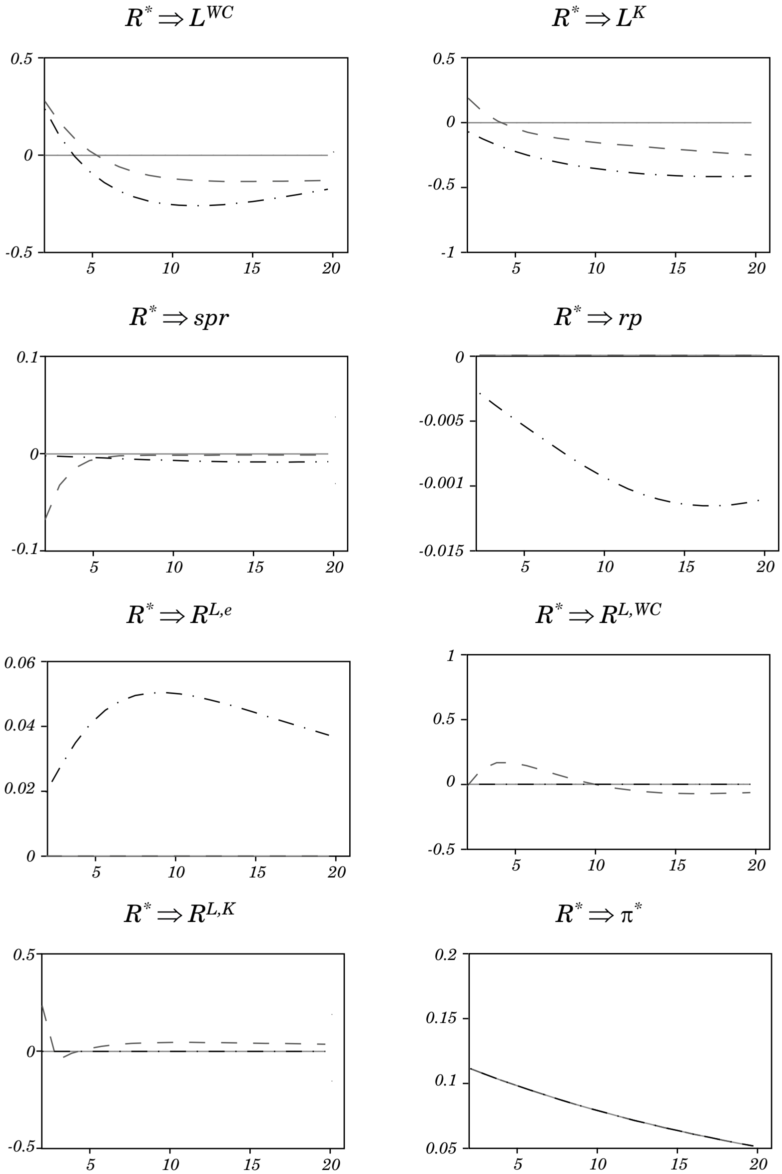


Figure 4. (continued)

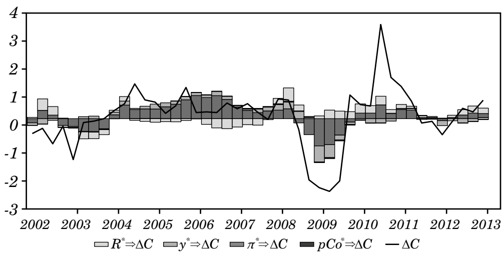


Note: See figure 2.

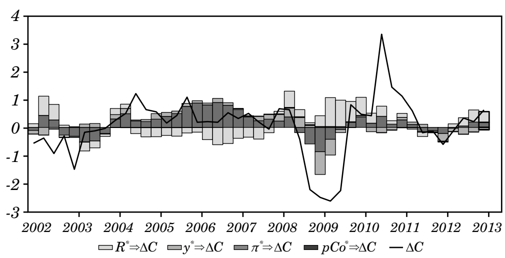
In figure 5 we display the historical decomposition for consumption growth. As expected, given the results previously analyzed, the role of external variables in explaining the evolution of consumption is amplified in the GK-BGG model, both in normal times and during the crisis. For the 2008-2009 episode, we can see how the alternative models assign different roles for international factors in explaining the contraction in consumption. In particular, according to the Base model, the drop in the price of commodities and, to a lesser extent, in foreign inflation, contributed to a drop in consumption: combined they explain more than a half of the drop in consumption growth in 2008Q4 and in 2009Q1.

Figure 5. Historical Decomposition of Consumption Growth Due to Foreign Shocks

Base



GK+BGG



Note: Historical decomposition computed at the posterior mode.

In the GK+BGG model, the contribution of the drop of commodity prices is relatively smaller, particularly in 2009Q1. In addition, the model infers that the fall in the world interest rate had an important contribution in ameliorating the effect of the recession. In particular, the drop in consumption growth would have been close to one percent larger in 2009 without the shocks to the world interest rate.[35] In contrast, the contribution of this shock is perceived as more modest in the Base model.

The historical decomposition for investment is displayed in figure 6. Focusing on the 2008-2009 contraction, we can again see how the presence of domestic financial frictions implies a different story for the contribution of external shocks. In the Base model, foreign shocks appear to have a limited role in explaining the drop in investment. In contrast, in the GK+BGG model, external shocks are relatively more important.[36] In particular, the fall in commodity prices had a larger impact on the contraction of investment than in the Base model. This is in line with the above impulse-response analysis: the presence of financial frictions exacerbated the response of investment to this shock. In addition, as in the decomposition of consumption, the GK+BGG model also assigns an ameliorating role to the drop in the world interest rate during this period.

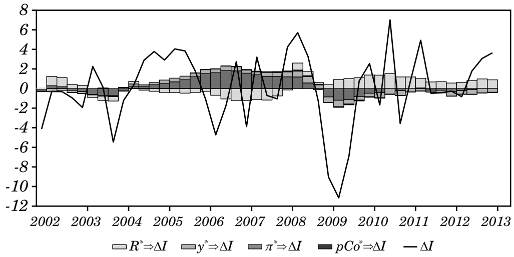
Overall, not only unconditionally as in the variance-decomposition analysis, but also in particular episodes such as during the 2008-2009 recession, accounting for domestic financial frictions seems to be particularly relevant to understand how foreign shocks propagate throughout the economy.

35. Obviously the drop in the world interest rate was produced by the expansionary monetary policy that the central banks in the developed world implemented in response to the crisis. However, as we argued in the analysis of the impulse response to shocks in the world interest rate, the impact of this world shock on consumption is exacerbated by the movement in the domestic policy rate, as the central bank is concerned by the change in inflation that this shocks generates (and this effect is large in the presence of financial frictions). Thus, the domestic central bank was also in part responsible for this countercyclical effect that the world interest rate shocks seem to have had.

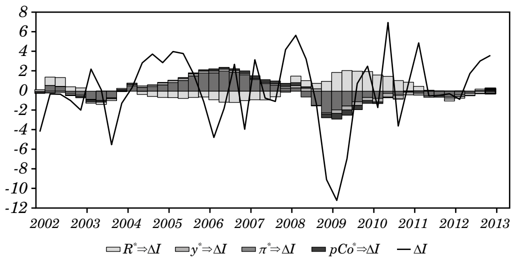
36. As can be seen in the figure, in either case, foreign shocks explain less than a quarter of the total drop in investment in that period. According to the GK+BGG model the shocks to entrepreneurs' risk ($\sigma_{w,t}$) was mainly responsible for this drop.

Figure 6. Historical Decomposition of Investment Growth Due to Foreign Shocks

Base



GK+BGG



Note: Historical decomposition computed at the posterior mode.

4. Conclusions

In this paper we have set up and estimated a DSGE model of a small open economy that includes two types of domestic financial frictions: one between domestic depositors and banks, and another between banks and domestic borrowers. The model was estimated with Chilean data from 2001 to 2012. We have used the model to determine how the propagation of foreign shocks is altered by the presence of these frictions.

Our results showed that, because the frictions are between domestic agents, the effect of the shock on the real exchange rate is crucial to understand the amplification of external shocks. In particular, the responses of investment and, to a lesser extent, output tend to be milder in the presence of financial frictions, while the responses of consumption and inflation are exacerbated. However, we also detected that in some cases the presence of the working capital channel could also provide additional amplification for these shocks, particularly if it interacts with both financial frictions. We have also shown that in the presence of domestic financial frictions the contribution of external factors in explaining the evolution of some macro variables during the 2008-2009 recession is larger and significantly different than in a model without these frictions.

To conclude, there are several aspects of our framework that deserve to be discussed, as they can point to future improvements in the analysis. First, in our model financial frictions are always binding. In contrast, part of the literature has emphasized financial frictions that are only occasionally binding, particularly in the lending relationship between domestic and foreign agents.[37] Assuming that frictions are always binding is convenient from a computational point of view (for it allows solving the model using perturbation methods),[38] but of course we can be missing important dynamics. For instance, while we argued in the introduction that the EMBI spread for Chile has been relatively small, it still experienced a spike during the 2008 world financial crisis. A similar sudden increase could also be seen in domestic spreads. This might reflect that financial conditions became suddenly more restrictive than in normal times. Still, in that particular episode it is not easy to disentangle if this was the channel in place, since the size of the external shock was also larger than usual. Thus it might be of interest to extend our analysis by considering a model in which financial frictions bind occasionally. Nonetheless, while of course this might be relevant from a quantitative point of view; qualitatively, the analysis in this paper is still useful to understand the relevant channels that might be part of the propagation of foreign shocks.

In addition, given the highlighted relevance of the real exchange rate, it would be of interest to consider a multi-sector model, with tradables and non-tradables. Arguably, the effects that we have described arise because all goods are tradable and in that way,

37. Some examples are Mendoza (2010), Benigno et al. (2013), and Bianchi (2011).

38. Linearization not only allows to estimate the model with a likelihood approach more easily, but it also allows to consider many other potentially relevant features of the economy in the model. Global solution methods, required to solve models with occasionally binding constraints, generally require to limit significantly the size of the model (for instance, it would be quite costly to compute the model of Mendoza (2010) assuming also sticky prices and wages with indexation).

for instance, a real depreciation improves the financial position of these firms. But if firms in the non-traded sector are also subject to financial constraints, a real depreciation will deteriorate their financial conditions, making less clear what the final effect would be.

Moreover, in the presence of debt denominated in foreign currency (e.g., due to liability dollarization), the movement in the real exchange rate may have an effect opposite to the one emphasized in this paper. For instance, if the real exchange rate appreciates it will lower the burden of debt denominated in dollars, and in the presence of financial frictions it will tend, *ceteris paribus*, to reduce improving the premium. While this is true conceptually, it is less clear whether it would be a relevant channel for Chile, as liability dollarization is not a widespread phenomenon.

Another relevant issue that we did not tackle in this paper is the relative importance of domestic *vis-a-vis* foreign financial frictions in propagating external shocks. To perform such a comparison, one would need to set up a model with both types of frictions at the same time. For instance, one could consider that banks obtain funds also from abroad, subject to the same type of frictions that we assume between banks and domestic depositors. In such a setup, movements in the real exchange rate will also alter the banks' balance sheet, leading to an additional amplification channel.

Alternatively, one could consider that firms (at least part of them) obtain funds not only in the domestic market but also abroad (for instance through corporate debt or equity markets). In particular, this can lead to additional and relevant dynamics as emphasized, for instance, by Caballero (2002) to explain how the Asian crisis propagated to the Chilean economy. If large firms can obtain funds both domestically and abroad while smaller firms (particularly in the non-traded sector) have only access to domestic financing, a sudden stop in capital inflows will lead these large firms to turn to the domestic market for financing, crowding-out the credit available for smaller firms. Thus, in such a setup both domestic and foreign financial frictions would be relevant for the propagation of external shocks. We left these extensions for future research.

Appendix

Model Appendix

Intermediary Objective

This section shows that the objective of financial intermediaries, given by

$$V_t = E_t \sum_{s=0}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1} \left[(r^{L,WC}_{t+1+s} - r_{t+1+s}) L^{WC}_{t+s} + (r^{L,K}_{t+1+s} - r_{t+1+s}) L^{K}_{t+s} + r_{t+1+s} N_{t+s} \right],$$

can be expressed as

$$V_t = \rho_t^{L,WC} L_t^{WC} + \rho_t^{L,K} L_t^{K} + \rho_t^{N} N_t.$$

First, notice that

$$V_t = E_t \sum_{s=0}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1} \left[(r^{L,WC}_{t+1+s} - r_{t+1+s}) \frac{L^{WC}_{t+s}}{L^{WC}_t} L^{WC}_t + (r^{L,K}_{t+1+s} - r_{t+1+s}) \frac{L^{K}_{t+s}}{L^{K}_t} L^{K}_t + r_{t+1+s} \frac{N_{t+s}}{N_t} N_t \right].$$

Thus,

$$\rho_t^{L,WC} \equiv E_t \textstyle\sum_{s=0}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1} (r^{L,WC}_{t+1+s} - r_{t+1+s}) \dfrac{L^{WC}_{t+s}}{L^{WC}_t},$$

$$\rho_t^{L,K} \equiv E_t \textstyle\sum_{s=0}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1} (r^{L,K}_{t+1+s} - r_{t+1+s}) \dfrac{L^{K}_{t+s}}{L^{K}_t}$$

and

$$\rho_t^{N} \equiv E_t \textstyle\sum_{s=0}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1}\, r_{t+1+s} \dfrac{N_{t+s}}{N_t}.$$

In terms of ρ_t^N,

$$\rho_t^{N} = E_t \left\{ (1-\omega)\beta \Xi_{t,t+1} r_{t+1} + \textstyle\sum_{s=1}^{\infty} (1-\omega)\omega^s \beta^{s+1} \Xi_{t,t+s+1} r_{t+1+s} \dfrac{N_{t+s}}{N_t} \right\}$$

or,

$$\rho_t^N = E_t\left\{(1-\omega)\beta\Xi_{t,t+1}r_{t+1} + \beta\omega\Xi_{t,t+1}\frac{N_{t+1}}{N_t}\sum_{s=1}^{\infty}(1-\omega)\omega^{s-1}\beta^s\Xi_{t+1,t+s+1}r_{t+1+s}\frac{N_{t+s}}{N_{t+1}}\right\}.$$

Finally, changing the index in the sum by $j = s - 1$, we obtain

$$\rho_t^N = E_t\left\{(1-\omega)\beta\Xi_{t,t+1}r_{t+1} + \beta\omega\Xi_{t,t+1}\frac{N_{t+1}}{N_t}\right.$$
$$\left.\sum_{j=0}^{\infty}(1-\omega)\omega^{j}\beta^{j+1}\Xi_{t+1,t+1+j+1}r_{t+1+j+1}\frac{N_{t+j+1}}{N_{t+1}}\right\}$$

or, using the definition of ρ_t^N evaluated at $t + 1$,

$$\begin{aligned}\rho_t^N &= E_t\left\{(1-\omega)\beta\Xi_{t,t+1}r_{t+1} + \beta\omega\Xi_{t,t+1}\frac{N_{t+1}}{N_t}\rho_{t+1}^N\right\}\\ &= \beta E_t\left\{\Xi_{t,t+1}\left[(1-\omega)r_{t+1} + \omega\frac{N_{t+1}}{N_t}\rho_{t+1}^N\right]\right\}.\end{aligned}$$

With an analogous procedure we can obtain the expression for $\rho_t^{L,WC}$ and $\rho_t^{L,K}$.

Entrepreneurs' Optimization Problem

Using the definition for lev_t^e and (13), the Lagrangian for the optimal-contract problem can be written as,

$$E_t\left\{lev_t^e\frac{[r_{t+1}^K + (1-\delta)q_{t+1}]}{q_t}h(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})\right.$$
$$\left.+\eta_{t+1}\left[g(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})\frac{[r_{t+1}^K + (1-\delta)q_{t+1}]}{q_t}lev_t^e - (lev_t^e - 1)r_{t+1}^L\right]\right\},$$

where η_{t+1} is the Lagrange multiplier. The choice variables are lev_t^e and a state-contingent $\bar{\omega}_{t+1}^e$. The first order conditions are the constraint holding with equality and

$$E_t\left\{\frac{[r^K_{t+1}+(1-\delta)q_{t+1}]}{q_t}h(\bar{\omega}^e_{t+1};\sigma_{\omega,t})+\eta_{t+1}\right.$$

$$\left.\left[g(\bar{\omega}^e_{t+1};\sigma_{\omega,t})\frac{[r^K_{t+1}+(1-\delta)q_{t+1}]}{q_t}-(lev^e_t-1)r^L_{t+1}\right]\right\}=0,$$

$$h'(\bar{\omega}^e_{t+1})+\eta_{t+1}g'(\bar{\omega}^e_{t+1})=0.$$

Combining these to eliminate η_{t+1} and rearranging we obtain (15) in the text.

Finally, we need a functional form for $F(\omega^e_t;\sigma_{\omega,t-1})$. We follow BGG and assume that $\ln(\omega^e_t): N(-.5\sigma^2_{\omega,t-1},\sigma^2_{\omega,t-1})$ (so that $E(\omega^e_t)=1$). Under this assumption, we can define

$$aux^1_t\equiv\frac{ln(\bar{\omega}^e_t)+.5\sigma^2_{\omega,t-1}}{\sigma_{\omega,t-1}},$$

and, letting $\Phi(\cdot)$ be the standard normal c.d.f. and $\Phi(\cdot)$ its p.d.f., we can write,[39]

$$g(\bar{\omega}^e_t;\sigma_{\omega,t-1})=\bar{\omega}_t[1-\Phi(aux^1_t)]+(1-\mu^e)\Phi(aux^1_t-\sigma_{\omega,t-1}),$$

$$g'(\bar{\omega}^e_t;\sigma_{\omega,t-1})=[1-\Phi(aux^1_t)]-\bar{\omega}^e_t\phi(aux^1_t)\frac{1}{\sigma_{\omega,t-1}}\frac{1}{\bar{\omega}^e_t}$$

$$+(1-\mu^e)\phi(aux^1_t-\sigma_{\omega,t-1})\frac{1}{\sigma_{\omega,t-1}}\frac{1}{\bar{\omega}^e_t}$$

$$=[1-\Phi(aux^1_t)]-\mu^e\phi(aux^1_t),$$

$$h(\bar{\omega}^e_t;\sigma_{\omega,t-1})=1-\Phi(aux^1_t-\sigma_{\omega,t-1})-\bar{\omega}^e_t[1-\Phi(aux^1_t)],$$

$$h'(\bar{\omega}^e_t;\sigma_{\omega,t-1})=-\phi(aux^1_t-\sigma_{\omega,t-1})\frac{1}{\sigma_{\omega,t-1}}\frac{1}{\bar{\omega}^e_t}$$

$$-[1-\Phi(aux^1_t)]+\bar{\omega}^e_t\phi(aux^1_t)\frac{1}{\sigma_{\omega,t-1}}\frac{1}{\bar{\omega}^e_t}$$

$$=-[1-\Phi(aux^1_t)].$$

39. See, for instance, the appendix of Devereux et al. (2006).

Equilibrium Conditions

The variables in uppercase that are not prices contain a unit root in equilibrium due to the presence of the non-stationary productivity shock A_t. We need to transform these variables to have a stationary version of the model. To do this, with the exceptions we enumerate below, lowercase variables denote the uppercase variable divided by A_{t-1} (e.g., $c_t \equiv \frac{C_t}{A_{t-1}}$). The only exception is the Lagrange multiplier Λ_t that is multiplied by A_{t-1} (i.e., $\lambda_t \equiv \Lambda_t A_{t-1}$), for it decreases along the balanced growth path.

The rational expectations equilibrium of the stationary version of the model is the set of sequences

$$\{\lambda_t, c_t, h_t, h_t^d, w_t, \tilde{w}_t, mc_t^W, f_t^W, \text{”}_t^W, i_t, k_t, r_t^K, q_t, y_t, y_t^C, y_t^F, y_t^H, x_t^{C,F}, x_t^{C,H},$$
$$x_t^{I,F}, x_t^{I,H}, x_t^{I,F}, x_t^{I,H}, x_t^{H*}, R_t, \xi_t, \pi_t, \pi_t^S, rer_t, p_t^H, \tilde{p}_t^H, p_t^F, \tilde{p}_t^F, p_t^Y, p_t^G, p_t^I, mc_t^H,$$
$$f_t^H, \text{”}_t^H, mc_t^F, f_t^F, \text{”}_t^F, b_t^*, m_t, tb_t, u_t, l_t, l_t^{WC}, l_t^{WC}, d_t, n_t, \rho_t^L, \rho_t^N, lev_t, r_t^{L,K}, r_t^{L,e},$$
$$r_t^{L,WC}, R_t^{L,e}, R_t^{L,WC}, spr_t, \bar{\omega}_t, n_t^e, rp_t, lev_t^e\}_{t=0}^{\infty},$$

(64 variables) such that for given initial values and exogenous sequences

$$\{v_t, \varpi_t, z_t, a_t, \zeta_t, \varepsilon_t^R, R_t^*, \pi_t^*, p_t^{Co*}, y_t^{Co}, y_t^*, g_t, \mu_t, \sigma_{\omega,t}\}_{t=0}^{\infty},$$

the following conditions are satisfied. Households:

$$\lambda_t = \left(c_t - \varsigma\frac{c_{t-1}}{a_{t-1}}\right)^{-1} - \beta\varsigma E_t\left\{\frac{v_{t+1}}{v_t}\left(c_{t+1}a_t - \varsigma c_t\right)^{-1}\right\}, \tag{1}$$

$$w_t mc_t^W = \kappa\frac{h_t^{\phi}}{\lambda_t}, \tag{2}$$

$$\lambda_t = \frac{\beta}{a_t}R_t E_t\left\{\frac{v_{t+1}}{v_t}\frac{\lambda_{t+1}}{\pi_{t+1}}\right\}, \tag{3}$$

$$\lambda_t = \frac{\beta}{a_t} R_t^* \xi_t E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\pi_{t+1}^S \lambda_{t+1}}{\pi_{t+1}} \right\}, \tag{4}$$

$$f_t^W = mc_t^W \bar{w}_t^{-\varepsilon_W} h_t^d + \beta\theta_W E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{\pi_t^{\vartheta_W} \pi^{1-\vartheta_W}}{\pi_{t+1}} \right)^{-\varepsilon_W} \left(\frac{\bar{w}_t}{\bar{w}_{t+1}} \right)^{-\varepsilon_W} \left(\frac{w_t}{w_{t+1}} \right)^{-1-\varepsilon_W} f_{t+1}^W \right\}, \tag{5}$$

$$f_t^W = \bar{w}_t^{1-\varepsilon_W} h_t^d \left(\frac{\varepsilon_W - 1}{\varepsilon_W} \right) + \beta\theta_W E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{\pi_t^{\vartheta_W} \pi^{1-\vartheta_W}}{\pi_{t+1}} \right)^{1-\varepsilon_W} \left(\frac{\bar{w}_t}{\bar{w}_{t+1}} \right)^{1-\varepsilon_W} \left(\frac{w_t}{w_{t+1}} \right)^{-\varepsilon_W} f_t^W \right\}, \tag{6}$$

$$1 = (1-\theta_W)\tilde{w}_t^{1-\varepsilon_W} + \theta_W \left(\frac{w_{t-1}}{w_t} \frac{\pi_{t-1}^{\vartheta_W} \pi^{1-\vartheta_W}}{\pi_t} \right)^{1-\varepsilon_W}, \tag{7}$$

$$\Delta_t^W = (1-\theta_W)\bar{w}_t^{-\varepsilon_W} + \theta_W \left(\frac{w_{t-1}}{w_t} \frac{\pi_{t-1}^{\vartheta_W} \pi^{1-\vartheta_W}}{\pi_t} \right)^{-\varepsilon_W} \Delta_{t-1}^W, \tag{8}$$

$$h_t = h_t^d \Delta_t^W. \tag{9}$$

Composite final goods:

$$y_t^C = \left[(1-o_C)^{\frac{1}{\eta_C}} (x_t^{C,H})^{\frac{\eta_C - 1}{\eta_C}} + o_C^{\frac{1}{\eta_C}} (x_t^{C,F})^{\frac{\eta_C - 1}{\eta_C}} \right]^{\frac{\eta_C}{\eta_C - 1}}, \tag{10}$$

$$i_t = \left[(1-o_I)^{\frac{1}{\eta_I}} (x_t^{I,H})^{\frac{\eta_I - 1}{\eta_I}} + o_I^{\frac{1}{\eta_I}} (x_t^{I,F})^{\frac{\eta_I - 1}{\eta_I}} \right]^{\frac{\eta_I}{\eta_I - 1}}, \tag{11}$$

$$g_t = \left[(1-o_G)^{\frac{1}{\eta_G}} (x_t^{G,H})^{\frac{\eta_G - 1}{\eta_G}} + o_G^{\frac{1}{\eta_G}} (x_t^{G,F})^{\frac{\eta_G - 1}{\eta_G}} \right]^{\frac{\eta_G}{\eta_G - 1}}, \tag{12}$$

$$x_t^{C,H} = (1 - o_C)(p_t^H)^{-\eta_C} y_t^C, \tag{13}$$

$$x_t^{C,F} = o_C (p_t^F)^{-\eta_C} y_t^C, \tag{14}$$

$$x_t^{I,H} = (1 - o_I)\left(\frac{p_t^H}{p_t^I}\right)^{-\eta_I} i_t, \tag{15}$$

$$x_t^{I,F} = o_I \left(\frac{p_t^F}{p_t^I}\right)^{-\eta_I} i_t, \tag{16}$$

$$x_t^{G,H} = (1 - o_G)\left(\frac{p_t^H}{p_t^G}\right)^{-\eta_G} g_t, \tag{17}$$

$$x_t^{G,F} = o_G \left(\frac{p_t^F}{p_t^G}\right)^{-\eta_G} g_t. \tag{18}$$

Home goods:

$$mc_t^H = \frac{1}{\alpha^\alpha (1-\alpha)^{1-\alpha}} \frac{(r_t^K)^\alpha w_t^{1-\alpha}[1 + \alpha_L^{WC}(R_t^{L,WC} - 1)]}{p_t^H z_t a_t^{1-\alpha}}, \tag{19}$$

$$\frac{u_t k_{t-1}}{h_t^d} = a_{t-1} \frac{\alpha}{1-\alpha} \frac{w_t}{r_t^K}, \tag{20}$$

$$l_t^{WC} = \alpha_L^{WC}\left(w_t h_t^d + r_t^K u_t \frac{k_{t-1}}{a_{t-1}}\right), \tag{21}$$

$$f_t^H = \left(\tilde{p}_t^H\right)^{-\varepsilon_H} y_t^H mc_t^H + \beta\theta_H E_t \left\{\frac{\upsilon_{t+1}}{\upsilon_t}\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{\pi_t^{\vartheta_H}\pi^{1-\vartheta_H}}{\pi_{t+1}}\right)^{-\varepsilon_H}\left(\frac{\tilde{p}_t^H}{\tilde{p}_{t+1}^H}\right)^{-\varepsilon_H}\left(\frac{p_t^H}{p_{t+1}^H}\right)^{-1-\varepsilon_H} f_{t+1}^H\right\}, \tag{22}$$

$$f_t^H = \left(\tilde{p}_t^H\right)^{1-\varepsilon_H} y_t^H \left(\frac{\varepsilon_H - 1}{\varepsilon_H}\right) + \beta\theta_H E_t \left\{\frac{\upsilon_{t+1}}{\upsilon_t}\frac{\lambda_{t+1}}{\lambda_t}\left(\frac{\pi_t^{\vartheta_H}\pi^{1-\vartheta_H}}{\pi_{t+1}}\right)^{1-\varepsilon_H}\left(\frac{\tilde{p}_t^H}{\tilde{p}_{t+1}^H}\right)^{1-\varepsilon_H}\left(\frac{p_t^H}{p_{t+1}^H}\right)^{-\varepsilon_H} f_{t+1}^H\right\}, \tag{23}$$

$$y_t^H \Delta_t^H = z_t \left(\frac{u_t k_{t-1}}{a_{t-1}} \right)^{\alpha} (a_t h_t^d)^{1-\alpha}, \tag{24}$$

$$1 = \theta_H \left(\frac{p_{t-1}^H}{p_t^H} \frac{\pi_{t-1}^{\vartheta_H} \pi^{1-\vartheta_H}}{\pi_t} \right)^{1-\varepsilon_H} + (1-\theta_H)(\tilde{p}_t^H)^{1-\varepsilon_H}, \tag{25}$$

$$\Delta_t^H = (1-\theta_H)(\tilde{p}_t^H)^{-\varepsilon_H} + \theta_H \left(\frac{p_{t-1}^H}{p_t^H} \frac{\pi_{t-1}^{\vartheta_H} \pi^{1-\vartheta_H}}{\pi_t} \right)^{-\varepsilon_H} \Delta_{t-1}^H. \tag{26}$$

Capital accumulation:

$$k_t = (1-\delta) \frac{k_{t-1}}{a_{t-1}} + \left[1 - \frac{\gamma}{2} \left(\frac{i_t}{i_{t-1}} a_{t-1} - \bar{a} \right)^2 \right] \varpi_t i_t, \tag{27}$$

$$\frac{p_t^I}{q_t} = \left[1 - \frac{\gamma}{2} \left(\frac{i_t}{i_{t-1}} a_{t-1} - \bar{a} \right)^2 - \gamma \left(\frac{i_t}{i_{t-1}} a_{t-1} - \bar{a} \right) \frac{i_t}{i_{t-1}} a_{t-1} \right] \varpi_t$$
$$+ \frac{\beta}{a_t} \gamma E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \frac{q_{t+1}}{q_t} \left(\frac{i_{t+1}}{i_t} a_t - \bar{a} \right) \left(\frac{i_{t+1}}{i_t} a_t \right)^2 \varpi_{t+1} \right\}. \tag{28}$$

Imported goods:

$$mc_t^F = rer_t / p_t^F, \tag{29}$$

$$f_t^F = \left(\tilde{p}_t^F \right)^{-\varepsilon_F} y_t^F mc_t^F + \beta \theta_F E_t$$
$$\left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{\pi_t^{\vartheta_F} \pi^{1-\vartheta_F}}{\pi_{t+1}} \right)^{-\varepsilon_F} \left(\frac{\tilde{p}_t^F}{\tilde{p}_{t+1}^F} \right)^{-\varepsilon_F} \left(\frac{p_t^F}{p_{t+1}^F} \right)^{-1-\varepsilon_F} f_{t+1}^F \right\}, \tag{30}$$

$$f_t^F = \left(\tilde{p}_t^F \right)^{1-\varepsilon_F} y_t^F \left(\frac{\varepsilon_F - 1}{\varepsilon_F} \right) + \beta \theta_F E_t$$
$$\left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left(\frac{\pi_t^{\vartheta_F} \pi^{1-\vartheta_F}}{\pi_{t+1}} \right)^{1-\varepsilon_F} \left(\frac{\tilde{p}_t^F}{\tilde{p}_{t+1}^F} \right)^{1-\varepsilon_F} \left(\frac{p_t^F}{p_{t+1}^F} \right)^{-\varepsilon_F} f_{t+1}^F \right\}, \tag{31}$$

$$1=\theta_F\left(\frac{p_{t-1}^F}{p_t^F}\frac{\pi_{t-1}^{\vartheta_F}\pi^{1-\vartheta_F}}{\pi_t}\right)^{1-\varepsilon_F}+(1-\theta_F)(\tilde{p}_t^F)^{1-\varepsilon_F}. \tag{32}$$

$$m_t=y_t^F\Delta_t^F, \tag{33}$$

$$\Delta_t^F=(1-\theta_F)(\tilde{p}_t^F)^{-\varepsilon_F}+\theta_F\left(\frac{p_{t-1}^F}{p_t^F}\frac{\pi_{t-1}^{\vartheta_F}\pi^{1-\vartheta_F}}{\pi_t}\right)^{-\varepsilon_F}\Delta_{t-1}^F. \tag{34}$$

Entrepreneurs:

$$r_t^K=r^K\exp[\phi_u(u_t-1)], \tag{35}$$

$$l_{t-1}^K r_t^{L,K}=g(\bar{\omega}_t;\sigma_{\omega,\,t-1})[r_t^K u_t-\phi(u_t)+(1-\delta)q_t]k_{t-1}, \tag{36}$$

$$E_t\left\{\frac{[r_{t+1}^K u_{t+1}-\phi(u_{t+1})+(1-\delta)q_{t+1}]}{q_t}\left[\frac{h'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})g(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}{g'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}-h(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})\right]\right\}=$$

$$E_t\left\{r_{t+1}^{L,K}\frac{h'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}{g'(\bar{\omega}_{t+1}^e;\sigma_{\omega,t})}\right\}, \tag{37}$$

$$r_{t-1}^{L,e}=\bar{\omega}_t[r_t^K u_t-\phi(u_t)+(1-\delta)q_t]\frac{k_{t-1}}{l_{t-1}^K}, \tag{38}$$

$$n_t^e=\frac{\upsilon}{a_{t-1}}\left\{[r_t^K u_t-\phi(u_t)+(1-\delta)q_t]k_{t-1}h(\bar{\omega}_t^e;\sigma_{\omega,t-1})\right\}+\iota^e n^e, \tag{39}$$

$$l_t^K=q_t k_t-n_t^e, \tag{40}$$

$$rp_t=\frac{E_t\left\{\frac{[r_{t+1}^K u_{t+1}-\phi(u_{t+1})+(1-\delta)q_{t+1}]}{q_t}\right\}}{E_t\left\{r_{t+1}^{L,K}\right\}}, \tag{41}$$

$$lev_t^e=\frac{q_t k_t}{n_t^e}, \tag{42}$$

$$r_{t-1}^{L,e}=\frac{R_{t-1}^{L,e}}{\pi_t}. \tag{43}$$

Banks:

$$\rho_t^L = \frac{\beta}{a_t} E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\omega)(r_{t+1}^{L,WC} - r_{t+1}) + \omega \frac{l_{t+1}^{WC}}{l_t^{WC}} a_t \rho_{t+1}^L \right] \right\}, \tag{44}$$

$$\rho_t^L = \frac{\beta}{a_t} E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\omega)(r_{t+1}^{L,K} - r_{t+1}) + \omega \frac{l_{t+1}^{K}}{l_t^{K}} a_t \rho_{t+1}^L \right] \right\}, \tag{45}$$

$$\rho_t^N = \frac{\beta}{a_t} E_t \left\{ \frac{\upsilon_{t+1}}{\upsilon_t} \frac{\lambda_{t+1}}{\lambda_t} \left[(1-\omega) r_{t+1} + \omega \frac{n_{t+1}}{n_t} a_t \rho_{t+1}^N \right] \right\}, \tag{46}$$

$$lev_t = \frac{\rho_t^N}{\mu_t - \rho_t^L}, \tag{47}$$

$$l_t = lev_t n_t, \tag{48}$$

$$l_t = l_t^K + l_t^{WC}, \tag{49}$$

$$d_t = l_t - n_t, \tag{50}$$

$$n_t = \frac{\omega}{a_{t-1}} \left[(r_t^{L,WC} - r_t) l_{t-1}^{WC} + (r_t^{L,K} - r_t) l_{t-1}^{K} + r_t n_{t-1} \right] + \iota n, \tag{51}$$

$$spr_t = \frac{(R_t^{L,WC} l_t^{WC} + R_t^{L,e} l_t^{K})}{l_t} \frac{1}{R_t}, \tag{52}$$

$$r_t^{L,WC} = \frac{R_{t-1}^{L,WC}}{\pi_t}. \tag{53}$$

Rest of the world:

$$x_t^{H*} = o^* \left(\frac{p_t^H}{rer_t} \right)^{-\eta^*} y_t^*, \tag{54}$$

$$\xi_t = \bar{\xi} \exp\left[-\psi \frac{rer_t b_t^* - rer \times \bar{b}^*}{rer \times \bar{b}^*} + \frac{\zeta_t - \zeta}{\zeta} \right]. \tag{55}$$

Monetary policy:

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho_R} \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\alpha_\pi} \left(\frac{y_t}{y_{t-1}}\right)^{\alpha_y}\right]^{1-\rho_R} \exp(\varepsilon_t^R). \tag{56}$$

Market clearing and definitions:

$$y_t^H = x_t^{C,H} + x_t^{G,H} + x_t^{G,H} + x_t^{H*}, \tag{57}$$

$$\frac{rer_t}{rer_{t-1}} = \frac{\pi_t^S \pi_t^*}{\pi_t}, \tag{58}$$

$$y_t = c_t + i_t + g_t + x_t^{H*} + y_t^{Co} - m_t, \tag{59}$$

$$tb_t = p_t^H x_t^{H*} + rer_t p_t^{Co*} y_t^{Co} - rer_t m_t, \tag{60}$$

$$rer_t b_t^* = rer_t \frac{b_{t-1}^*}{a_{t-1}\pi_t^*} R_{t-1}^* \xi_{t-1} + tb_t - (1-\chi) rer_t p_t^{Co*} y_t^{Co}, \tag{61}$$

$$p_t^Y y_t = c_t + p_t^I i_t + p_t^G g_t + tb_t. \tag{62}$$

$$y_t^F = x_t^{C,F} + x_t^{G,F} + x_t^{G,F}, \tag{63}$$

$$y_t^C = c_t + \frac{r^K}{\phi_u}\{\exp[\phi_u(u_t - 1)] - 1\}\frac{k_{t-1}}{a_{t-1}} + \mu^e [r_t^K u_t - \phi(u_t) + (1-\delta) q_t] \frac{k_{t-1}}{a_{t-1}} ¦ (aux_t^1 - \sigma_{\omega,t-1}). \tag{64}$$

The exogenous processes are

$\log\left(x_t / \bar{x}\right) = \rho_x \log\left(x_{t-1} / \bar{x}\right) + \varepsilon_t^x, \qquad \rho_x \in 0,1), \qquad \bar{x} > 0,$ for

$x = \{\upsilon, \varpi, z, a, \zeta, R^*, \pi^*, p^{Co*}, y^{Co}, y^*, g, \mu, \sigma_\omega\}$, where the ε_t^x are n.i.d. shocks (including also ε_t^R).

Steady State

We show how to compute the steady state for given values of R, $h, p^H, s^{tb}= tb/(p^Y y), s^g= p^G g/(p^Y y), s^{Co}= rer \text{x} p^{Co*} y^{Co}/(p^Y y), \Gamma \equiv r^{L,e} / r, lev$, ι, rp, υ, lev^e and μ^e. The parameters β, $\bar{\pi}^*$, κ, o^*, $\bar{g}$, $\bar{y}^{Co}$, $\bar{\mu}$, ω, $\bar{\sigma}_\omega$ and ι^e are determined endogenously while the values of the remaining parameters are taken as given.

From the exogenous processes for $v_t, u_t, z_t, a_t, y_t^{Co}, R_t^*, y_t^*$ and p_t^{Co*}, $v = \bar{v},\ u = \bar{u},\ z = \bar{z},\ a = \bar{a},\ y^{Co} = \bar{y}^{Co},\ \zeta = \bar{\zeta},\ R^* = \bar{R}^*,\ y^* = \bar{y}^*,\ p^{Co*} = \bar{p}^{Co*}$, From (55), $\xi = \bar{\xi}$.

From (56), $\pi = \bar{\pi}$.

From (3), $\beta = a\pi / R$.

From (35), u=1,

which implies that monitoring costs $\phi(u)$ are zero in steady state. From (4), $\pi^S = a\pi / (\beta R^* \xi)$.

From (58) and the exogenous process for π_t^*, $\pi^* = \bar{\pi}^* = \pi / \pi^S$.

Also, from (36), (37), (41) and (42),

$$rp\left[h'(\bar{\omega}^e;\sigma_\omega) g(\bar{\omega}^e;\sigma_\omega) - h(\bar{\omega}^e;\sigma_\omega) g'(\bar{\omega}^e;\sigma_\omega) \right] = h'(\bar{\omega}^e;\sigma_\omega),$$

$$\frac{lev^e - 1}{lev^e} = g(\bar{\omega}^e;\sigma_\omega) rp.$$

These two equation can be solved numerically to obtain $\bar{\omega}^e$ and σ_ω. Then, from the definition of Γ,

$$R^{L,e} = \Gamma R,$$

and combining (36) and (38),

$$R^{L,K} = \frac{R^{L,e}}{rp} \frac{lev^e - 1}{lev^e \bar{\omega}^e}, \quad r^{L,K} = R^{L,K} / \pi.$$

Thus, from (44) and (45)

$$R^{L,WC} = R^{L,K}, \ r^{L,WC} = r^{L,K}.$$

From (10)-(18),

$$p^F = \left[\frac{1}{o_C} - \frac{1-o_C}{o_C} (p^H)^{1-\eta_C} \right]^{\frac{1}{1-\eta}},$$

$$p^I = [(1-o_I)(p^H)^{1-\eta_I} + o_I (p^F)^{1-\eta_I}]^{\frac{1}{1-\eta_I}},$$

$$p^G = [(1-o_G)(p^H)^{1-\eta_G} + o_G (p^F)^{1-\eta_G}]^{\frac{1}{1-\eta_G}}.$$

From (25), (32) and (7),

$$\tilde{p}^H = 1, \ \ \tilde{p}^F = 1, \ \ \tilde{w} = 1.$$

From (26), (34) and (8),

$$\Delta^H = (\tilde{p}^H)^{-\varepsilon_H}, \ \ \Delta^F = (\tilde{p}^H)^{-\varepsilon_F}, \ \ \Delta^W = \tilde{w}^{-\varepsilon_W}.$$

From (22)-(23), (30)-(31) and (5)-(6),

$$mc^H = \frac{\varepsilon_H - 1}{\varepsilon_H} \tilde{p}^H, \ \ mc^F = \frac{\varepsilon_F - 1}{\varepsilon_F} \tilde{p}^F, \ \ mc^W = \left(\frac{\varepsilon_W - 1}{\varepsilon_W} \right) \tilde{w}.$$

From (9),

$$h^d = h / \Delta^W.$$

From (28),

$$q = \frac{p^I}{\varpi}.$$

From (41),

$$r^K = q\left[rp \times r^{L,K} - (1-\delta) q \right].$$

From (19),

$$w = \left\{ \frac{\alpha^\alpha (1-\alpha)^{1-\alpha} p^H mc^H z a^{1-\alpha}}{(r^K)^\alpha [1 + \alpha_L^{WC} (R^{L,WC} - 1)]} \right\}^{\frac{1}{1-\alpha}}.$$

From (5),

$$f^W = \tilde{w}^{-\varepsilon_W} h^d mc^W / (1 - \beta\theta_W).$$

From (20),

$$k = \frac{\alpha a w h^d}{(1-\alpha) r^K}.$$

From (24),

$$y^H = z(k/a)^{\alpha} (ah^d)^{1-\alpha} / \Delta^H.$$

From (22),

$$f^H = mc^H (\tilde{p}^H)^{-\varepsilon_H} y^H / (1 - \beta\theta_H).$$

From (27),

$$i = k\left(\frac{1-(1-\delta)/a}{\varpi}\right).$$

From (29),

$$rer = mc^F p^F.$$

From (15)-(16),

$$x^{I,H} = (1 - o_I)\left(\frac{p^H}{p^I}\right)^{-\eta_I} i,$$

$$x^{I,F} = o_I \left(\frac{p^F}{p^I}\right)^{-\eta_I} i.$$

Let $mon \equiv \mu^e [r^K + (1-\delta)q]\frac{k}{a}\Phi(aux^1 - \sigma_\omega)$ be the monitoring costs payed in steady state. From GDP equal to value added, equivalent to (62), and (33),

$$p^Y y = p^H y^H + p^Y y s^{Co} + p^F (1 - mc^{F\text{”}\ F}) y^F - mon.$$

Using (63) and (14),

$$p^Y y = p^H y^H + p^Y y s^{Co} + p^F(1 - mc^F \Delta^F)$$
$$\left[o_C (p^F)^{-\eta_C} y^C + x^{IF} + o_G \left(\frac{p^F}{p^G} \right)^{-\eta_G} g \right] - mon.$$

Using (64),

$$p^Y y = p^H y^H + p^Y y s^{Co} + p^F(1 - mc^F \Delta^F)$$
$$\left[o_C (p^F)^{-\eta_C} (c + mon) + x^{IF} + o_G \left(\frac{p^F}{p^G} \right)^{-\eta_G} g \right] - mon.$$

Using (62),

$$p^Y y = p^H y^H + p^Y y s^{Co} + p^F(1 - mc^F \Delta^F)$$
$$\left[o_C (p^F)^{-\eta_C} (p^Y y (1 - s^{tb} - s^g) - p^I i + mon) \right.$$
$$\left. + x^{IF} + o_G \left(\frac{p^F}{p^G} \right)^{-\eta_G} \frac{p^Y y s^g}{p^G} \right] - mon.$$

Thus,

$$p^Y y = \frac{p^H y^H + p^F(1 - mc^F \Delta^F)[-o_C (p^F)^{-\eta_C}(p^I i - mon) + x^{IF}] - mon}{1 - s^{Co} - p^F(1 - mc^F \Delta^F) \left[o_C (p^F)^{-\eta_C} (1 - s^{tb} - s^g) + o_G \left(\frac{p^F}{p^G} \right)^{-\eta_G} \frac{s^g}{p^G} \right]}.$$

From $s^{tb} = tb/(p^Y y)$, $s^g = p^G g/(p^Y y)$, $s^{Co} = rer$ x $p^{Co*} y^{Co}/(p^Y y)$ and the exogenous process for g_t,

$$tb = s^{tb} p^Y y, \;\; g = \bar{g} = \frac{s^g p^Y y}{p^G}, \;\; y^{Co} = \bar{y}^{Co} = s^{Co} p^Y y / (rer \times p^{Co*}).$$

From (62),

$c = p^Y y - p^I i - p^G g - tb.$

From (64),

$y^c = c + mom.$

From (13)-(14) and (17)-(18),

$$x^{C,H} = (1 - o_C)(p^H)^{-\eta_C} y^C,$$

$$x^{C,F} = o_C (p^F)^{-\eta_C} y^C,$$

$$x^{G,H} = (1 - o_G)\left(\frac{p^H}{p^G}\right)^{-\eta_G} g,$$

$$x^{G,F} = o_G \left(\frac{p^F}{p^G}\right)^{-\eta_G} g.$$

From (57),

$$x^{H*} = y^H - x^{C,H} - x^{I,H} - x^{G,H}.$$

From (63),

$$y^F = x^{C,F} + x^{I,F} + x^{G,F}.$$

From (30),

$$f^F = mc^F (\tilde{p}^F)^{-\varepsilon_F} y^F / (1 - \beta\theta_F).$$

From (33),

$$m = y^F \Delta^F.$$

From (59),

$$y = c + i + g + x^{H*} + y^{Co} - m.$$

From (62),

$$p^Y = (c + p^I i + p^G g + tb)/y.$$

From (1),

$$\lambda = \left(c - \varsigma \frac{c}{a}\right)^{-1} - \beta\varsigma\left\{(ca - \varsigma c)^{-1}\right\}.$$

From (2),

$$\kappa = mc^{W}\lambda w / h^{\phi}.$$

From (54),

$$o^{*} = (x^{H*} / y^{*})(p^{H} / rer)^{\eta^{*}}.$$

From (61),

$$b^{*} = \bar{b}^{*} = \frac{tb - (1-\chi)rer \times p^{Co*}y^{Co}}{rer\left[1-(R^{*}+\xi)/(\pi^{*}a)\right]}.$$

From (38),

$$r^{Le} = \bar{\omega}^{e}\frac{[r^{K}+(1-\delta)q]k}{l}.$$

From (42),

$$n^{e} = \frac{qk}{lev^{e}}.$$

From (40),

$$l^{K} = qk - n^{e}.$$

From (39),

$$\iota^{e} = \left\{n^{e} - \omega^{e}\left([r^{K}+(1-\delta)q]kh(\bar{\omega}^{e},\sigma_{\omega})\right)\right\} / n^{e}.$$

From (51),

$$\omega = a\left(1-\iota\right) / \left[(r^{L,K}-r)lev + r\right].$$

From (46),

$$\rho^{N} = \frac{\beta}{a}\frac{1-\omega}{1-\beta\omega}r.$$

From (44),

$$\rho^{L} = \frac{\beta}{a}\frac{1-\omega}{1-\beta\omega}(r^{L,K}-r).$$

From (47),

$$\mu = \rho^L + \frac{\rho^N}{lev}.$$

From (21),

$$l^{WC} = \alpha_L^{WC}\left(wh + r^K \frac{k}{a}\right).$$

From (49),

$$l = l^{WC} + l^K.$$

From (50),

$$n = \frac{l}{lev}.$$

From (50),

$$d = l - n.$$

From (52),

$$spr = \frac{(R^{L,WC} l^{WC} + R^{L,e} l^K)}{l} \frac{1}{R}.$$

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Sterilized Foreign Exchange Interventions under Inflation Targeting

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Inflation targeting needs exchange rate flexibility. If the policy interest rate is geared to achieving the inflation target, the central bank must be willing to accept the resulting exchange rate. Simply put, if the central bank has both an inflation target and an exchange rate target, the private sector will not know which will take precedence in cases where they conflict; at most, therefore, the central bank should react to exchange rate movements only to the extent that they affect expected inflation.

In practice, however, emerging market economies have never followed this textbook approach. Regardless of their formal exchange rate regime, most emerging economy central banks do intervene in the foreign exchange markets. Against the backdrop of most modern models of open economies, this behavior by emerging economy central banks (including those with formal inflation-targeting frameworks) is puzzling. In these models, influencing the exchange rate without changing the monetary stance is neither feasible nor desirable. Such models typically assume that uncovered interest parity (UIP) holds.

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If that is the case, sterilized intervention will not have any effect on the exchange rate. The only tool for monetary policy is the policy rate—but that is already assigned to meeting the inflation target. Even in cases where it is possible to affect the exchange rate through sterilized intervention (for instance, because domestic and foreign assets are not perfect substitutes), doing so may not improve welfare.

In this paper, we examine whether such benign neglect is the optimal policy for inflation-targeting emerging market economies—and argue that it is not. In particular, there are reasons to question both the applicability of the standard model and its policy conclusions. In emerging economies, borrowing often involves currency mismatches, firms are more likely to be credit constrained, and financial fragilities are often present. When the exchange rate appreciates, the tradable sector will lose competitiveness. There are large adjustment costs associated with movements from the tradable to the nontradable sector. These costs cannot be avoided in the case of permanent shocks, but large sectoral reallocations can be inefficient if driven by temporary movements in the exchange rate. Sharp depreciations of the exchange rate can amplify financial fragilities in the presence of currency mismatches. For example, an otherwise profitable nontradable firm with foreign currency debt may become distressed if the local currency value of its liabilities were to increase sharply following a large depreciation. Currency mismatches are particularly dangerous if present in the banking system, and they can quickly become a source of systemic risk.[1]

Even if some management of the exchange rate may be desirable in emerging market economies, it does not necessarily follow that it is feasible (that is, without changing monetary policy). Again, there is a marked contrast between advanced economies (where sterilized intervention is rarely viewed as being effective) and emerging economies, where the very thinness of the currency markets, together with imperfect capital mobility and asset substitutability, means that sterilized intervention is more likely to be a viable policy tool. As an empirical matter, emerging economy central banks do undertake sterilized intervention, suggesting that they believe this instrument to be effective.

We conclude that some currency intervention is both desirable and feasible in emerging market economies. Consequently, even inflation-

1. For a detailed discussion of currency mismatches and their potential causes, see Chamon (2013).

targeting central banks in these countries should make use of both instruments—the policy interest rate and sterilized intervention—to achieve the inflation target while offsetting disequilibrium movements of the exchange rate. Crucially, the existence of two instruments—the policy rate and sterilized intervention—means that managing the exchange rate should not undermine the credibility of the inflation target; on the contrary, it may strengthen it.

The crux of our argument is laid out in the next section. We do not model the actual underlying channels through which sterilized intervention could have an impact on the exchange rate, which would be beyond the scope of this paper. Instead, we take the effect on the exchange rate as given and analyze how the presence of this second instrument affects policy decisions. We survey evidence on the effectiveness of sterilized intervention in emerging markets, since our argument is predicated on the central bank having two independent instruments. While the evidence is mixed, it is at least suggestive of the central bank's scope for influencing the path of the exchange rate. We then examine how the central bank would wish to deploy its two instruments in response to shocks under inflation targeting with or without sterilized foreign exchange intervention. Key results from our analysis are that intervention should only be used in the face of shocks that push the currency away from its medium-run warranted value; and that it should be two-way (that is, involving, at different times, purchases or sales of official reserves, with no net accumulation or loss). Such a strategy is not without costs or potential drawbacks, and these are discussed alongside the benefits. A final section draws out the main policy implications.

1. Two Targets, Two Instruments

Modern macroeconomics, dating back at least to the Mundell-Flemming-Dornbusch model (Flemming, 1962; Mundell, 1963; Dornbusch, 1976), tends to assume perfect capital mobility. That assumption is embodied in an uncovered interest parity (UIP) condition, which is one of the cornerstones of the open economy macroeconomic literature (for example, Obstfeld and Rogoff, 1995; Galí and Monacelli, 2005). With perfect asset substitutability, central bank swaps of assets can have no effect, and there is no role for sterilized intervention. An exception is Benes and others (2013), where sterilized interventions lead to deviations from UIP through portfolio effects in an otherwise standard new Keynesian framework. Moreover, in many modern models of advanced economies, welfare depends on inflation and the output gap (that is, the exchange rate only affects welfare through its impact on inflation and output), and there are no benefits from sterilized intervention even if it were possible. For example, in Galí and Monacelli (2005), the output gap is also stabilized when domestic inflation is stabilized, which a central bank with sufficient credibility can achieve with the interest rate alone (what Blanchard and Galí, 2007, call as divine coincidence). If that is the case, the resulting exchange rate fluctuations are equilibrium movements, and welfare would not be improved by smoothing them—so there is no need for a second instrument such as sterilized intervention.

The situation in emerging market economies may be quite different. First, even if divine coincidence holds for inflation and the output gap, there may be good reasons to try to offset large, temporary movements of the exchange rate from its medium-term equilibrium, as discussed in the introduction. The second crucial difference between advanced and emerging economies is that sterilized intervention is more likely to be an effective tool in the latter.

There are two main ways through which sterilized intervention (that is, purchases and sales of foreign exchange that leave the central bank's interest rate unchanged) can affect the exchange rate: the portfolio balance and the signaling channels. The former stems from the change in the relative supply of domestic and foreign currency assets following the intervention. If the two types of assets are perfect substitutes (that is, if uncovered interest parity holds), then changes in the relative supply would not affect the exchange rate. Under imperfect substitutability, the exchange rate adjusts as investors demand compensation to shift their portfolio holdings toward the asset that has become relatively more abundant. There are reasons to be skeptical about the quantitative importance of this channel in the case of advanced economies, where bond markets are so huge that even massive intervention barely makes a dent on the relative supply of assets (Ghosh, 1992), although the recent Swiss experience suggests that large-scale intervention can be successful even in a reserve currency (a signaling channel also helped achieve that outcome). In the case of emerging markets, however, interventions can amount to a significant share of local bond markets, and the portfolio balance channel can be stronger.

The signaling or expectation channel affects the exchange rate through a change in market expectations about future fundamentals (including the stance of monetary policy). If the central bank has better information about fundamentals (which is certainly the case, at least regarding the future stance of monetary policy), then intervention can be perceived as a signal of future exchange rate movements. The strength of that signal may depend on how sporadic or frequent interventions are. For example, all else equal, an intervention by a central bank that rarely intervenes may send a stronger signal than an intervention by a central bank that intervenes often. Unlike the portfolio balance channel, it is not clear a priori whether this channel should be stronger in emerging or advanced economies.

Figure 1 reports the size of reserves relative to different metrics for a sample of emerging economies in 2007 and 2012. The ratio of reserves to M2 (first panel) and reserves to GDP (second panel) are, on average, comparable between inflation-targeting and non-inflation-targeting countries, with inflation targeters being more likely to have experienced an increase in the ratio during that period. But perhaps the most indicative gauge for the potential strength of a portfolio balance effect is the ratio of reserves to domestic currency government debt (third panel). That ratio is above 50 percent for nine of the 12 inflation-targeting countries in that sample, and it is also large among nontargeters. Therefore, the portfolio balance channel of sterilized intervention is likely to be much stronger in emerging markets than in advanced economies. One crude measure of the extent of foreign exchange intervention is the standard deviation of the change in reserves relative to the sum of the standard deviations of the change in reserves and of the change in the real exchange rate. That ratio ranges from zero (when there is no intervention) to one (when there is no variation in the real effective exchange rate). The average of that ratio over 2007–12 is 0.62 and 0.76 among the inflation targeters and nontargeters in figure 1, respectively. Thus, not only is the stock of reserves comparable among targeters and nontargeters, but so is a measure, albeit crude, of activism in the use of foreign exchange intervention.

Sarno and Taylor (2001) provide a survey of the literature on sterilized intervention. The earlier literature, which typically focuses on advanced economies, generally concludes that sterilized intervention—except possibly by signaling future monetary policy—is unlikely to be effective in the advanced economy context, not least because the magnitude of outstanding assets means that the central bank would need to undertake implausibly large interventions to materially affect the exchange rate through any portfolio balance channel (Ghosh, 1992). The existing literature does suggest that such intervention is more likely to be effective in emerging than in advanced economies (especially the large reserve currency countries).

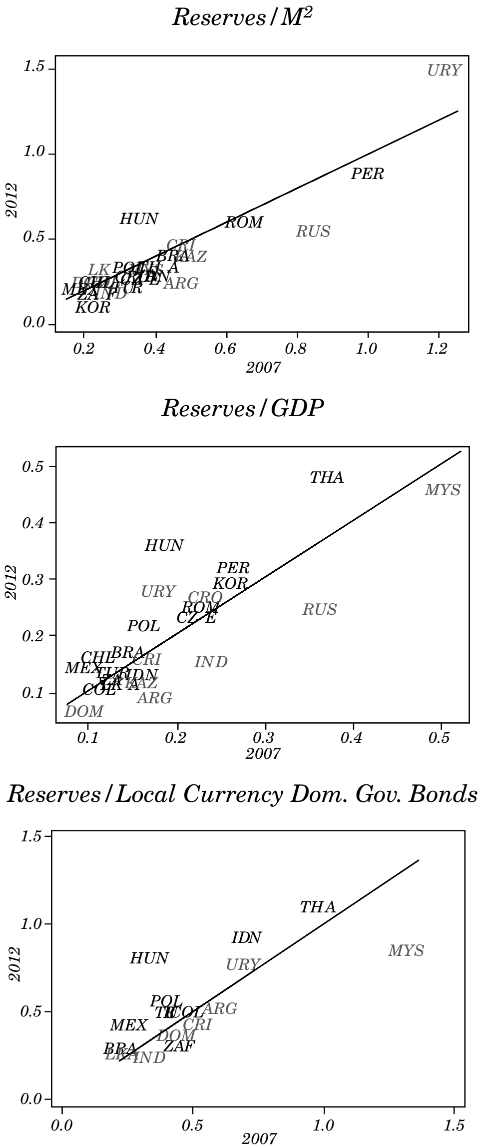
A number of empirical studies find evidence of an effect of sterilized intervention on exchange rates in emerging economies. Some of the countries for which an effect is found include Brazil (Stone, Walker and Yosuke, 2009); Chile (Tapia and Tokman, 2004); Colombia (Kamil, 2008); Czech Republic (Disyatat and Galati, 2005); India (Pattanaik and Sahoo, 2003); South Korea (Rhee and Song, 1999); Mexico and Turkey (Domaç and Mendoza, 2004; Guimarães and Karacadag 2004). Adler and Tovar (2011) analyze a cross-country sample of mainly Latin American countries and also find supportive evidence of an effect. Nordstrom et al. (2009) survey intervention practices in 14 inflation targeting emerging markets.

How does the use of both instruments (the policy rate and sterilized intervention) compare to the use of just the policy rate? To fix ideas, it is useful to contrast the response of the central bank to aggregate demand and capital inflow shocks under alternative policy regimes. If the economy exhibits divine coincidence (in the sense that the inflation target is consistent with a zero output gap) and the exchange rate does not affect welfare (other than through output and inflation), then inflation targeting would imply that the policy interest rate should be lowered in the face of capital inflows or negative shocks to aggregate demand. Under a floating exchange rate regime, the central bank does not intervene in the foreign exchange markets, allowing the exchange rate to appreciate when there are capital inflows and depreciate when there are negative demand shocks.

If policymakers do care about the exchange rate, can they do better than the strict inflation-targeting-cum-floating-exchange-rate regime implies? The answer is yes. Indeed, in a limiting case, there is a clear policy assignment rule: the interest rate should be used to meet the inflation target, while sterilized intervention should be geared to the exchange rate objective.[2] Thus, the policy interest rate would be lowered in the face of negative demand shocks but would not react to capital flow shocks, while intervention would be used to resist appreciation pressures from inflows and depreciation from negative demand shocks (depending on the cost of undertaking such an intervention). How extensively intervention is used will also depend on the costs associated with that instrument.

2. See De Gregorio (2010) for a discussion of the Chilean case.

Figure 1. Size of Foreign Exchange Reserves Relative to Different Metrics for IT and non-IT Emerging Markets



Notes: Inflation Targeting countries indicated by a black font; Non-Inflation Targeting countries indicated by a grey font. Peru and Russia are outside of the range in the third panel, and their ratios for 2012 were 293 and 364 percent, respectively.
Sources: IMF International Financial Statistics, World Economic Outlook, and IMF Desk Estimates.

Despite its simplicity, this argument embodies a basic truth: if policymakers have multiple objectives (which they surely do), and if the central bank has multiple instruments (which it probably has), then in general it makes sense to use the full set of available instruments. While it is difficult to argue against this point in the abstract, in our particular context, three objections can be raised: first, that modern emerging market central banks (like their advanced economy counterparts) are largely indifferent to the level of the exchange rate provided they are meeting their inflation objective; second, that central banks do not really have two instruments because sterilized intervention is ineffective; and third, that the flexibility afforded by an active exchange rate policy is not costless because it potentially sends confusing signals about the primacy of the inflation target, undermining its credibility.

On the first objection, while modern emerging market central banks can afford to ignore small movements in the exchange rate away from its equilibrium, there are a host of financial stability considerations involved in the case of a more significant misalignment, as discussed in the introduction. On the second objection, while the evidence on foreign exchange intervention remains mixed, in practice emerging market central banks do tend to intervene in the foreign exchange market regardless of their regime (as documented above). Implicitly, they must believe that such (costly) intervention is effective at least to some degree. Otherwise there would be no point in intervening.

Finally, on whether having a second policy objective undermines the credibility of the inflation target, we would argue that it does not—provided the central bank indeed has two instruments and clearly communicates the primacy of the inflation target over other objectives. In such a case, explicit recognition of the central bank's preferences over the exchange rate might actually strengthen the credibility of the central bank's inflation target. This is because policy is not made in a vacuum. When the exchange rate moves strongly out of line with fundamentals, the central bank inevitably comes under pressure to do something about it. Obstinately refusing to acknowledge the problem and the need for policy adjustments likely undermines policy credibility, because the public realizes that the stance is untenable. By acknowledging that the exchange rate has moved too far or too abruptly, and by openly undertaking foreign exchange intervention, an inflation-targeting central bank's claim that it will respect its inflation target arguably becomes more—not less—credible. At the same time, aiming for an exchange rate that deviates substantially from the level consistent with medium-term fundamentals (itself never easy to estimate) may have consequences for inflation that ultimately undermine the central bank's inflation target. This underscores the importance of limiting any intervention to instances where the exchange rate is clearly deviating from its medium-term warranted value.

Accepting the logic of this argument still leaves a number of complications that need to be taken into account. For example, sterilized intervention is not costless, so the central bank will not want to intervene in arbitrarily large amounts—especially if the intervention is not very effective or the inflows are highly persistent.

2. Inflation Targeting and Foreign Exchange Intervention

Given its objectives of maintaining low inflation and avoiding large movements in the exchange rate away from its medium-run equilibrium, what is the best policy regime for an emerging market central bank? While fully discretionary monetary and exchange rate policies allow maximum flexibility, they can also send confusing signals about central bank objectives that may ultimately undermine policy credibility. For this reason, the central bank may opt for an inflation-targeting regime, subordinating its monetary policy to achieving the inflation objective. If, as discussed above, emerging market central banks also have available a second instrument (foreign exchange intervention), they can limit temporary movements of the exchange rate without prejudicing attainment of their primary target, the inflation rate.

Here we consider how the central bank would respond to various shocks in a small open economy model of an emerging market economy with imperfect capital mobility, such that capital flows are specified as a partial adjustment process, responding positively to the interest differential (taking account of any expected appreciation of the currency), but at a finite pace:

$$\Delta k_t = \gamma_r \left(r_t - r_t^* + E_t \Delta e_{t+1} \right) - \gamma_k k_{t-1} \ ,$$

where e is the real exchange rate (an increase is an appreciation), r and r^* are the domestic and foreign real interest rates, and k is the stock of the foreign liability position. All variables are expressed in logs unless otherwise indicated, and all parameters (Greek letters) are positive. In a world without frictions, the capital stock should adjust instantaneously, arbitraging away any expected return differential, but we assume uncovered interest rate parity (UIP) does not hold (as is the case in practice, where, if anything, a currency tends to appreciate in the presence of an interest rate differential, the forward premium puzzle). Note that the term on the lagged stock of foreign liabilities implies that capital flows eventually stop even in the presence of a positive expected return differential.

Shocks to the foreign real interest rate can "push" capital flows, and these shocks are assumed to follow a first-order autoregressive, or AR(1), process:

$$r_t^* = \rho_r r_{t-1}^* + \eta_{r^*t} .$$

The remaining equations in the model follow standard assumptions. We assume the current account balance is inversely proportional to domestic demand and the real exchange rate, and that the current account balance plus capital flows is equal to the change in reserves:

$$\mathrm{CA}_t = -\varphi_e \; e_t - \varphi_y \; y_t$$

and

$$\mathrm{CA}_t + \Delta k_t = \sigma \Delta R_t ,$$

where CA is the current account balance, measured as a ratio to k, y is domestic demand, R is the stock of reserves, and $s = R/k$. Demand depends on the current real exchange rate and real interest rate (the IS curve), and inflation depends on expected future inflation and contemporary demand (the Philips curve):

$$y_t = -\varphi_r r_t - \varphi_e e_t + u_t ;$$

$$\pi_t = \beta E_t \pi_{t+1} + \kappa y_t .$$

The shocks to aggregate demand also follow an AR(1) process:

$$u_t = \rho_u u_{t-1} + \eta_{ut}.$$

The central bank's objectives, which are assumed to be the same regardless of the policy regime, are threefold: to minimize the deviation of inflation from its target; to minimize the output gap around the economy's potential level of output; and to minimize the deviation of the exchange rate from the level implied by its medium-term fundamentals.[3] Our assumption of costly exchange rate deviations is motivated by concerns about competitiveness on the appreciation side and balance sheet risks of unhedged foreign currency exposure on the depreciation side (which can also be present on the appreciation side, since the eventual depreciation toward the equilibrium can pose risks).[4] In principle, the risks from an overvaluation and an undervaluation are likely to be asymmetric, but for the sake of simplicity and modeling convenience, we treat the loss as symmetric. In addition, recognizing that there are costs to holding reserves, the central bank is assumed to minimize its accumulation of excess reserves (relative to the coverage required for country-insurance purposes).[5] Thus, the central bank's objective function is

$$\min_{r,R} \text{EPDV}\left[\left(y_t - \bar{y}_t^e\right)^2 + a\pi_t^{\,2} + be_t^{\,2} + cR_t^{\,2}\right],$$

where $\bar{y}_t^e$ is the public's estimate of the central bank's inflationary bias, and a, b and c are the parameters that determine the relative loss from inflation, exchange rate and reserve deviations from their steady-state values.

3. See De Paoli (2009) for a micro-founded model in which welfare would be captured by this objective function.

4. The central bank's objective can be specified as penalizing the (log) level deviation of the real exchange rate or its rate of change. Though conceptually distinct, it makes little qualitative difference to the simulations, as in either case the central bank seeks to limit the movement of the exchange rate. The reported simulations assume the targeting of the real exchange rate level around the value implied by medium-run fundamentals.

5. The literature typically assumes that the cost of holding reserves is given by the interest rate differential, but that comparison fails to take into account credit and currency risk (see Jeanne and Rancière, 2011, for a detailed discussion of the opportunity cost of reserves).

Under discretionary policies, the central bank is unable to commit to not trying to inflate the economy above its nonaccelerating inflation potential; a measure of the central bank's (lack of) credibility is the public's perception of its incentive to do so. The latter imparts an inflationary bias under discretion.

For simplicity, inflation targeting is modeled as a constraint that inflation must remain zero at all times. That is, the central bank commits to a lexicographical ordering of objectives such that its inflation target is always met (in the sense that target and expected inflation are equal). This keeps inflation expectations firmly anchored at $\pi = 0$ throughout, so there is no inflationary bias under inflation targeting.[6] In what follows, we restrict attention to inflation-targeting regimes, with and without foreign exchange intervention, and the objective function becomes

$$\min_{r,R} \text{EPDV}\left(be_t^{\,2} + cR_t^{\,2}\right),$$

subject to $\pi_t = 0$ for all t.

We calibrate the model assuming the following initial ratios and parameters:

—Capital flow parameters: $\gamma_r = 1.0$; $\gamma_k = 0.5$; $\rho_{r*} = 0.9$;

—Balance-of-payment parameters: $\phi_\varepsilon = 0.15$; $\phi_y = 0.3$; $\sigma = 0.5$;

—Inflation and aggregate demand parameters: $\beta = 0.99$; $\rho_u = 0.9$; $\varphi_r = 1.0$; $\varphi_e = 0.25$;

—Objective function weights: $a = 1.0$; $b = 0.1$; $c = 0.01$.

2.1 Benefits of Using Two Instruments

We initially consider the impact of a positive aggregate demand shock, equivalent to 2.5 percentage points of output, which occurs in period 1 and dies out gradually (figure 2). The central bank responds by raising the policy interest rate in order to cool domestic demand. Comparing the interest rate response across regimes shows that the central bank raises the interest rate more when it also intervenes in the foreign exchange market. The higher policy rate attracts capital inflows and appreciates the exchange rate. When the central bank intervenes, those appreciation pressures are attenuated, causing the

6. If inflation targeting was modeled in more flexible terms, for example as a range for inflation, then the central bank would have more flexibility to accommodate other objectives than in our setting.

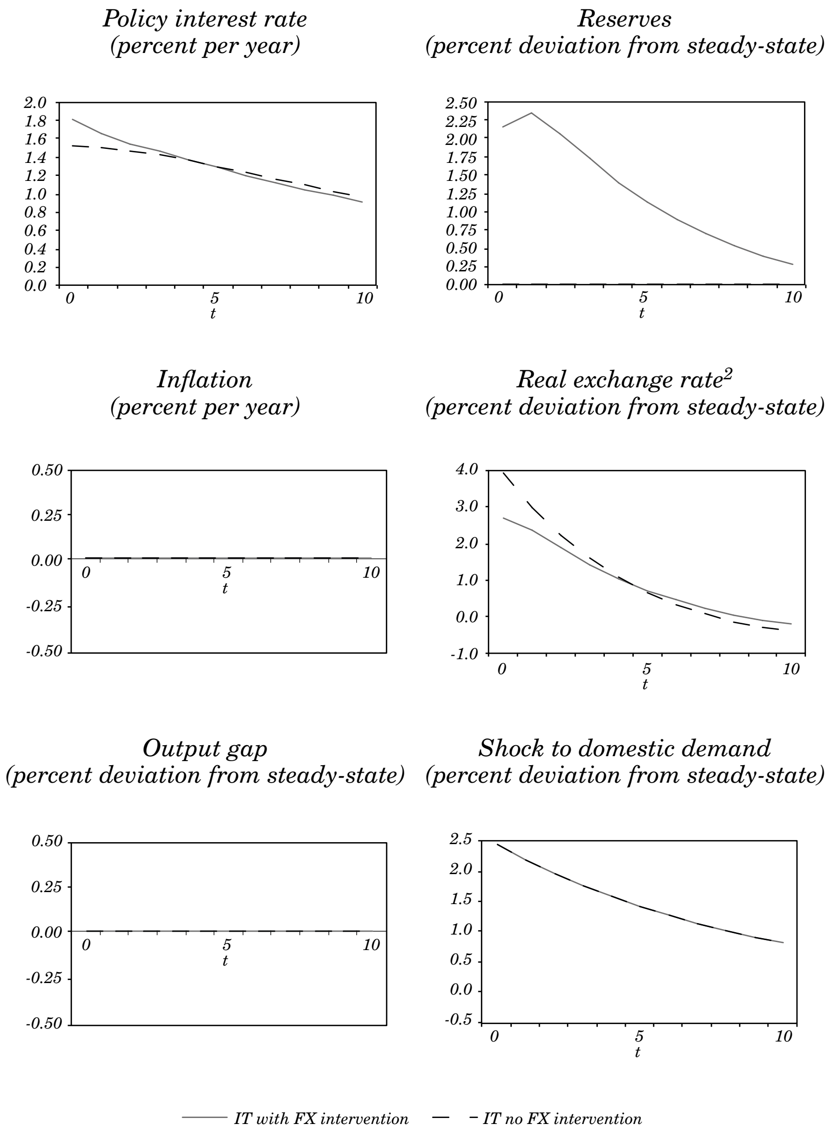
exchange rate to appreciate less even though the central bank raises the policy rate more when it also intervenes. The initial accumulation of reserves is gradually reversed, as they return to their steady-state value (normalized to zero). That is, the optimal response involves only a transitory accumulation of reserves, with no change in their steady-state stock.

A capital inflow shock is driven by an exogenous decline in foreign interest rates, which pushes capital into the domestic economy. That decline is also assumed to gradually reverse (figure 3), and the central bank responds by lowering the policy rate (so as to reduce the return differential and discourage flows) and accumulating reserves (in the regime where it intervenes). The central bank lowers the policy rate less when it also intervenes, but it is still able to achieve a lower appreciation of the exchange rate since sterilized intervention is helping to absorb part of the inflows. Inflation remains stabilized at its target under both regimes. Again, the build-up in reserves is temporary, with the initial accumulation being followed by a gradual reversal, as the stock of reserves reverts to its steady-state.

The use of reserves as a temporary tool is driven by the assumptions on the cost of reserves in our model. It is very costly to accumulate reserves in the steady-state, since that cost would be incurred in every period, so the build-up is temporary. Moreover, whereas the accumulation of reserves appreciates the exchange rate, the eventual decline in reserves will contribute to depreciation in the future, and that expectation will affect capital flows. As a result, reserve accumulation should be countercyclical. An attempt to depreciate the exchange rate by accumulating reserves in the absence of any shock would attract capital flows both because of the expectation of appreciation following the initial depreciation of the exchange rate and because of the increase in the policy rate required to meet the inflation target following that initial depreciation. If the cost of holding reserves was set to the return differential, which goes to zero in steady-state, then reserves would become costless in steady-state. That would lead to a much more aggressive use of that instrument. For the purposes of our model, setting the cost of reserves to a constant ensures that they remain costly in steady-state, which seems an empirically relevant assumption and yields more plausible results for the use of that instrument.[7]

7. While in our model both the domestic and foreign interest rates are zero in steady-state, in practice many emerging market economies have had interest rates persistently higher than the world interest rate. Capital flows would eventually converge to zero in our model even in the presence of a persistently higher domestic interest rate (because flows are assumed to depend negatively on the accumulated stock of foreign capital).

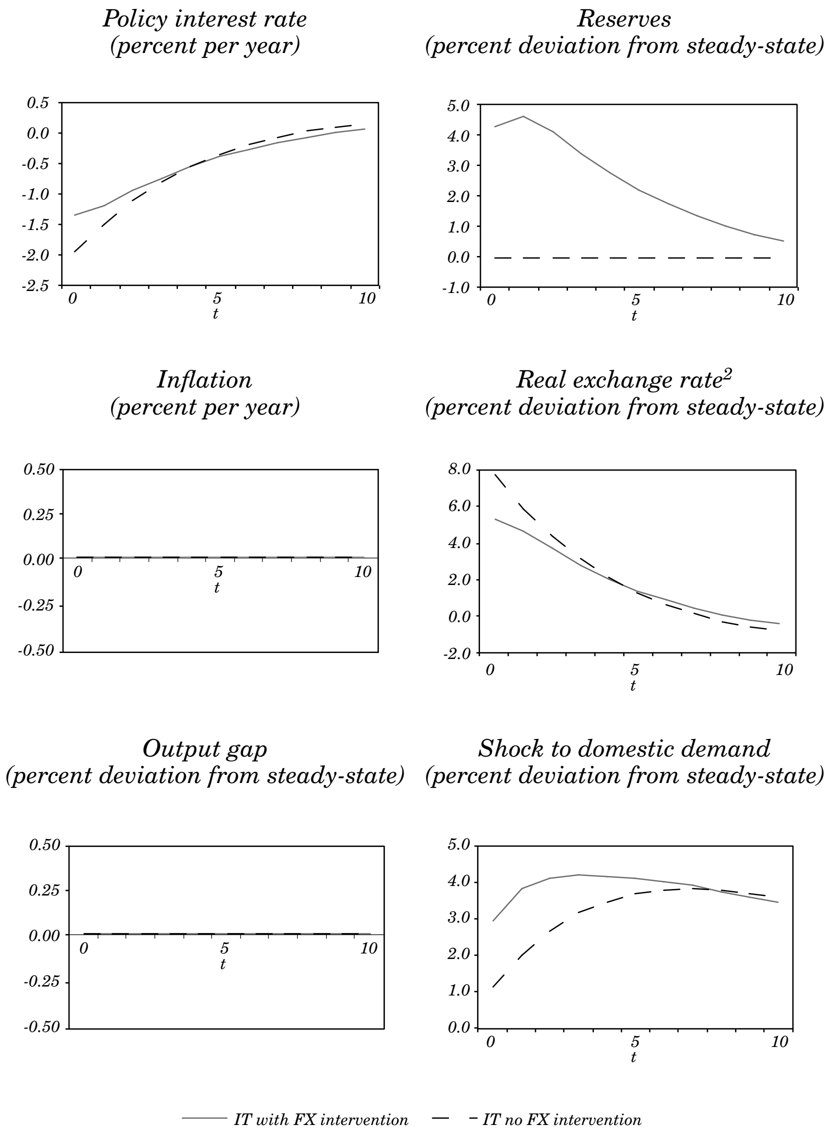
Figure 2. Policy Response to a Demand Shock[1]



1. The shock is based on a 2.5 percentage point increase in domestic demand.
2. An increase in the exchange rate is an appreciation of the domestic currency.

Source: Authors' elaboration.

Figure 3. Policy Response to a Capital Inflow Shock[1]



1. The capital inflow shock is based on a 5 percentage point decline in the world interest rate.
2. An increase in the exchange rate is an appreciation of the domestic currency.

Source: Authors' elaboration.

The central bank is able to deliver on its inflation target throughout. When it does not intervene, inflation is stabilized by the combination of a deeper cut in the policy rate and stronger appreciation. When it intervenes, the inflation target can be achieved by a smaller reduction in the policy rate and more modest appreciation. However, the more appreciated exchange rate in the nonintervention regime will lead to a lower welfare given the deviation of the exchange rate from its fundamental value. Thus, even though intervention is costly, the convex nature of that cost and objective function implies that it will always be optimal to deploy that additional instrument. Intervention will be deployed to a larger (smaller) extent when the cost is small (large), but the optimal response will always involve at least some intervention.

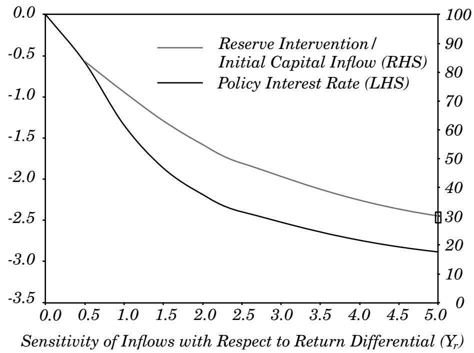
The benefits of sterilized intervention depend on the specific assumptions of the model. We illustrate this point by showing how the policy response varies depending on the sensitivity of flows to the return differential and the persistence of the capital flow shock.

Figure 4 plots the response of the policy rate and foreign exchange intervention as a function of the sensitivity of flows to the return differential (g_r). The higher that sensitivity, the larger the reduction in the policy rate in response to the inflow shock, and the smaller the size of the intervention (relative to the initial capital inflow). This sensitivity is the key parameter that determines how strong the deviation from UIP can be. The smaller that parameter, the larger the role for intervention. But the larger that parameter, the closer we approach a setting where UIP holds and intervention is not effective. In absolute terms, the effect of that parameter on intervention can be nonmonotonic: when that sensitivity is small, intervention is small because there is not much capital coming in to begin with. As that sensitivity increases, the capital inflow shock becomes stronger, which leads to more intervention in absolute terms (but corresponding to a smaller proportion of the capital inflow). For large enough values of that sensitivity, the amount of intervention starts to decline even in absolute terms, as we converge to the limit where UIP holds and intervention loses traction.

Figure 5 plots the response of the policy rate and foreign exchange intervention as a function of the persistence of the shock to the world interest rate. When that shock is relatively short-lived, the adjustment in the policy rate is small, and foreign exchange intervention plays a relatively large role in the response (helping absorb most of the initial inflows). But the larger the persistence of the shock, the stronger the adjustment in the policy rate and the smaller the intervention as a share of the initial inflows. This result emerges from the assumptions regarding the cost of foreign exchange intervention, which makes their sustained use very costly to the central bank. It also conforms to the usual intuition that an economy should adjust to permanent shocks (in this case a lower policy rate in response to persistently low world interest rates) but intervene to absorb transitory shocks that move it away from its equilibrium. While the logic is clear, in practice the central bank may have significant difficulty judging whether the shock is likely to be temporary or persistent, especially given its likely dependence on a host of factors, including global risk aversion and the behavior of monetary policy in industrial countries.

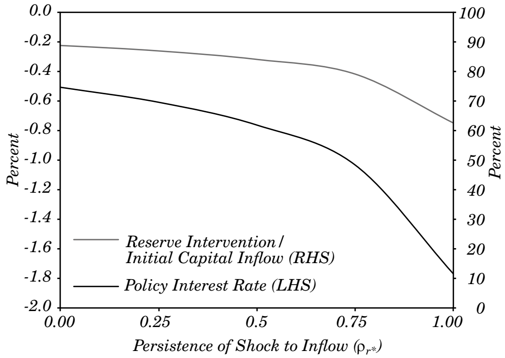
The discussion above pertains to capital inflows, though many of the same arguments apply to outflows (the response to an outflow shock is the mirror image of the response to an inflow shock of a similar magnitude). In the face of temporary capital outflows, the central bank would raise policy interest rates to keep the output gap at zero (and inflation at its target level), raising them more aggressively in the non-foreign-exchange-intervention regime. Despite the more aggressive interest rate policy, the central bank would need to tolerate a larger exchange rate depreciation when it does not intervene. Again, inflation targeting keeps the output gap at zero and inflation at its targeted level.

Figure 4. Policy Response and Sensitivity of Inflows with Respect to Return Differential (*)



(*) Response under an IT regime with FX intervention. The capital inflow shock is based on a 5 percentage point decline in the world interest rate. All parameters other than ρ_{r*} are kept constant at their baseline values.

Figure 5. Policy Response and Persistency of Inflow (*)



(*) Response under an IT regime with FX intervention. The capital inflow shock is based on a 5 percentage point decline in the world interest rate. All parameters other than ρ_{r*} are kept constant at their baseline values.

The logic of the simulations is thus symmetric to the case of capital inflows. Yet there is one crucial difference in that the central bank can run out of reserves, whereas there is no obvious limit to how much it can accumulate in the face of inflows. When it comes to outflows, therefore, it is particularly important to distinguish between temporary shocks and more persistent outflows, financing the former but relying more heavily on the policy interest rate for the latter (or just letting the currency depreciate). As in the case of capital inflows, an inflation-targeting central bank should only intervene when the exchange rate has clearly moved away from its medium-run equilibrium. If anything, the central bank will want to be especially cautious before intervening in the foreign exchange markets (as opposed to just raising interest rates) in the face of outflows, unless these are sufficiently large and abrupt (and perhaps more reflective of developments in capital-sending countries) that they threaten severe economic dislocation.

2.2 Some Costs

By construction, given our model's assumptions and the central bank's objective function, a policy of inflation-targeting-cum-sterilized-intervention is superior to inflation-targeting alone. In this setting, being able to optimize using two instruments will always yield a higher welfare than optimizing with a single instrument. It is important to recognize, however, that there is no time consistency/credibility problem in our model (any such problems are assumed to be addressed by the inflation-targeting framework).[8] In a richer setting, the use of the second instrument (namely, foreign exchange intervention) to help stabilize the exchange rate could lead the market to update its beliefs about the central bank's commitment to its inflation-targeting framework. While this can be a potentially large deterrent to the systematic use of the foreign exchange intervention as a second instrument, this need not be the case provided the central bank clearly articulates the primacy of its inflation objective.

There may be concerns about using two instruments in the face of real-time uncertainty. The central bank does not know with certainty what the equilibrium exchange rate is, whether the shocks it faces are persistent or transitory, and perhaps even how effective foreign exchange intervention is at affecting the exchange rate. This could lead to an outcome where the second instrument ends up being used less (or more) than it should have been and does not yield the desired effects. But similar challenges apply when the central bank implements inflation targeting with a single instrument. For example, any inflation-targeting central bank already has to take into account how persistent shocks to the exchange rate are likely to be, which affects their corresponding impact on future inflation. While the second instruments adds an additional dimension to this problem, limited real-time information is a challenge that central banks already have to cope with.

Another possible concern is that the use of foreign exchange intervention could affect investor behavior. A smaller adjustment in the policy rate (and smaller initial appreciation) provides investors with a larger expected return differential. In our model, the parameter that determines the sensitivity of flows to that return differential is fixed, but in practice, it may vary with the size of that differential. It may also vary with the risk around the expected return. Flows could respond to a decrease in that risk (for a given expected return differential). For example, if foreign exchange intervention succeeds in stabilizing the exchange rate despite a sizable interest rate differential, it could encourage more carry trade flows (since investors

8. Ghosh, Ostry and Chamon (2014) solve a two-period model with imperfect capital mobility, characterizing how welfare varies across regime (discretion versus inflation targeting) and use of foreign exchange intervention, as a function of the importance of shocks to capital flows and domestic demand and the degree of inflationary bias.

could reap the return differential while facing limited exchange risk). Similar concerns apply in the case of outflows, where intervention can facilitate capital flight, leading to a larger outflow than would be observed if the exchange rate was allowed to adjust more rapidly.

3. Conclusions

Inflation targeting has served well the many emerging market economies that adopted it. It helped them lower and stabilize inflation, and many central banks built their credibility around that framework. Even the emerging market inflation targeters that enjoy the most credibility would not contemplate abandoning that framework. At the same time, benign neglect of the exchange rate is not a viable option for most of these economies, where borrowing constraints, currency mismatches and other sources of financial fragility can compound the vulnerabilities caused by large swings in the exchange rate. Consequently, their inflation targeting needs to be sufficiently flexible to accommodate, at least to some extent, the smoothing of large shocks to the exchange rate. In this paper, we have argued that foreign exchange intervention can provide that needed flexibility.

Inflation-targeting emerging economies often intervene in the foreign exchange market. By many measures, they have intervened to a larger extent during the recent capital flow bonanza than their non-targeting counterparts. Since that intervention is often costly—at least if measured by the interest rate differential—these central banks must believe that intervention does have traction, or they would not pursue it. Some may worry that the use of foreign exchange intervention could eventually undermine the credibility of the inflation-targeting framework. In this paper, we have argued that that need not be the case, provided the central bank clearly communicates the primacy of its inflation target over the desire to stabilize shocks that move the exchange rate away from its fundamental value. Moreover, by acknowledging that a second instrument can be deployed (namely, foreign exchange intervention), the central bank can actually enhance its credibility, since the use of this second instrument provides more room to smooth shocks to the exchange rate in a way that is fully consistent with the inflation target.

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The Carry Trade in Industrialized and Emerging Markets

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The profitability of currency carry trades, in and of itself, is "economic" evidence against the uncovered interest parity (UIP) condition. There is a wide variety of "statistical" evidence against UIP. Yet, the relationship between these two types of evidence, and their implications for time variation in risk premia is not fully understood. Furthermore, most of the literature has focused on the currencies of industrialized economies. The failure of UIP in emerging market currencies, and its implications for the risk premia of these currencies, has received considerably less attention. In this paper I reconsider UIP, the carry trade, and the behavior of risk premia, and draw comparisons between currencies in industrialized economies and those in emerging markets.

Why should policy makers care about these questions? One reason is that some economists argue that central bank policy decisions play an important role in influencing capital flows. For example, Moutot and Vitale (2009), informally, and Plantin and Shin (2011), more formally, describe scenarios in which low interest rates in the world's larger economies cause capital to flow to smaller, higher interest rate economies. This capital tends to be inflationary, and leads inflation-targeting central banks in the small economies to raise interest rates, and this sets of a destabilizing spiral of further capital flows. A key aspect of these stories is that investors are chasing higher yields in the small economies believing that the yield spread reflects a positive

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expected return (or positive risk premium). This, in turn, requires that UIP does not hold. So, to assess whether there is a genuine policy problem, a better understanding of UIP and its implications for carry trades is important.

To summarize my findings, I confirm results, from many previous papers, that there are widespread "economic" and "statistical failures" of UIP for industrialized country currencies. I find that these failures appear to be linked, and that both reflect important time series variation in risk premia.[1] On the other hand, for emerging market currencies, I find stronger "economic" than "statistical" evidence against UIP. Additionally, because most emerging market currencies are persistently higher interest rate currencies, I find less compelling evidence that the average returns to carry trading in emerging markets are the result of time series variation in risk premia.

The UIP condition states that the interest rate differential between riskless assets, denominated in two currencies, is equal to the rate at which the higher interest rate currency is conditionally (and unconditionally) expected to depreciate against the lower interest rate currency. UIP has been widely tested in the literature, using regressions of changes in spot rates on interest differentials or, equivalently, forward premia. It has been widely rejected. This has led to the term "UIP puzzle" or "forward premium puzzle."

Several authors, e.g. Bilson (1981), Fama (1984), Bekaert and Hodrick (1992), Backus et al. (1993), and Engel (1996), have also studied the conditional expected payoff of bilateral exchange rate investments for groups of bilateral exchange rates. Here a numeraire currency is chosen, and the payoffs to long positions in the other currencies, financed by borrowing in the numeraire currency, are studied. In some cases, such as the tests performed by Fama (1984), there is one to one mapping between these tests and tests of UIP. In other cases, the tests involve projecting payoffs onto a wider variety of lagged variables. But once again, generally speaking, the literature has rejected the hypothesis that foreign currency investments have conditionally meant zero payoffs.

An additional fact about currency investments is that carry trades in currencies are profitable. This has been documented in a variety of ways by Burnside et al. (2006), Lustig and Verdelhan (2007),

1. In this paper, I use the term "risk premium" loosely. I *define* the risk premium as the conditional mean of the payoff to an investor's currency position, while ignoring possible transactions costs, and abstracting from any informational biases or frictions.

Villanueva (2007), Burnside et al. (2011b), Burnside et al. (2011a), Lustig et al. (2011), Burnside (2012), Menkhoff et al. (2012), Rafferty (2012), etc. In these carry trades, an investor specifically borrows a low interest rate currency in order to lend in a high interest rate currency. If investors were risk neutral—or even if UIP for some reason held despite risk aversion—the expected payoff on such trades would be zero, both conditionally and unconditionally, because these trades have a zero price.

In section 1, I revisit the statistical evidence against UIP. I do this using data for 18 industrialized economy currencies for samples of varying length in the period 1976 to 2013. I also study 25 emerging market currencies. The data for most of these currencies is available over a shorter time span. The literature has frequently emphasized negative slope coefficients in regressions of exchange rate changes on forward premia as a key component of the UIP puzzle. I find this characterization to be valid for the industrialized currencies, but only for a small subset of the emerging market currencies. Additionally, I find much less statistical evidence against UIP from "UIP regressions."

In section 2, I revisit the economic evidence provided by the profits of the carry trade. One of the advantages of economic evidence is that it can be aggregated across currencies by forming portfolios. As in previous work, I find that there are significant profits to carry trade investments formed using industrialized currencies. I also find significant profits associated with portfolios of carry trades involving emerging market currencies.

In section 3, like Hassan and Mano (2013), I explore the links between the statistical and economic evidence against UIP and the behavior of the risk premium. I find compelling evidence that the returns to the carry trade, at least for industrialized economies, are mainly due to the way in which this trade exploits time varying currency risk premia. I come to this conclusion by comparing the returns of standard carry trades and carry trades that hold static positions in each currency. Because most emerging market currencies are persistently "high interest rate," my method is not able to conclusively discern whether time varying premia are important for emerging market currencies. In a sense, the distinction between time variation and constant idiosyncratic risk premia is not important when forming carry trade portfolios in emerging market currencies.

In section 4, I consider risk-based explanations of the returns to carry trading measures of risk that have proven useful in the study of equity returns are insufficiently correlated with carry trade returns to explain the fact that carry trades are profitable. Borrowing the methodology of Lustig et al. (2011), for a panel of industrialized economies I show that a pair of risk factors, DOL and HML, usefully summarize most of the cross-sectional and time series variation in the returns to investing in these currencies.[2] I show, however, that these risk factors do not summarize the behavior of emerging market currencies. In particular, I show that these factors leave much more time series variation in the emerging market currencies unexplained. Additionally I show that there is insufficient cross-sectional variation in the exposure of emerging market currencies to HML to explain the cross-sectional variation in the returns to investing in emerging market currencies.

In section 5, I come back to the policy issue I highlighted above, and consider the role of interest rate spreads in determining capital flows. My discussion is limited to the correlation between interest rate differentials and the net positions taken by BIS reporting banks against foreign counterparties. The limited information I have from these data suggests that the quantitative association between bank capital flows and interest rate differentials is both small in the cross-section as well as in the time series dimension.

1. Uncovered Interest Parity and the Risk Premium

I start with a basic definition that is used throughout this paper. Ignoring transactions costs, the payoff to borrowing one U.S. dollar (USD) at time t in order to take a long position in a foreign currency is:

$$x_{t+1}^{L} = \left(1 + i_t^{*}\right)\frac{S_{t+1}}{S_t} - \left(1 + i_t\right), \tag{1}$$

where i_t is the rate of interest on riskless USD-denominated securities, i_t^{*} is the interest rate on riskless foreign denominated securities, S_t is the spot exchange rate expressed as USD per foreign currency unit (FCU).[3] Covered interest rate parity (CIP) implies that:

2. These risk factors are derived directly from currency returns, so there is a sense in which they reduce the dimensionality of the puzzle that carry trades are profitable on a currency-by-currency basis.

3. With this definition, X^L has a natural interpretation as the excess return to investing in foreign one-month treasury securities. Of course, if an investor has one dollar the first term, $(1+ i_t^{*})S_{t+1}/S_t$ is the gross return to investing that dollar in foreign short-term securities. So X^L can be interpreted as an excess return over the U.S. risk free rate.

$$\frac{1+i_t}{1+i_t^*}=\frac{F_t}{S_t}, \tag{2}$$

where F_t is the one period forward exchange rate expressed as USD per FCU. When CIP holds, we can equivalently rewrite equation (1) as

$$x_{t+1}^{L}=\left(\frac{S_{t+1}-F_t}{F_t}\right)(1+i_t), \tag{3}$$

I make frequent use of this definition throughout the paper.

If we assume that there is a stochastic discount factor (SDF) M_t, that prices foreign currency investments, then the payoff X_t^L, must satisfy:

$$E_t\left(M_{t+1}x_{t+1}^L\right)=0. \tag{4}$$

This follows from the fact that there is no up-front cost to the investment (it's price is zero).

I define the *risk premium* associated with the long position in foreign currency as $p_t = E_t(x_{(t+1)}^L)$, which, using equation (4), we can write as

$$p_t = -\frac{cov_t\left(M_{t+1},x_{t+1}^L\right)}{E_t\left(M_{t+1}\right)}. \tag{5}$$

The variable p_t is referred to as the conditional risk premium and corresponds to the conditional expectation of the payoff.

When investors are risk neutral, the SDF is constant over time ($M_t = M$ for all t), in which case $p_t = 0$ for all t. In this case equation (4) reduces to $E_t(x_{(t+1)}^L)$, , or, using equation (1):

$$\frac{E_tS_{t+1}}{S_t}=\frac{1+i_t}{1+i_t^*}. \tag{6}$$

Hence, if the foreign interest rate is higher than the U.S. interest rate, the foreign currency is expected to depreciate against the USD by the amount of the interest differential. This is the UIP condition.

Equivalently, equations (2) and (3) imply that the forward rate is an unbiased predictor of the future spot rate:

$$E_t(S_{t+1}) = F_t. \tag{7}$$

Another interesting special case is when the spot exchange rate is a martingale; i.e. $E_t(S_{t+1}) = S_t$. In this case, using equation (1), we see that the risk premium is equal to the interest differential:

$$p_t = E_t(x_{t+1}^L) = i_t^* - i_t. \tag{8}$$

Equivalently, using equation (3), we see that the risk premium is proportional to the forward discount of the foreign currency:

$$p_t = E_t(x_{t+1}^L) = \left(\frac{S_t - F_t}{F_t}\right)(1 + i_t). \tag{9}$$

The UIP condition, (6), is often tested using regressions that involve logarithmic approximations:

$$\Delta \ln S_{t+1} = a + b(i_t - i_t^*) + \varepsilon_{t+1}, \tag{10}$$

or

$$\Delta \ln S_{t+1} = a + b\ln(F_t / S_t) + \varepsilon_{t+1}. \tag{11}$$

When UIP holds, up to the log approximation, $plim\,\hat{a} = 0$ and $plim\,\hat{b} = 0$[4] if, instead, the logarithm of the spot exchange rate is a martingale, $plim\,\hat{a} = plim\,\hat{b} = 0$, rather than using this type of regression, I directly test the UIP condition by running the regression

$$x_{t+1}^L = \alpha + \beta\phi_t + \varepsilon_{t+1}, \tag{12}$$

where

$$\phi_t = \left(\frac{F_t - S_t}{F_t}\right)(1 + i_t) \tag{13}$$

4. An exact test could, instead, be based on the regression $\frac{S_{t+1} - S_t}{S_t} = a + b(\frac{i_t - i_t^*}{1 + i_t^*}) + \varepsilon_{t+1}$. Under the null hypothesis that UIP holds, $plim\,\hat{a} = 0$ and $plim\,\hat{b} = 0$.

is proportional to the forward premium of the foreign currency. If UIP holds, $plim\hat{\alpha} = plim\hat{\beta} = 0$, because X^L is conditionally (and unconditionally) mean zero. When $E_t(S_{t+1}) = S_t$, instead, we have $plim\hat{\alpha} = 0$ and $plim\hat{\beta} = -1$. Additionally, in any finite sample, we have $\hat{\alpha} \approx \hat{a}$, and $\hat{\beta} \approx \hat{b} - 1$.[5]

Estimates of equation (12) are shown in table 1 using both monthly data on spot and one-month forward rates. The data are sampled on the last business day of each month. The sample size used in these regressions varies by currency, depending on available data. For euro-legacy currencies, the sample usually begins in 1976 and ends in 1998 (see table 1A). I combine data for the Deutschmark (DEM) with data for the euro (EUR) and treat it as one currency. These data, and data for several other advanced economy currencies, run from 1976 to mid-2013, although the sample for Australia and New Zealand begins in the mid-1980s (table 1B). Data for emerging market currencies is generally available over a shorter sample, mainly beginning after 1996 and ending in 2013 (table 1C). For this reason, cross country comparisons of parameter estimates are non-trivial. I begin by simply reporting estimates over available samples and making broad qualitative comparisons. Figure 1 also summarizes the estimates of $\hat{\alpha}$ and $\hat{\beta}$ in a scatter plot. Estimates for a "G18" of industrialized economies appear as solid grey circles. Estimates for 26 emerging market (E26) currencies appear as open circles. When the joint null hypothesis that $\alpha = \beta = 0$ is rejected at the 5% level or less, the circle is surrounded by a box.

The estimates for the G18 and E26 currencies appear to have somewhat different characteristics. First, most of the point estimates for the G18 lie away from the origin, with sharply negative values of $\hat{\beta}$ in 12 of the 18 cases. In contrast, most of the estimates for the E26 currencies lie below but not far from the origin. Second, out of the G18 currencies, there are ten for which the null hypothesis of UIP is rejected. Of the remaining eight countries, six are euro-legacy currencies. On the other hand, for the E26 currencies, there are only eight currencies for which the null hypothesis is rejected.

There are at least two caveats to the tempting conclusion that emerging market currencies are different. First, consider a different null hypothesis where $\alpha = 0$ and $\beta = -1$. This hypothesis is rejected for only three of the G18 currencies and seven of the E26 currencies.

5. To see this, notice that $z^L_{t+1} \approx \Delta \ln S_{t+1} - \ln(F_t / S_t)$ and $\phi_t \approx \ln(F_t / S_t)$. If these equalities were exact we would have $\hat{\alpha} = \hat{a}$ and $\hat{\beta} = \hat{b} - 1$.

Table 1. Uncovered Interest Parity Regressions
A) Euro-Legacy Currencies

	$\alpha\times100$	β	R^2	(β=0)	(β=−1)	(*UIP*)	(*RW*)
ATS	0.318	-2.02	0.028	0.015	0.217	0.036	0.228
	(0.211)	(0.83)					
BEF	0.062	-1.46	0.014	0.034	0.502	0.065	0.696
	(0.213)	(0.69)					
FRF	0.012	-0.76	0.006	0.333	0.757	0.490	0.944
	(0.231)	(0.78)					
IEP	0.034	-0.49	0.003	0.617	0.604	0.733	0.837
	(0.279)	(0.98)					
ITL	-0.116	-0.76	0.012	0.083	0.591	0.099	0.415
	(0.276)	(0.44)					
NLG	0.339	-2.55	0.044	0.001	0.044	0.004	0.090
	(0.215)	(0.77)					
PTE	-0.153	-0.47	0.021	0.099	0.065	0.143	0.003
	(0.286)	(0.29)					
ESP	0.238	-0.13	0.001	0.787	0.076	0.266	0.133
	(0.300)	(0.49)					

Thus, it is difficult to reject that exchange rates are a martingale for most of the currencies in both samples. Second, the sample periods are quite different for the two sets of countries. To address this, I consider the sample period from 1997 to 2013 for both sets of currencies. For all practical purposes this eliminates the euro-legacy currencies from consideration leaving a G10 group. The G10 currencies are available for the full 1997 to 2013 sample period, while an E26 group of emerging country currencies is available for various subsets of this period. In this case, I find that the null hypothesis $\alpha=0$, $\beta=-1$ is rejected at the 5% level for eight of the G10 currencies, but only eight of the E26 currencies.

Sometimes, the fact that $\hat{\beta}$ is less than −1, or equivalently, that $\hat{b}<0$ when the regression is based on equation (10), for several currencies is interpreted as evidence that high interest rate currencies tend to appreciate relative to low interest rate currencies.

Table 1. Continued
B) Other Industrialized Economies

	$\alpha \times 100$	β	R^2	$(\beta=0)$	$(\beta=-1)$	*(UIP)*	*(RW)*
AUD	-0.161	-1.94	0.018	0.005	0.169	0.004	0.362
	(0.252)	(0.69)					
CAD	-0.048	-1.77	0.018	0.003	0.202	0.003	0.398
	(0.111)	(0.60)					
DKK	-0.030	-1.72	0.031	0.000	0.120	0.001	0.283
	(0.158)	(0.46)					
EUR/DEM	0.174	-1.98	0.014	0.016	0.231	0.053	0.407
	(0.191)	(0.82)					
JPY	0.696	-2.76	0.035	0.000	0.018	0.001	0.010
	(0.230)	(0.74)					
NOK	-0.052	-1.42	0.019	0.023	0.502	0.037	0.795
	(0.173)	(0.62)					
NZD	-0.170	-2.04	0.046	0.000	0.046	0.000	0.104
	(0.244)	(0.52)					
SEK	0.103	-0.07	0.000	0.913	0.137	0.749	0.330
	(0.168)	(0.63)					
CHF	0.593	-2.25	0.030	0.003	0.100	0.010	0.039
	(0.233)	(0.76)					
GBP	-0.269	-2.57	0.036	0.000	0.033	0.002	0.088
	(0.165)	(0.74)					

However, as Hassan and Mano (2013) point out, this interpretation is not directly warranted. Using equation (12) we have

$$\Delta \ln S_{t+1} - E(\Delta \ln S_{t+1}) \approx -(\beta+1)[i_t^* - i_t - E(i_t^* - i_t)] + \varepsilon_{t+1}. \qquad (14)$$

The fact that $\beta<-1$, by itself, only implies that when a country's interest differential is above its mean value, it's currency will tend to appreciate more (or depreciate less) than it does on average. Indeed, if we use equation (10) to infer general tendencies we have

$$E(\Delta \ln S_{t+1}) \approx \alpha - (\beta+1)E(i_t^* - i_t) \approx \alpha + (\beta+1)E[\ln(F_t / S_t)]. \qquad (15)$$

Clearly, β<−1 is not sufficient for currencies having a high interest rate (or having a negative average forward premium) to appreciate, on average. This also depends on the value of α. Figure 2 shows that, in fact, currencies that, on average, have high interest rates relative to the USD also, on average, depreciate against the USD.

Table 1. Continued
C) Emerging Market Currencies

	$\alpha \times 100$	β	R^2	(β=0)	(β=−1)	(UIP)	(RW)
ARS	-0.295	-0.91	0.626	0.000	0.342	0.000	0.013
	(0.173)	(0.10)					
BRL	-0.239	-1.84	0.030	0.038	0.343	0.001	0.333
	(0.811)	(0.88)					
CLP	0.166	-0.27	0.001	0.635	0.190	0.542	0.418
	(0.289)	(0.56)					
COP	0.373	0.01	0.000	0.988	0.007	0.334	0.020
	(0.323)	(0.37)					
HRK	-0.085	-2.14	0.031	0.033	0.257	0.077	0.507
	(0.331)	(1.00)					
CZK	0.300	-0.42	0.002	0.464	0.316	0.321	0.396
	(0.268)	(0.58)					
EGP	0.108	-0.77	0.329	0.000	0.014	0.000	0.048
	(0.100)	(0.09)					
HUF	-0.180	-1.34	0.008	0.113	0.685	0.009	0.905
	(0.637)	(0.85)					
ISK	-0.148	-0.58	0.001	0.822	0.870	0.925	0.696
	(1.336)	(2.57)					
IDR	-1.092	-2.06	0.053	0.096	0.392	0.225	0.211
	(0.678)	(1.24)					
INR	-0.165	-0.80	0.014	0.104	0.680	0.239	0.263
	(0.200)	(0.49)					
ILS	0.196	-0.33	0.001	0.756	0.523	0.441	0.746
	(0.266)	(1.05)					
KRW	0.338	0.59	0.012	0.351	0.012	0.374	0.029
	(0.293)	(0.63)					

This is true for 12 of the G18 currencies and 17 of the E26 currencies. Figure 2 also, however, shows that most currencies did not depreciate or appreciate as much, on average, as UIP would predict in our sample period. For 36 of the 37 currencies on the left side of the origin, $E(\Delta \ln S_{t+1})$ lies above the 45 degree line, while for three of the seven currencies on the right side of the origin, $E(\Delta \ln S_{t+1})$ lies below the 45 degree line.

Table 1. Continued

C) Emerging Market Currencies

	α×100	β	R^2	(β=0)	(β=−1)	(*UIP*)	(*RW*)
MXN	-0.156	-0.83	0.038	0.011	0.589	0.003	0.318
	(0.312)	(0.32)					
MAD	0.325	-0.01	0.000	0.994	0.265	0.378	0.428
	(0.278)	(0.89)					
MYR	-0.217	-0.69	0.012	0.437	0.729	0.285	0.420
	(0.167)	(0.89)					
MYR	0.234	-0.43	0.001	0.712	0.626	0.421	0.429
	(0.189)	(1.17)					
PHP	0.449	0.71	0.008	0.512	0.114	0.255	0.260
	(0.361)	(1.08)					
PLN	0.416	-0.18	0.001	0.621	0.029	0.039	0.030
	(0.424)	(0.37)					
RON	-0.103	-1.29	0.017	0.268	0.801	0.236	0.966
	(0.630)	(1.17)					
RUB	0.598	0.64	0.029	0.266	0.004	0.132	0.013
	(0.298)	(0.58)					
SGD	0.215	-1.41	0.013	0.070	0.600	0.192	0.141
	(0.139)	(0.78)					
THB	0.142	-0.16	0.001	0.806	0.201	0.653	0.286
	(0.159)	(0.66)					
TRY	-1.161	-2.03	0.115	0.001	0.100	0.000	0.237
	(0.711)	(0.63)					
TWD	-0.070	-0.48	0.007	0.200	0.159	0.184	0.368
	(0.128)	(0.37)					
ZAR	-0.104	-0.41	0.014	0.000	0.000	0.000	0.000
	(0.244)	(0.06)					

Figure 1. Regression Tests of Uncovered Interest Parity

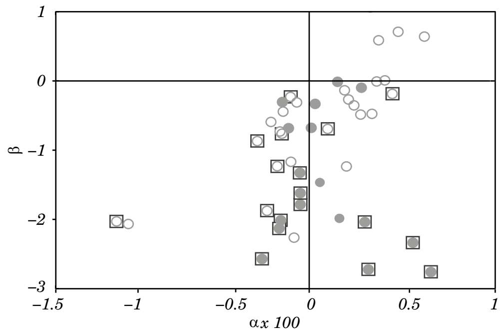
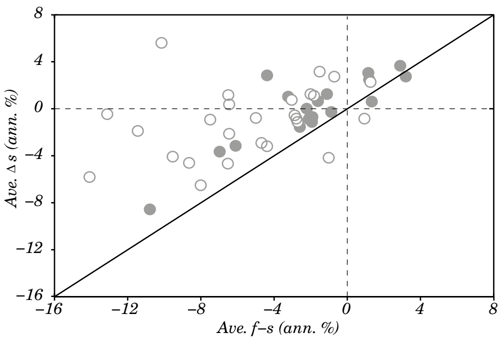
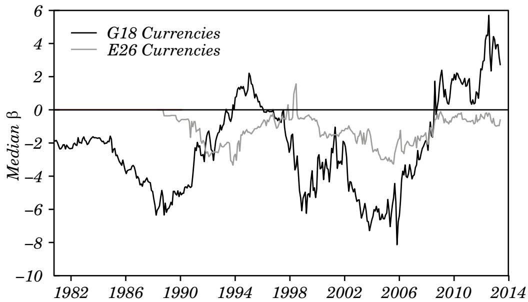


Figure 2. Average Rates of Appreciation and Forward Premia



Typically, estimates of β are unstable when they are estimated on rolling subsamples of the data. In figure 3, I illustrate this by showing the median estimates of β obtained using five-year rolling windows. The values of $median(\hat{\beta})_{G18}$ and $median(\hat{\beta})_{E26}$ are plotted as a time series, with the date on the horizontal axis being the end of the rolling window used in estimation. Estimates for the G18 currencies are highly volatile and, not surprisingly, persistent through time since the windows overlap. There is much less variation in $median(\hat{\beta})_{E26}$ than in $median(\hat{\beta})_{G18}$. Up to 2000, they appear to covary negatively, with the sign of the correlation changing thereafter.

Figure 3. Median Rolling Betas from UIP Regression



2. Carry Trade

2.1 Benchmark Carry Trade Strategies

As in Burnside et al. (2011a), Burnside et al. (2011b), and Burnside (2012), I define the payoff of a USD carry trade in currency j as:

$$x^C_{jt+1} = sign(i^*_{jt} - i_t)\left[(1+i^*_{jt})\frac{S_{jt+1}}{S_{jt}} - (1+i_t)\right] = sign(i^*_{jt} - i_t)x^L_{jt+1}. \qquad (16)$$

Under CIP, this is equivalent to defining

$$x^C_{jt+1} = sign(S_{jt} - F_{jt})x^L_{jt+1}. \qquad (17)$$

I measure the carry trade payoffs using equation (17), and implement the strategy currency-by-currency at the one month horizon. Statistics for these individual carry trades are provided in the appendix. To summarize them, nine of the G18 currencies have statistically significant positive average returns. Six of the E26 currencies have statistically significant positive average returns.

I also consider portfolios of carry trades. In particular, I define the payoff of an equally weighted carry (EWC) portfolio of all the individual currency carry trades as

$$x_t^{\text{EWC}} = \frac{1}{N_t} \Sigma_{j=1}^{N_t} x_{jt+1}^{C}, \tag{18}$$

where N_t is the number of currencies available in the sample at time t.

Table 2 provides summary information about the profitability of the EWC portfolio, depending on the set of currencies it includes, and depending on the sample period. Over the full sample (1976M1-2013M6) a portfolio based only on the G18 currencies earns an annualized average excess return of 4.5% with a standard deviation of 5.2%, and a Sharpe ratio of 0.87. If all currencies are used to define the equally-weighted portfolio, the average return is slightly lower (4.4%) but the standard deviation is lower still (4.8%), so the Sharpe ratio is higher (0.92). In each case, the average return and the Sharpe ratio are statistically significant at low levels of significance. It's useful to compare the performance of these portfolios to the U.S. stock market, which earned an average return of 6.9% in this period, with a standard deviation of 15.6%, and a Sharpe ratio of 0.45 (table 3).

It is impossible to define an emerging market portfolio over the full sample because the number of available emerging market currencies is zero until 1983 and is very small until the mid-1990s. Instead, for comparisons, I compute returns from the end of 1996 to 2013. Over this period the average returns to the G18 portfolio (3.7%) are similar to those of the E26 portfolio (3.8%), though the latter portfolio has more volatile returns, and has a smaller Sharpe ratio that is not quite significant at the 5% level. As it turns out, the portfolio that includes all currencies performs best of all. Its returns are higher (4.0%) because emerging currencies are given more weight towards the end of the sample when their performance improves. The Sharpe ratio for the combined portfolio is 0.80 and is statistically significant. Over the same period, as table 3 indicates, the U.S. stock market had an average excess return of 5.7%, a standard deviation of 16.6% and a Sharpe ratio of 0.34. Neither the average return nor the Sharpe ratio is statistically significant over this period.

The strong performance of the EWC portfolio over the full sample period is also illustrated in figure 4. Here I plot the cumulative returns to reinvesting all funds in a bank account in the EWC portfolio starting with \$1 in January 1976. By the end of June 2013, a carry trade investor would have had roughly \$32 in the account. An investor in the U.S. stock market, on the other hand, would have had roughly \$54. However, the investor in the stock market clearly faces the risk of persistently negative returns.

Table 2. Excess Returns to Equally-Weighted Carry Trade Portfolios

1976M1 - 2013M6	*Mean*	*SD*	*SR*	*Skew*	*Kurt*
G18 currencies	0.045	0.052	0.87	-0.55	3.84
	(0.009)	(0.004)	(0.19)	(0.35)	(1.37)
All currencies	0.044	0.048	0.92	-0.65	4.16
	(0.009)	(0.004)	(0.21)	(0.33)	(1.13)
1996M12 - 2013M6	*Mean*	*SD*	*SR*	*Skew*	*Kurt*
G18 currencies	0.037	0.054	0.68	-0.22	0.88
	(0.013)	(0.004)	(0.26)	(0.19)	(0.35)
E26 currencies	0.038	0.067	0.57	-0.34	3.26
	(0.018)	(0.008)	(0.31)	(0.34)	(1.07)
All currencies	0.040	0.050	0.80	-0.62	2.28
	(0.013)	(0.005)	(0.31)	(0.27)	(0.78)

Table 3. Excess Returns to Equally-Weighted Carry Trade Portfolios

	Mean	*SD*	*SR*	*Skew*	*Kurt*
1976M1 - 2013M6	0.069	0.155	0.45	-0.73	2.28
	(0.026)	(0.009)	(0.18)	(0.27)	(1.16)
1996M12 - 2013M6	0.056	0.165	0.34	-0.65	0.76
	(0.045)	(0.013)	(0.29)	(0.20)	(0.58)

Figure 5 compares the cumulative performance of the different carry trade strategies over the 1996-2013 sample. Once again, we see that the carry trade offers cumulative returns similar to the stock market without the same degree of volatility. An investor in the “All Currency” portfolio who starts with $1 in Dec. 1996, ends up with $2.87 at the end of June 2013. An investor in the U.S. stock market, in contrast, ends up with $3.09. The investor in stocks, however, twice sees his cumulative returns reduced to less than those of an investor in U.S. treasuries. There is, of course, a period from mid-1997 into early 1998 where an investor in the emerging market currencies suffers considerable losses, with the cumulative return falling to 0.83. This reflects losses from holding long positions in Asian currencies through the currency crisis of that period.

Figure 4. Cumulative Returns to Investment Strategies

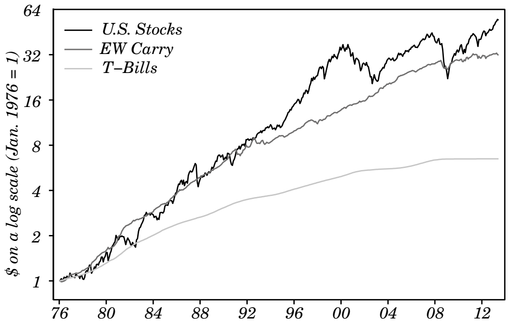
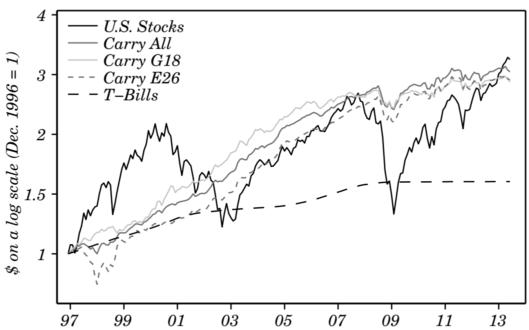


Figure 5. Cumulative Returns to Investment Strategies



2.2 Alternative Carry Trade Strategies

High-Minus-Low (HML)

I construct one alternative strategy as follows. At each point in time, I sort the currencies in my sample into five bins according to their forward discount against the USD. The USD is also included in the sorting with a forward discount of zero. The bins, labeled C1, C2, C3, C4 and C5 start from the currencies with the smallest forward discounts (lowest interest rates), and work up to the currencies with the largest forward discounts (highest interest rates). I then calculate the return to an equally weighted long position in the constituent currencies of each bin.[6] This is equivalent to calculating the average value of $(S_{t+1} - F_t)(1+i_t)/F_t$ for the currencies within the bin. The high-minus-low (HML) carry trade portfolio that I study involves investing 1 USD in C5 and −1 USD in C1. This strategy, compared to the EWC strategy, is dollar neutral, in the sense that the USD interest rate plays no special role in determining whether each of the other currencies appears as a long or short position, or not at all. Here the investor borrows funds in a group of low interest rate currencies to fund a position in high interest rate currencies. I form two versions of the HML strategy. One includes only the G18 currencies; one includes all the currencies in my sample.

Deutsche Bank-Mimicking (DBM)

I construct another alternative strategy to mimic the Deutsche Bank G10 Currency Future Harvest (DBCFH) index. The DBCFH index, which dates back to 1993, currently takes positions in up to six currencies from a list of ten. It is formed by taking equally-weighted long (short) positions in the three currencies with the highest (lowest) interest rates. Its currency composition is rebalanced quarterly. To mimic this index, I form an index using the same procedure as used for HML, but where the portfolio takes a long position in the top three deciles and takes a short position in the bottom three deciles in my interest rate sort. I rebalance the portfolio monthly, and refer to it as the DBM portfolio. I form two versions of the DBM strategy. One includes only the G18 currencies; one includes all the currencies in my sample.

Performance of the Alternative Strategies

As table 4 indicates, over the full sample, the HML carry trade strategy based on the G18 currencies had an average annual excess return of 6.7%, with a standard deviation of 9.3%, and a Sharpe ratio of 0.72. The DBM strategy, which is a more diversified close cousin of the HML strategy had a lower average return (5.8%), but was considerably less volatile (SD=7.5%) and so had a slightly higher Sharpe ratio (0.78). When the emerging market currencies are included in these portfolios their performance is considerably stronger with average returns rising to 9.0% and 7.1%, respectively,

6. This is, essentially, the same procedure used by Lustig et al. (2011) and Menkhoff et al. (2012).

and Sharpe ratios in excess of . These results should be treated with caution because both portfolios put heavy weight on relatively high interest rate emerging market currencies which may or may not be sufficiently liquid to absorb large speculative positions, and which may have had capital controls in place during the period I study.

2.3 Higher Moments of Currency Returns

Brunnermeier et al. (2008) note the saying among traders that "exchange rates go up by the stairs and down by the elevator." This refers to the skewness of payoffs to currency bets. Indeed, as can be seen in tables 2 and 4, most of the currency portfolios formed here have negatively skewed payoffs. Additionally, these payoffs display excess kurtosis with noticeable central peakedness. However, this evidence must be put in context compared to similar statistics for stock returns. As can be seen in table 3, U.S. stock returns are as skewed or more skewed than currency returns. They are also considerably more volatile. The worst monthly payoffs to stocks are also considerably more negative than those for currency returns. For example, over the full 1976 to 2013 sample, the worst payoff to any of the currency portfolios is −11%, for the HML-G18 portfolio in October 2008. The same portfolio lost more than 5% of its value in 17 out of 449 months in the sample. In contrast, the worst month for U.S. stocks was an excess return of −23% (October 1987), there were five months with returns less than −11%, and 43 months with returns less than −5%. Given this evidence, it is hard to argue that the observed skewness of currency returns, in and of itself, would deter investors from holding the portfolios discussed in this paper.

3. UIP, Carry Trade, and Currency Returns

As mentioned in section 1, if the UIP condition held, the conditional expectation for a long position in foreign currency would always be zero. That is, $E_t x^L_{jt+1} = 0$ for all j, t. In section 1, we documented the statistical failure of UIP for ten of the G18 currencies and eight of the E26 currencies based on standard "UIP (or forward premium) regressions." Additionally, we saw that the null hypothesis of a random walk was rejected for only three of the G18 currencies and eight of the E26 currencies. In a sense, section 2 also documents the failure of UIP. Why? Recall that all the strategies discussed in section 2 involve forming portfolios of positions in foreign currency.

Table 4. Excess Returns to Alternative Carry Trade Portfolios, 1976M1 - 2013M6

HML Carry	*Mean*	*SD*	*SR*	*Skew*	*Kurt*
G18 currencies	0.067	0.093	0.72	-0.31	2.63
	(0.016)	(0.006)	(0.19)	(0.31)	(0.92)
All currencies	0.090	0.083	1.08	-0.38	1.32
	(0.014)	(0.004)	(0.19)	(0.17)	(0.38)
DBM Carry	*Mean*	*SD*	*SR*	*Skew*	*Kurt*
G18 currencies	0.058	0.075	0.78	-0.54	2.51
	(0.013)	(0.005)	(0.20)	(0.27)	(0.75)
All currencies	0.071	0.067	1.06	-0.37	1.99
	(0.011)	(0.005)	(0.20)	(0.20)	(0.51)

These portfolios are formed based on information available to the investor at time t, and their payoffs are all linear combinations, across j, of the currency-level payoffs x^L_{jt+1}. Hence, each of these portfolios as well as the individual currency carry trades should have an expected payoff of zero under UIP. What we found, however, is that for several currencies, average carry trade returns were significantly positive in our sample. Secondly, we found that several portfolios of carry trades were highly profitable in our sample. Since this should not be the case under UIP, our evidence in section 2 constitutes a strong rejection of UIP.

In this sense, the failure of UIP and the returns of the carry trade are clearly intimately related. However, it isn't entirely clear what aspect of the failure of UIP is linked to the returns of carry trading. Are carry trades profitable because risk premia are constant or close to constant? Or is time variation in risk premia responsible for these returns?

To shed light on these questions consider, once more, the definition of the risk premium associated with a long position in currency j: $p_{jt}=E_t x^L_{jt+1}$. This means we can write

$$x^L_{jt+1} = p_{jt} + \varepsilon_{jt+1}$$

with $E_t \varepsilon_{jt+1} = 0$. Now let

$$p_{jt} = p_j + p_t + v_{jt},$$

where p_j is some constant, p_t is a time varying component with zero mean, and v_{jt} is a currency-and-time varying component with zero mean. Therefore $E(x^L_{jt+1}) = p_j$. I now try to assess to what extent the carry trade profits reflect constant risk premia that vary across currencies (i.e., the p_j term), common risk premia that vary over time (i.e., the p_t term), or idiosyncratically time-varying risk premia (i.e., the v_{jt} term).

To assess the nature of risk premia, I consider currency strategies of the following kind. An investor takes a long position in a foreign currency if an observable variable z_{jt} lies in some set, otherwise he takes a short position. In particular, I consider strategies that can be defined as follows

$$x_{jt+1} = \begin{cases} x^L_{jt+1} & if \quad z_{jt} > 0 \\ -x^L_{jt+1} & if \quad z_{jt} \leq 0. \end{cases}$$

What is the expected payoff of this strategy? It is

$$E(x_{jt+1}) = -\Pr(z_{jt} \leq 0)E(x^L_{jt+1} \mid z_{jt} \leq 0) + \Pr(z_{jt} > 0)E(x^L_{jt+1} \mid z_{jt} > 0).$$

Because z_{jt} is in the time t information set

$$E(x_{jt+1}) = -\Pr(z_{it} \leq 0)E(p_{jt} \mid z_{jt} \leq 0) + \Pr(z_{jt} > 0)E(p_{jt} \mid z_{jt} > 0). \qquad (19)$$

Because

$$E(p_{jt}) = \Pr(z_{jt} \leq 0)E(p_{jt} \mid z_{jt} \leq 0) + \Pr(z_{jt} > 0)E(p_{jt} \mid z_{jt} > 0)$$

we can solve for

$$\Pr(z_{jt} \leq 0)E(p_{jt} \mid z_{it} \leq 0) = E(p_{jt}) - \Pr(z_{jt} > 0)E(p_{jt} \mid z_{jt} > 0).$$

Using this expression in equation (19), we get

$$E(x_{jt+1}) = 2\Pr(z_{jt} > 0)E(p_{jt} \mid z_{jt} > 0) - E(p_{jt}). \qquad (20)$$

If the risk premium is time invariant, so that $p_{jt}=p_j$ for all t then $E(p_{jt} \mid z_{jt}>0) = E(p_{jt})=p_j$. Then the expected payoff of any strategy of the type described above is

$$E(x_{jt+1}) = \left[2\Pr(z_{jt} > 0) - 1\right] p_j. \tag{21}$$

A Static Carry Trade Strategy

Suppose $z_{jt} = z_j = E(S_{jt} - F_{jt})$, the mean of the forward discount for currency j. This means the investor goes long currency j *always* if, *on average*, it is at a forward discount. In this case, since z_{jt} is time invariant, the probability in the expression for profits is 1 if $E(S_{jt} - F_{jt}) > 0$ and 0 if $E(S_{jt} - F_{jt}) \leq 0$ and expected profits are just

$$E(x_j^{\text{STATIC}}) = sign[E(S_{jt} - F_{jt})]p_j.$$

This strategy is profitable if a country's mean forward discount, $E(S_{jt} - F_{jt})$, has the same sign as its constant risk premium p_j. In other words, if a country has a high interest rate and a positive risk premium, then the strategy is profitable.

As it turns out, for most currencies, the static carry trade is profitable as illustrated by figure 6. The solid grey dots in the figure are G18 currencies, the open dots are E26 currencies. The average forward discount for most (37 of 44) currencies is positive, and for all but one of these currencies the average payoff to being long, i.e. the risk premium, is also positive. For the seven currencies with a negative average forward discount only three have negative risk premia.[7] Summary statistics for an equally weighted portfolio of all the static strategies are found in table 5. Over the full sample the mean annualized payoff to the static G18 carry trade is 1.8%, with a Sharpe ratio of 0.44. For all currencies, it is 2.3%, with a Sharpe ratio of 0.52. All of these statistics are significant at the 5% level. Over the 1996-2013 sample we see some contrast between results for the G18 and E26 currencies. For the G18 currencies, the average payoff is just 1.0% in this period, while for E26 currencies it is 4.2% and statistically significant.

7. It is important to keep in mind that we can really only execute the static carry trade ex-post using an estimate of $E(S_{jt} - F_{jt})$ for each currency. This is arguably not a problem since the exercise here is not to study the static carry trade as an investment strategy, per se. Rather, it is to use the hypothetical payoffs to static trade to help discern the nature of the risk premium.

Figure 6. Mean Forward Discounts and Payoffs to Static Carry Trade

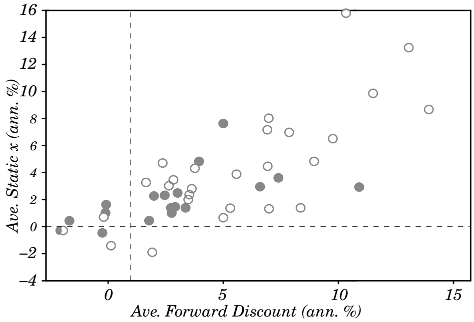


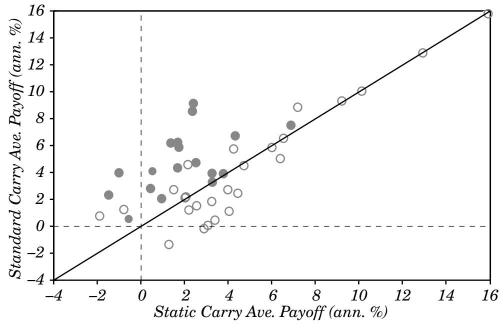
Table 5. Excess Returns to Static Carry Trade Portfolios

1976M1 - 2013M6	*Mean*	*SD*	*SR*	*Skew*	*Kurt*
G18 currencies	0.018	0.041	0.44	-0.61	4.62
	(0.008)	(0.003)	(0.21)	(0.53)	(2.57)
All currencies	0.023	0.045	0.52	-0.75	4.76
	(0.009)	(0.004)	(0.21)	(0.47)	(1.84)
1996M12 - 2013M6	*Mean*	*SD*	*SR*	*Skew*	*Kurt*
G18 currencies	0.010	0.028	0.35	-0.30	0.79
	(0.007)	(0.002)	(0.24)	(0.29)	(0.88)
E26 currencies	0.042	0.070	0.59	-0.63	2.68
	(0.019)	(0.008)	(0.31)	(0.30)	(0.80)
All currencies	0.032	0.044	0.73	-0.98	3.53
	(0.012)	(0.005)	(0.33)	(0.40)	(1.32)

Standard Carry Trade

Now suppose $z_{jt} = S_{jt} - F_{jt}$, the forward discount for currency j at time t. The investor goes long currency j if it is *currently* at a forward discount. This is standard carry trade described in section (2.1).

Figure 7. Static and Standard Carry Trade Payoffs



What are the expected profits associated with this strategy? Since we are currently assuming that the true risk premium is constant we simply use equation (21) which becomes

$$E(x_j^{\text{STD.}}) = \left[2\Pr(S_{jt} - F_{jt} > 0) - 1\right] p_j.$$

Notice that if currency j is sometimes at a forward discount and sometimes at a forward premium the probability in this expression lies strictly between 0 and 1. In this case, if $sign[E(S_{jt} - F_{jt})] = sign(p_j)$ we have

$$E(x_j^{\text{STD.}}) < E(x_j^{\text{STATIC}}).$$

In other words, if the static carry trade is profitable, and risk premia are constant, the standard carry trade should be less profitable than the static carry trade.

Looking currency-by-currency figure 7 plots the sample mean of $x_j^{STD.}$ against the sample mean of x_j^{STATIC}. If risk premia are constant the null hypothesis is that the points in this figure should lie below the 45 degree line. As it turns out, there is a stark contrast between the results for the G18 currencies and those for the E26 currencies. For most of the G18 currencies the null hypothesis seems to be incorrect as most of the points lie above the 45 degree line. A standard carry trade strategy is more profitable than a static one. On the other hand, for the E26 currencies most of the points lie below the 45 degree line or on the 45 degree line. The points on the 45 degree line correspond to currencies that were always at a forward discount in sample. Consequently, the static and standard carry trade are equivalent and our test has no power to distinguish between time varying and constant risk premia.

The overall picture left by figure 7 is that the comparison between static and standard carry trade allows us to reject the notion that risk premia are constant for the G18 currencies, but not for the E26 currencies. Indeed, if we formally test the null hypothesis that $E(x_j^{STD.}) < E(x_j^{STATIC})$ for each of the G18 currencies, it is rejected at the 5% level for six of them, and at the 10% level for a further six. It is only rejected for four of the E26 currencies.

If we look at portfolio returns, the results are even sharper, as indicated by a comparison of tables 2 and 4. Over the full sample, and over the 1996-2013 sample, there is a 2.7% gap between the returns to the standard EWC-G18 strategy, and an equally-weighted portfolio of static strategies. The difference is statistically significant at less than the 1% level over the full sample, and at the 5% level over the shorter sample. The results also suggest that the constant components of the risk premia account for no more than 40% of the overall returns to the carry trade. Over the 1996-2013 sample, in contrast, the returns to the standard EWC-E26 strategy are actually lower, though not significantly so, than those of an equally-weighted portfolio of static strategies. While our test does not rule out the possibility that currency risk premia are time varying in emerging markets, this time variation may not be that important in determining the *average* profits to carry trades in these currencies.

Returning to the UIP regressions, as specified in equation (12), notice that we can rewrite the equation as

$$p_j + p_t + v_{jt} + \varepsilon_{jt+1} = \alpha_j + \beta_j \phi_{jt} + \varepsilon_{jt+1}. \tag{22}$$

Clearly, the mean of the risk premium does not affect the slope coefficient in this regression. The slope coefficient reflects the covariance between the time varying components and the forward premium of currency j:

$$\beta_j = \frac{cov(p_t, \phi_{jt}) + cov(v_{jt}, \phi_{jt})}{var(\phi_{jt})}. \tag{23}$$

Unfortunately, UIP regressions do not make it straightforward to determine the separate roles of p_t and v_{jt}.

If risk premia were purely constant, clearly the typical UIP regression would result in a constant $\alpha_j = p_j$ and $\beta_j = 0$. Going back to the evidence in table 1, this is not what we find from typical UIP regressions, most especially for the G18 currencies. For 12 of these currencies we can reject $\beta_j = 0$ at less than the 5% level, and for two more we can do so at the 10% level. For the E26 currencies, β is significantly different from 0 in seven cases, and borderline so in four more. So the strongest evidence against the constant risk premium is for the G18 currencies.

4. Risk Exposure of Carry Trades

A number of explanations of the returns to the carry trade have been explored in the literature. Perhaps the most obvious explanation is that carry trades are risky, and that UIP fails in empirical tests because investors are risk averse. In this case the UIP condition, (6), does not hold, and is replaced by its risk-adjusted equivalent, equation (4).

While the literature has sought risk-based explanations for the returns to the carry trade, these have only met with a modest degree of empirical success. According to standard asset pricing theory, zero price investments, such as the carry trade, should have risk-adjusted conditional means equal to zero. That is, $E_t(M_{t+1}x_{t+1})=0$, where x_{t+1} is the payoff to the investment and M_{t+1} is some measure of risk. Using the law of iterated expectations it follows that

$$E(Mx)=0 \tag{24}$$

Much of empirical finance is devoted to models in which the measure of risk, M, is specified to be linear in one or more risk factors. For example, suppose we let

$$M_t = \xi\left[1-\left(f_t-\mu\right)' b\right], \tag{25}$$

where ξ is a scalar, f_t is a kx1 vector of risk factors, $\mu= E(f_t)$, and b is a kx1 vector of parameters. Given the normalization $\xi=1$, equation (24) implies that

$$E(x)=cov(x,f)b \tag{26}$$

or

$$E(z) = \underbrace{cov(x,f)\Sigma_f^{-1}}_{(\beta)} \underbrace{\Sigma_f b}_{(\lambda)}, \tag{27}$$

where Σ_f is the covariance matrix of f_t. Equation (27) is the beta representation of the model. Equation (26) tells us that if risk explains the returns to the carry trade then there should be some risk factors, *f*, that are correlated with those returns. As Burnside et al. (2011a), Burnside et al. (2011b) and Burnside (2012) point out, however, standard measures of risk, such as stock returns, stock market volatility, consumption growth, and many more, are approximately uncorrelated with, or insufficiently correlated with, the returns to carry trade strategies such as the EWC, HML, and DBM strategies discussed above.[8]

Another approach is to construct "risk factors" from currency returns themselves. For example, Lustig et al. (2011) construct portfolios of currency similar to the portfolios C1, C2, C3, C4 and C5 that I constructed above. They use the payoff to an equally-weighted long position in all foreign currencies (*vis-a-vis* the USD), denoted DOL, and the payoffs to the HML strategy as risk factors to explain the cross-section of returns to the C1-C5 portfolios. It turns out that the five portfolios have very similar exposures to DOL, but very different different exposures to HML. This can be seen in table 6 which shows estimates of β for the two-factor DOL-HML model. The betas with respect to DOL are all close to 1, while the betas with respect to HML rise from a low value of −0.52 for the C1 portfolio to a high value of 0.48 for the C5 portfolio. Additionally, the R^2 statistics in table 6 indicates that DOL and HML can explain a great deal of the time variation in the returns to C1 through C5. Estimates of the SDF [equation (26)] and beta [equation (27)] representations for this model are found in table 7. To evaluate the estimated model there are at least three standard metrics. First, the *b* and λ coefficients associated with the HML factor are statistically significant. Second, as indicated by the R^2-statistic the model-predicted expected returns, $\hat{\beta}\hat{\lambda}$, explain 84% of the cross-sectional variation of the average returns in the data ($\bar{z}$).

8. By "uncorrelated" and "insufficiently correlated" I mean the following. Given estimates of the risk premia (λ) associated with the risk factors, the betas (β) of the carry trade portfolios with respect to the factors are either statistical zeros or they are statistically significant but too small to explain the expected returns.

Finally, because the model has less parameters than moment restrictions the *J*-statistic indicates that the model is marginally rejected at the 5% level. This is mainly due to the large pricing error associated with the C2 portfolio.

Table 6. Excess Returns to Static Carry Trade Portfolios (*)

Portfolio	*Mean Return*	*DOL*	*HML*	R^2
C1	-0.9%	0.98*	-0.52*	0.94
	(1.8)	(0.02)	(0.02)	
C2	-0.9%	0.86*	-0.09*	0.79
	(1.6)	(0.03)	(0.03)	
C3	2.1%	0.90*	0.03	0.87
	(1.7)	(0.02)	(0.02)	
C4	3.1%	0.94*	0.08*	0.86
	(1.6)	(0.02)	(0.02)	
C5	5.8%	0.98*	0.48*	0.94
	(2.0)	(0.02)	(0.02)	

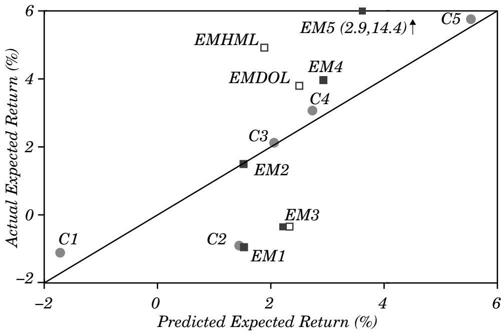
(*) February 1976 to June 2013. The table reports estimates of the equation $z_t = a + f_t' \beta + \varepsilon_{(t+1)}$, where z_t is the monthly excess return of each of the portfolios indicated and f_t is a 2×1 vector of the indicated risk factors. The DOL factor is the average excess return to an equally weighted portfolio of long positions in all the available G18 currencies. The HML carry portfolio is the excess return to being long portfolio C5 and short portfolio C1. Heteroskedasticity consistent standard errors are in parentheses. Slope coefficients that are statistically significant at the 5 percent level are indicated by an asterisk (*).

Table 7. GMM Estimates of Linear Factor Models for the Sorted G18 Currency Portfolios

	b	λ	R^2	*J*	*Pricing Errors* (α)				
		(%)			*C1*	*C2*	*C3*	*C4*	*C5*
DOL	1.77	0.17	0.84	7.97	0.8%	-2.0*	0.1	0.6	0.4
	(1.95)	(0.13)		(0.047)	(0.4)	(0.7)	(0.6)	(0.6)	(0.5)
HML	8.10*	0.59*							
	(2.06)	(0.13)							

(*) February 1976 to June 2013. Test assets are the sorted currency portfolios C1-C5. The DOL factor is the average excess return to an equally weighted portfolio of long positions in all the available G18 currencies. The HML carry portfolio is the excess return to being long portfolio C5 and short portfolio C1. The table reports first stage GMM estimates of the SDF parameter, *b*, and the factor risk premia, λ, reported in monthly percent. The R^2 is a measure of fit between the mean excess returns and the predicted mean returns. Test statistics, *J*, for the overidentifying restrictions are also reported. The annualized pricing errors of the S1-S5 portfolios (α) are reported (in percent). Heteroskedasticity consistent standard errors are in parentheses, except for the *J* statistics, for which the *p*-value is in parentheses. An asterisk (*) indicates statistical significance at the 5 percent level.

Figure 8. Actual and Model-Predicted Expected Returns for the DOL-HML Mode



The DOL-HML model leaves unexplained by the HML strategy, itself, is profitable, but it suggests that we can understand most of the behavior of the five G18 portfolios through a further understanding of DOL and HML.

An obvious question, then, is whether the factors that seem to explain the returns to portfolios of developed country currencies also explain the returns to investing in emerging market currencies. With this question in mind, I first form an equally-weighted portfolio of long-positions in the E26 currencies, which I refer to as EMDOL. I also form five portfolios on the basis of each period's forward discount versus the U.S. dollar, which I refer to as EM1, EM2, EM3, EM4 and EM5. When I regress the returns to these portfolios on the DOL and HML factors, I find that DOL is significant but the coefficients are much smaller than is typically the case for the G18 currencies (table 8). I find, consistent with the G18 currencies, that the coefficients on HML are small for the lower interest rate portfolios and larger for the high interest rate portfolios. But I also find the R^2-statistics in these time series regressions to be much smaller than for the G18 currencies. There seems to be significant time series variation in the values of the E26 currencies that is not captured by the DOL and HML factors. I also use the estimated values of λ obtained using the G18 currencies (found in table 7) to check whether the DOL-HML model correctly prices the five emerging market currency portfolios and EMDOL. It does not. To see this, consider

Table 8. Factor Betas of Emerging Market Currency Portfolios

Portfolio	*Mean Return*	*DOL*	*HML*	R^2
EMDOL	3.8%	0.63*	0.13*	0.58
	(2.2)	(0.05)	(0.04)	
EM1	-0.9%	0.50*	0.03	0.60
	(1.5)	(0.04)	(0.03)	
EM2	1.5%	0.56*	0.07	0.41
	(2.2)	(0.05)	(0.04)	
EM3	-0.3%	0.71*	0.12*	0.43
	(2.6)	(0.06)	(0.05)	
EM4	4.0%	0.69*	0.17*	0.49
	(2.5)	(0.07)	(0.04)	
EM5	14.4%	0.53*	0.25*	0.25
	(3.2)	(0.09)	(0.09)	

January 1997 to June 2013. The table reports estimates of the equation $z_t = a + f_t'\beta + \varepsilon_{(t+1)}$, where z_t is the monthly excess return of each of the portfolios indicated and f_t is a 2×1 vector of the indicated risk factors. The DOL factor is the average excess return to an equally weighted portfolio of long positions in all the available G18 currencies. The HML carry portfolio is the excess return to being long portfolio C5 and short portfolio C1. Heteroskedasticity consistent standard errors are in parentheses. Slope coefficients that are statistically significant at the 5 percent level are indicated by an asterisk (*).

Figure 8 which plots actual expected returns, $\bar{z}$ (vertical axis), against model predicted expected returns, $\hat{\beta}\hat{\lambda}$ (horizontal axis). Figure 8 illustrates two issues. First, the highest interest rate portfolio, EM5, is clearly a different animal. The average return in the data is very high compared to any of the other portfolios, but its exposure to HML is similar to that of the other portfolios. Second, because the EM portfolios all have similar exposures to HML the model explains very little of the cross-sectional variation in their returns.

One interesting possibility is that an investor might be tempted to borrow the low interest rate EM currencies in order to go long the high interest rate EM currencies. For now I will leave aside the EM5 portfolio since it frequently contains currencies with very high interest rates. Instead I consider the return to being long the EM4 portfolio and short the EM1 portfolio. This EMHML portfolio earned a 4.9% annual return in sample, with a standard deviation of 6.9%, and an annualized Sharpe ratio of 0.71. This portfolio has a DOL beta equal to 0.19 and an HML beta equal to 0.14, so from the perspective of the DOL-HML model it should only have an expected return of 1.4% per year. One reason this strategy is so profitable and has such a high Sharpe ratio is that the exchange rates in the EM1 and EM4 portfolios are highly correlated in the time series (they have a correlation of 0.71). Consequently, an investor who goes long one portfolio and short the other hedges considerable common comovement against the dollar.[9]

5. Bank Capital Flows and Interest Differentials

As I mentioned in the introduction, one view of policy making in small open economies is that the central bank's decisions play an important role in determining capital flows because of a variety of market frictions. Moutot and Vitale (2009) imagine a scenario in which investors in a large economy with low interest rates are attracted to a higher prevailing interest rate in a small open economy. This leads to a sort of feedback loop in which the resulting capital flows gradually appreciate the exchange rate, create inflationary pressure, thus causing the central bank in the recipient country to raise rates, thus causing more inflows, etc. Plantin and Shin (2011) provide a more formal model that captures the same idea. In their model, sluggish exchange rate dynamics resulting from infrequent portfolio rebalancing, combined with an inflation targeting central bank, lead to similar feedback loop. The model predicts that bubbly equilibria can emerge in which the exchange rate appreciates for a while and then reverts sharply towards its fundamental value. The policy angle provided by their analysis is that the stronger the central bank's response to inflationary pressure, the more likely are realized paths with occasional sharp depreciations of the recipient economy's currency.

To briefly evaluate these ideas, I consider the correlation between interest rate differentials and the net positions taken by BIS reporting banks against foreign counterparties. For each country in my sample, I measure these net positions on a quarterly basis and express their annual averages as a proportion of GDP. I examine data from 1990 to 2012, although the sample depends on the availability of forward discounts for the recipient countries. Similarly, I measure the average forward discount (or interest differential) of each of the countries in my sample. I then regress the BIS bank net positions on the forward discounts to obtain some notion as to the sensitivity

9. I am grateful to my discussant, Rodrigo Valdés for suggesting that I examine a "within EM" trading strategy like this one.

of capital flows to the spreads. When I include no other regressors, the results suggest that when the interest rate spread rises by 1 percentage point, the position of BIS banks rises by 0.79 percent of GDP against the recipient country. This strikes me as a relatively small value. When I include country fixed effects in the analysis the estimate shrinks to 0.26 percent of GDP. When I also include time dummies in the analysis the estimate shrinks to 0.08 percent of GDP and is statistically insignificant.

I do not think these results are conclusive, but they at least cast doubt on the hypothesis that widening interest rate spreads attract massive capital inflows. It could, for example, be the case that the BIS data do not reflect the type of "hot money" capital inflows that are most relevant to the policy question. Additionally, in my sample period there were significant changes in international financial markets. Capital flows to emerging markets have increased significantly in the past decade and the relevance of carry trade to these markets has probably increased with them.

6. Conclusion

In this paper, I revisited the evidence regarding the UIP puzzle and carry trade profitability, with an emphasis on a comparison between a group of industrialized-country and emerging market currencies. I found that there is less regression-based evidence against UIP in emerging markets but carry trades in these currencies are nonetheless profitable.

The returns to investing in industrialized economies' currencies are well summarized in the cross-section and time dimension by two risk factors, DOL and HML. However, these risk factors are much less successful in explaining the returns to emerging market currencies both in the time dimension and cross-section. Additional factors seem to be at work.

Interest rate spreads attract carry trade investors. Policy makers are often concerned that the resulting capital flows could be destabilizing. I briefly consider how sensitive capital flows are to interest rate differentials by looking at their association with the net investment positions of BIS banks. Although I find a statistically significant association the effect is quantitatively small.

APPENDIX

I use data from Reuters/WMR and Barclays (available from Datastream) for spot and forward exchange rates. There are eight euro-legacy currencies: ATS, BEF, FFR, ITL, NLG, PTE, ESP (available Jan 1976–Dec 1998) and IEP (Apr 1979–Dec 1998). I treat the DEM and EUR as one currency (available Jan 1976–Jun 2013). I define the rest of the G18 currencies as CAD, DKK, NOK, SEK, CHF and GBP (Jan 1976–Jun 2013), JPY (Jun 1978–Jun 2013) and AUD and NZD (Dec 1984–Jun 2013).

The E26 currencies, with start dates indicated, are ZAR (Jan 1984), SGD (Dec 1984), MYR (Dec 1984–Aug 1998), IDR, THB (Feb 1995), PLN (May 1995), MXN (Sept 1995), CZK (Jun 1996), TWD (Oct 1996), PHP (Dec 1996), INR, KRW (Mar 1997), COP, HUF (Oct 1997), CLP (Jan 1998), ILS (Aug 2000), ARS, BRL, TRY (Jan 2003), HRK, EGP, ISK, MAD, RON, RUB (Mar 2004), and MYR (Jul 2005). All end dates are Jun 2013 except as indicated for MYR. I treat the second sample for MYR as a separate currency.

For all currencies most data prior to Dec 1996 is taken from Reuters/WMR GBP quotes on Datastream, although data for some currencies (AUD, NZD, SGD, MYR, ZAR), is taken from Barclays USD quotes on Datastream. Data after Dec 1996 is mainly taken from Reuters/WMR USD quotes on Datastream. Additionally, some data from J.P. Morgan is used to fill in data for some emerging market currencies both before and after Dec 1996. I use the risk free rate from Kenneth French's database as a measure of the U.S. interest rate.

Table 1. Average Payoffs to Individual Currency Carry Trades

A) euro-Legacy Currencies				*B) Other Industrialized Currencies*			
	Mean	*SD*	*SR*		*Mean*	*SD*	*SR*
ATS	0.023	0.117	0.20	AUD	0.065	0.121	0.54
	(0.027)	(0.006)	(0.23)		(0.024)	(0.009)	(0.21)
BEF	0.081	0.115	0.70	CAD	0.021	0.067	0.31
	(0.024)	(0.006)	(0.21)		(0.011)	(0.005)	(0.17)
FRF	0.060	0.110	0.55	DKK	0.085	0.109	0.78
	(0.024)	(0.005)	(0.22)		(0.019)	(0.005)	(0.18)
IEP	0.063	0.111	0.57	EUR/DEM	0.045	0.138	0.32
	(0.028)	(0.006)	(0.25)		(0.024)	(0.023)	(0.15)
ITL	0.029	0.108	0.27	JPY	0.027	0.119	0.22
	(0.025)	(0.007)	(0.23)		(0.021)	(0.006)	(0.18)
NLG	0.036	0.117	0.31	NOK	0.051	0.106	0.48
	(0.027)	(0.006)	(0.23)		(0.018)	(0.005)	(0.17)
PTE	0.034	0.112	0.31	NZD	0.073	0.126	0.58
	(0.026)	(0.006)	(0.24)		(0.026)	(0.010)	(0.21)
ESP	0.034	0.112	0.30	SEK	0.063	0.109	0.57
	(0.029)	(0.007)	(0.26)		(0.017)	(0.006)	(0.17)
				CHF	0.005	0.124	0.04
					(0.022)	(0.006)	(0.17)
				GBP	0.048	0.105	0.46
					(0.017)	(0.006)	(0.16)

Table 1. Continued

C) Emerging Market Currencies							
	Mean	*SD*	*SR*		*Mean*	*SD*	*SR*
ARS	0.091	0.089	1.02	MXN	0.060	0.104	0.58
	(0.026)	(0.029)	(0.21)		(0.025)	(0.010)	(0.28)
BRL	0.158	0.152	1.04	MAD	0.009	0.090	0.10
	(0.055)	(0.017)	(0.41)		(0.029)	(0.010)	(0.32)
CLP	-0.001	0.115	0.00	MYR	0.008	0.085	0.09
	(0.028)	(0.013)	(0.24)		(0.026)	(0.020)	(0.31)
COP	0.023	0.119	0.19	MYR	0.015	0.067	0.23
	(0.033)	(0.011)	(0.28)		(0.020)	(0.008)	(0.29)
HRK	0.005	0.111	0.04	PHP	0.021	0.089	0.23
	(0.037)	(0.011)	(0.33)		(0.024)	(0.013)	(0.29)
CZK	0.057	0.129	0.44	PLN	0.054	0.136	0.40
	(0.029)	(0.008)	(0.22)		(0.028)	(0.012)	(0.21)
EGP	0.101	0.041	2.49	RON	0.083	0.140	0.59
	(0.019)	(0.006)	(0.50)		(0.049)	(0.013)	(0.37)
HUF	0.065	0.144	0.45	RUB	0.025	0.105	0.24
	(0.037)	(0.015)	(0.28)		(0.034)	(0.016)	(0.33)
ISK	0.020	0.162	0.12	SGD	0.010	0.056	0.18
	(0.059)	(0.034)	(0.38)		(0.009)	(0.005)	(0.15)
IDR	0.048	0.283	0.17	THB	0.050	0.113	0.45
	(0.066)	(0.070)	(0.25)		(0.029)	(0.027)	(0.31)
INR	0.025	0.071	0.35	TRY	0.127	0.150	0.85
	(0.017)	(0.008)	(0.25)		(0.052)	(0.016)	(0.36)
ILS	0.001	0.087	0.02	TWD	-0.013	0.057	-0.23
	(0.024)	(0.008)	(0.27)		(0.014)	(0.006)	(0.23)
KRW	0.013	0.151	0.08	ZAR	0.010	0.155	0.07
	(0.034)	(0.028)	(0.23)		(0.030)	(0.011)	(0.19)

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Spillovers to Emerging Markets during Global Financial Crisis

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At the heart of the debate on how the 2007–09 global financial crisis spread from the United States to the rest of the world lies the global banks. Using a large sample, composed of advanced and emerging economies since the 1980s, Abiad and others (2013) show that the effect of financial linkages on output comovements during normal times is the opposite of the effect during crises. During tranquil periods, increased financial linkages induce greater output divergence, since capital is better able to move to where it is most productive.[1] During the global financial crisis, financial linkages contributed to the spread of financial stress across borders, but other factors such as global panic, increased uncertainty and wake-up calls that changed investors' perceptions acted as a common shock and played a much larger role in increasing output synchronization.

In this paper, we explore the main channels that caused the transmission of the global crisis from advanced countries to emerging markets. Since this crisis was not an emerging market crisis, it is important to understand how it spilled over to these economies: whether via conventional linkages like banking and trade or through the means of a global panic. Understanding the mechanisms is more important than ever in light of the potential spillovers from upcoming changes in U.S. monetary policy.[2] For our empirical analysis, we use a unique bilateral panel data set of cross-border banking linkages from the Bank for International Settlements (BIS) for 17 advanced

1. These results were first established by Kalemli-Özcan, Papaioannou and Peydro (2013) and Kalemli-Özcan, Papaioannou and Perri (2013), using data for advanced countries only.

2. In May–June of 2013, indications of tapering by the U.S. Federal Reserve caused a massive capital outflow from emerging markets.

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and 11 emerging economies, with data on their business cycles. Our data starts in 1977 and ends in 2012, thus covering several episodes of financial crises, including the 2007-09 global crisis. Emerging market data start in the late 1980s or early 1990s for most of our emerging markets.

A key challenge is to isolate spillovers from shocks that are common to all countries. There is a lack of systemic evidence linking financial globalization with output decline. This finding could reflect the fact that there are no spillovers via financial linkages or that the 2007–09 global crisis might have been a large common shock. For example, Acharya and Schnabl (2010) show that all big international banks had positions with similar risk profiles before the crisis, making the rollover of their debt quite hard when they started experiencing losses and hence causing a large common financial shock. Perri and Quadrini (2011) argue that the strong correlation of both financial and real aggregates across developed countries points to a large global confidence shock. Since common shocks and contagion may be observationally similar, it is quite hard to separate one from another in an empirical setting (Reinhart and Rogoff, 2009). The panel structure of our data allows us to identify common shocks and then to relate financial integration to the part of economic activity that is not explained by the common shock.

We start our analysis using the total sample, which includes all the country pairs and thus all three sets of linkages: namely, advanced-to-advanced, advanced-to-emerging and emerging-to-emerging linkages. Our first finding is that during periods without large financial crises, increases in bilateral banking linkages are associated with more divergent output cycles. This result is in line with the recent evidence in Abiad and others (2013), who uses a similar but smaller sample, and also with the evidence in Kalemli-Özcan, Papaioannou and Peydro (2013), who only uses advanced-to-advanced country pairs. This negative relation turns positive during the recent global financial crisis period. Previous studies also show a partial positive effect of financial linkages on synchronization during global crisis, but they document the total effect of financial linkages to be negative.[3] This is thus the first paper that shows evidence consistent with the idea of transmission of global financial crisis via financial linkages worldwide.

3. See Abiad and others (2013); Kalemli-Özcan, Papaioannou and Perri (2013).

Next, we omit advanced-to-advanced country pairs and use only advanced-to-emerging and emerging-to-emerging pairs. In this sample, we find no effect of financial linkages on spillovers during normal times or crisis times. This is an important result since this sample explicitly allows for advanced-to-emerging linkages and crisis transmission through such linkages. The results suggest that those linkages are not first order for the transmission or synchronization. This could be due to the fact that those linkages are not as deep as the ties between advanced economies. When we limit the sample to emerging-to-emerging market pairs (now also excluding advanced-to-emerging linkages), we find that emerging markets that are financially linked more closely to each other comove more during the crisis. This results holds when we condition on common shocks and trade linkages. In light of the previous set of findings, our interpretation of these results is that heightened uncertainty and investor panic during large crises can cause a synchronized retreat in emerging markets, where the effect of such a common shock will be amplified more for more financially linked emerging markets.

Theoretical models make opposing predictions on the association between financial integration and the synchronization of economic activity, depending on whether real or financial shocks are the source of the fluctuations. In a financially integrated world, if firms in certain countries are hit by a negative (positive) real shock, both domestic and foreign banks decrease (increase) lending in these countries and increase (decrease) lending in the unaffected countries, thereby causing a further divergence of output growth.[4] In contrast, if the negative (positive) shock is to the efficiency of the banking sector, globally operating banks pull out funds from all countries, transmitting the domestic banking shock internationally, which makes the business cycles of the two countries more alike.[5]

Empirically, the literatures on the correlates of business cycle synchronization and on how contagion spreads evolved separately. The business cycle synchronization literature focuses on long-term averages and tries to identify the effect of financial integration and other (mostly bilateral) factors on business cycle synchronization using cross-country variation. This literature generally finds a

4. See Backus, Kehoe and Kydland (1992); Obstfeld (1994), Holmstrom and Tirole (1997); Morgan, Rime and Strahan (2004); Heathcote and Perri (2004).

5. See Holmstrom and Tirole (1997); Morgan, Rime and Strahan (2004); Calvo (1998); Calvo and Mendoza (2000); Allen and Gale (2000); Mendoza and Quadrini (2010); Olivero (2010); Devereux and Yetman (2010).

positive relation between financial integration and synchronization, independent of whether the sample includes financial crisis episodes.[6] Yet, recent work by Kalemli-Özcan, Papaiannou and Peydro (2013) shows that in a sample of developed countries before 2007, when financial crises were rare (or absent for most countries), within-country-pair increases in cross-border financial linkages are associated with less synchronized output cycles.[7] In contrast, the contagion literature limits its focus to crises periods, primarily in emerging markets. Overall this body of work provides compelling evidence that crises spread contagiously from the origin, mostly via financial linkages.[8]

The existing empirical evidence, based on macroeconomic data, on whether the recent global financial crisis spread via financial linkages from the United States to the rest of the world is, thus far, inconclusive. In particular, Rose and Spiegel (2010, 2011) find no role for international financial linkages in transmitting the crisis for either developed or emerging markets. In contrast, VAR analysis provides supporting evidence. Employing global VARs, Helbling and others (2010) find that the U.S. credit market shocks had a significant impact on the evolution of global growth in the latest episode. Chudik and Fratszcher (2011), again using a global VAR approach, find that while the tightening of financial conditions was a key transmission channel for advanced economies, for emerging markets it was mainly the real side of the economy that suffered due to the collapse of worldwide economic activity.

Using microeconomic data from banks, Cetorelli and Goldberg (2011) find that the lending supply in emerging markets was affected through a contraction in cross-border lending by foreign banks. Raddatz and Schmukler (2012) use microeconomic data on mutual funds to study how investors and managers behave and transmit shocks across countries. The paper finds that both investors and managers respond to country returns and crises and adjust their investments substantially. Their behavior tends to be procyclical and thus amplifies the cycle. These findings are consistent with our results.

6. See Otto, Voss and Willard (2001); Baxter and Kouparitsas (2005); Kose, Prasad and Terrones (2004); Rose (2010).

7. See also Kalemli-Özcan, Sørensen and Yosha (2001); García-Herrero and Ruiz (2008).

8. Kaminsky and Reinhart (2000); Kaminsky, Reinhart and Végh (2003); Cetorelli and Goldberg (2011).

The remainder of the paper is structured as follows. Section 1 presents the empirical methodology and discusses our data on output synchronization and international banking linkages. Section 2 reports the empirical results. Section 3 concludes.

1. Methodology and Data

We estimate variants of the following regression equation:

$$Synch_{ijt} = \alpha_{ij} + \lambda_t + \beta Linkages_{ijt-1} + \gamma Post_t \times Linkages_{ijt-1} + X'_{ijt}\Phi + \varepsilon_{ijt}, \quad (1)$$

where $Synch_{ijt}$ is a time-varying bilateral measure reflecting the synchronization of output growth between countries i and j in period (quarter) t. We use gross domestic product (GDP) data from the Organization for Economic Cooperation and Development (OECD) statistical database to construct growth rates. $Linkages_{ijt-1}$ measures cross-border banking activities between country i and country j in the previous period/quarter. $Post_t$ is an indicator variable for the crisis period that switches to one in several quarters after 2007:3 and/or 2008:2, when the financial crisis in the U.S. mortgage market started unfolding. All specifications include country-pair fixed effects (α_{ij}), as this allows us to account for time-invariant bilateral factors that affect both financial integration and business cycle synchronization (such as trust, social capital, geography, and so on).[9] We also include time fixed effects (λ_t), to account for shocks that are common to all countries. In some specifications, we replace the time fixed effects with country-specific time trends ($trend_i$ and $trend_j$), to shed light on the importance of common global shocks versus country-specific shocks. We also estimate specifications including both time fixed effects and country-specific time trends to better capture common shocks and hard-to-observe country-specific output dynamics. We control for other factors, such as the level of income, population and

9. Kalemli-Özcan, Papaioannou and Peydro (2013) show that accounting for country-pair fixed effects is fundamental. Both the literature on the correlates of cross-border investment (for example, Portes and Rey, 2005; Guiso, Sapienza and Zingales, 2009; Buch, 2003; Papaioannou, 2009) and the literature on the determinants of output comovement (for example, Baxter and Kouparitsas, 2005) show that time-invariant factors related to geographic proximity, trust and cultural ties are the key robust correlates of financial integration and output synchronization.

bilateral trade.[10], However, since most of the usual correlates of output synchronization are either time invariant (such as distance or information asymmetry proxies) or slowly moving over time (such as similarities in production and bilateral trade), no other variable enters the specification with a significant point estimate, with the exception of lagged GDP per capita and population.

1.1 Output Synchronization

We measure business cycle synchronization (*Synch*) with the negative of divergence in growth rates, defined as the absolute value of GDP growth differences between country i and j in quarter t:

$$Synch_{ijt} \equiv -\left|\left(\ln Y_{it} - \ln Y_{it-1}\right) - \left(\ln Y_{jt} - \ln Y_{jt-1}\right)\right| , \qquad (2)$$

This index, which follows Giannone, Lenza and Reichlin (2010), is simple and easy to grasp. In addition, it is not sensitive to various filtering methods that have been criticized on different grounds (Canova, 1998, 1999). In contrast to correlation measures more commonly used in cross-country studies, this synchronization index does not (directly at least) reflect the volatility of output growth and, therefore, allows us to identify the impact of banking integration on the covariation of output growth. Another benefit of this index is that, as we do not have many post-crisis observations, the rolling-average correlation measures are not very well estimated (Doyle and Faust, 2005).[11]

10. In all panel specifications, we cluster standard errors at the country-pair level to account for arbitrary heteroskedasticity and autocorrelation within each country pair. (Bertrand, Duflo and Mullainathan, 2004).

11. For robustness and for comparability with the work of Morgan, Rime and Strahan (2004) on the impact of banking integration on the evolution of business cycles across states in the United States, we also experimented with an alternative (though similar) synchronization measure, with similar results. To construct the Morgan, Strahan and Rime (2004) synchronization index, we first regress GDP growth separately for country i and j on country fixed effects and period fixed effects and take the residuals that reflect how much GDP and its components differ in each country and year compared to average growth in that year (across countries) and the average growth of this country over the estimation period. The absolute value of these residuals reflects fluctuations with respect to the cross-country and across-year mean growth. Second we construct the business cycle synchronization proxy as the negative of the divergence of these residuals, taking the absolute difference of residual growth.

1.2 International Banking Linkages

To construct the bilateral financial linkage measures, we use proprietary data from the Bank for International Settlements (BIS) locational banking statistics database. The database reports investments from banks located in up to 40 countries (the reporting area) into more than 200 countries (the *vis-à-vis* area) on a quarterly basis from the late 1970s to the present, although data for around 20 reporting-area countries are available only in the past decade or so. We use 17 advanced and 11 emerging economies.[12]

We never replace data, meaning that if a country pair has data, then both countries are reporting. That is, both countries must have reported their assets and liabilities in order to be included in our data on financial linkages. If only one country reported, the data are not included in our sample. This gives us limited variation in the case of emerging economies, but better measurement and more reliability.

The data are originally collected from domestic monetary authorities and supervisory agencies and include all of banks' on-balance-sheet exposure, as well as some off-balance-sheet items. The database follows the locational principle and thus also includes lending to subsidiaries and affiliates. Therefore, the locational banking statistics more accurately reflect the international exposure of countries (and banks) than the BIS consolidated statistics database, which nets out lending and investment to affiliated institutions. The statistics mainly capture international bank-to-bank debt instruments, such as interbank loans and deposits, credit lines, and trade-related lines of credit. The data also cover bank investment in equity-like instruments, as well as foreign corporate and government bonds.[13]

While not without drawbacks, our data offer important advantages over other international investment databases, which are essential for understanding the impact of financial globalization on the transmission of the recent crisis. First, the BIS statistics have

12. See the appendix for a list of the advanced and emerging economies.

13. Assets include mainly deposits and balances placed with nonresident banks, including a bank's own related offices abroad. They also include holdings of securities and participation (that is, permanent holdings of financial interest in other undertakings) in nonresident entities. Data also include trade-related credit, arrears of interest and principal that have not been written down and holdings of banks own issues of international securities. They also cover portfolio and direct investment flows of financial interest in enterprises.

by far the most extensive time coverage of all similar database on cross-border investment holdings. For example, the Coordinated Portfolio Investment Survey (CPIS) database maintained by the International Monetary Fund (IMF) reports bilateral cross-border financial flows and stocks only after 1999. Second, the data report bilateral financial linkages between each country in the world and the United States, where the crisis originated. This allows us to investigate the direct impact of the credit shock in the United States on the rest of the world. The main limitation of our data set is that it reports the aggregate international exposure only of the banking system.[14] As such, our data set does not include portfolio investment by mutual funds and the shadow financial system (hedge funds), foreign direct investment (FDI) and other international transactions (Lane and Milesi-Ferretti, 2007). Nevertheless, cross-border banking activities was by far the largest component of cross-border investment in the 1980s and the 1990s, and even now it accounts for the bulk of international finance. The country-level aggregate statistics of Lane and Milesi-Ferretti (2008) indicate that the stock of cross-border banking is currently more than 50 percent of total international holdings (including FDI and portfolio investment), and it was more than two-thirds in the 1980s and 1990s.

As long as there is a high correlation between international banking and other forms of portfolio investment (such as equity flows, FDI and debt flows), our estimates will not be systematically biased. According to the latest vintage of the Lane and Milesi-Ferretti data set of aggregate country-level foreign holdings, the correlation of total debt, portfolio debt, banking, FDI and equity in levels (expressed either as a share of total assets or as a share of GDP) is in the range of 0.75–0.99. Other country-pair data sets on foreign capital holdings also suggest a strong correlation between the various types of international investment. For example, Kubelec and Sa (2010) document that the correlation between our BIS data and the IMF CPIS bilateral debt data, which has a broader coverage of debt assets and liabilities, is 80 percent.

We use two measures of cross-border banking activities or linkages ($Linkages_{ij,t-s}$). First, we use the sum of bilateral assets and

14. Another limitation is that the BIS does not distinguishes between traditional banking activities, equity investment and holdings of international debt. Therefore, we cannot examine the effects of the different types of financial integration on output synchronization.

liabilities between countries *i* and *j* over the sum of the two countries' GDP in each quarter:[15]

$$\frac{Linkages}{GDP} = \frac{Assets_{ijt} + Liabilities_{ijt} + Assets_{jit} + Liabilities_{jit}}{GDP_{it} + GDP_{jt}}.$$

Second, we use the share of bilateral assets and liabilities between countries *i* and *j* over the sum of the total external assets and liabilities of each country in each quarter:

$$\frac{Linkages}{Total\ Linkages} = \frac{Assets_{ijt} + Liabilities_{ijt} + Assets_{jit} + Liabilities_{jit}}{Tot\_Assets_{it} + Tot\_Liabilities_{it} + Tot\_Assets_{jt} + Tot\_Liabilities_{jt}}$$

Likewise we measure banking exposure to the U.S. financial system with the sum of bilateral assets and liabilities of each country pair *vis-à-vis* the United States over the sum of the two countries' GDP in each quarter and over the sum of total external assets and liabilities of the two countries in each quarter. The results are similar for both measures. Table 1 provides descriptive statistics for the variables employed in the empirical analysis.

15. We also used flows, with similar results. We prefer working with stocks, because theoretically it is more appealing. Changes in stocks may not solely reflect increased/decreased investment, as stocks (assets and liabilities) may change due to valuation effects arising from movements in the exchange rate or the market value of international investment.

Table 1. Descriptive Statistics: All Country Pairs

Variable	*No. obs.*	*Mean*	*Std. dev.*	*Min.*	*Max.*	*p1*	*p5*	*p25*	*p50*	*p75*	*p95*	*p99*
Pairwise correlation of GDPa	154,188	0.1798	0.2987	−0.8898	0.9657	−0.4771	−0.2983	−0.0299	0.1666	0.3858	0.6992	0.8344
Synchronization of GDP	191,295	−6.1358	6.7029	−101.7878	−0.0001	−32.1779	−17.8464	−7.9830	−4.3090	−1.9634	−0.3896	−0.0787
Linkages/GDP	21,467	0.0583	0.1206	0.0000	1.2926	0.0001	0.0004	0.0031	0.0135	0.0534	0.2646	0.6439
Linkages/total linkages	24,854	0.0247	0.0373	0.0000	0.3958	0.0001	0.0004	0.0027	0.0093	0.0291	0.1047	0.1785
U.S. linkages/GDP	19,878	0.4412	0.4884	0.0243	3.8989	0.0507	0.0771	0.1586	0.2873	0.4885	1.4796	2.6249
U.S. linkages/total linkages	22,398	1.2317	0.1961	1.0192	4.9590	1.0427	1.0719	1.1189	1.1677	1.2993	1.5502	1.8913

Note: The pairwise correlation of GDP is the correlation of real GDP growth estimated using 20 quarterly No. observations.

2. Empirical Results

First, we run simple difference-in-differences type specifications in the period just before and during the recent financial crisis. There are no other emerging market crises that are relevant for the period used. Specifically, focusing on our total sample over the period 2002–12, we split the sample into two five-year periods, and for each time span we estimate the correlation of real per capita GDP growth between each country pair using quarterly data over 20 quarters. The pre-crisis period is 2002:4–2007:3, and post-crisis period is 2007:4–2012:3.

We regress the correlation in output growth on a bilateral index of banking integration based on the total assets and liabilities of banks in the two countries at the beginning of each period, allowing the coefficient on the banking integration measure to differ in the two periods. As we condition on country-pair fixed effects, these specifications examine whether within-country-pair increases in banking integration are associated with a lower or higher degree of business cycle synchronization; by allowing the coefficient on banking integration to differ at the beginning of each period, we examine whether this association changed during the recent crisis. All specifications also include the log of the product of the two countries' GDP at the beginning of each period and the log of the product of the two countries' population.

Tables 2 and 3 reports the results. They are based on the same specifications, where the only difference is the measure of financial linkages. In table 2 the financial linkage variable is normalized by the total linkages of the countries in the pair *vis-à-vis* the rest of the world, whereas in table 3 the financial linkages between the pairs are normalized by the GDP of the countries in the pair. We use two different samples. The first sample is composed of all countries and hence includes all advanced-to-advanced, advanced-to-emerging and emerging-to-emerging country pairs. As shown in columns (1) through (3), the coefficient on the second period time effect (the crisis dummy variable), which captures the effect of the financial crisis on output synchronization, is positive and highly significant. This reflects the fact that correlations increased tremendously in 2007–09. Our estimate suggests that output growth correlations increased by around 0.4–0.5 during the recent crisis period relative to the five years before. Second, the coefficient on banking integration in the simple specification in columns (1) through (3) is negative and highly significant. This suggests that conditional on shocks that are common to all countries, within-country-pair increases in banking integration are associated with less synchronized output cycles. Third, when we allow the coefficient on banking integration to differ in the two five-year periods via an interaction effect, we find a positive and significant coefficient of the interaction between banking linkages and the second period dummy variable: this implies that country pairs that were strongly integrated via the international banking system at the start of the 2007–09 crisis experienced more synchronized contractions during the crisis.

While the partial effect of financial integration on output synchronization during the recent crisis is positive, the total effect is negative. Thus the crisis has just made the relation between financial integration and output synchronization less negative, a result that is also found by Abiad and others (2013) and Kalemli-Özcan, Papaioannou and Perri (2013). This total effect will turn positive below, when we run more flexible specifications with a larger time dimension.

Columns (4) through (6) show the results for our second sample, which only includes advanced-to-emerging and emerging-to-emerging country pairs and hence omits all advanced-to-advanced linkages. The results change drastically. While the coefficient on the second period time effect (the crisis dummy variable) is still positive and highly significant, indicating that output growth correlations increased by around 0.6–0.8, nothing else is significant anymore. Of course, we lose a lot of observations. In fact, a sample that is composed of only emerging-to-emerging country pairs cannot be used in the specification of tables 2 and 3 given the few observations (we practically have two time periods in a country-pair fixed-effects estimation) It is possible that the original results are all driven by advanced country linkages, but it is also possible that there is not enough time variation to run this restrictive country-pair fixed-effects specifications. We therefore turn to our main specification, as described in the previous section, to sort this out.

Panel B of tables 2 and 3 shows the same specifications without country-pair fixed effects. The crisis dummy variable is still highly positively significant in both samples, and the total effect of financial linkages turns positive in the advanced country sample. This mimics the typical finding in the literature that when country-pair effects are not used, the identification is biased since it is based on cross-sectional variation.[16]

16. The endogeneity problem manifests itself clearly in sign reversal when one uses country-pair fixed effects or not.

Table 4 reports our benchmark estimates from our main regression equation, using data from the whole period (1977-2012). We use three samples. Our first sample includes all country pairs. The estimates in column (1) are in line with the simple difference-in-differences estimates reported in tables 2 and 3, where we used the correlation of GDP growth as the dependent variable and focused on the periods just before and during the recent financial crisis. In tranquil times, there is a significantly negative association between banking integration and output synchronization.

The coefficient on banking integration changes sign when we focus on the recent financial crisis period, defined as the period from 2008 to 2009. The estimate on the interaction term between bilateral banking activities and the recent crisis period implies that during the crisis years, an increased degree of banking integration was followed by more synchronized cycles.

In column (2) we include time (quarter) fixed effects to account for common global shocks, while in columns (3) and (4) we include bilateral trade linkages and their interaction with the crisis dummy variable. In all these specifications, the coefficient on banking integration continues to enter with a negative and significant estimate; the coefficient changes sign and turns positive (and significant) in the recent crisis period. The coefficient on goods trade is small and statistically indistinguishable from zero.[17] Most importantly, conditioning on goods trade does not affect the coefficient on banking integration both during tranquil periods and during the recent financial crisis.[18]

An important change from the previous results is that the total effect of financial integration is now positive. Hence in the sample of all country pairs, financial linkages act as a channel of contagion under a global financial shock. This finding supports the idea that the global financial crisis was transmitted from the United States to the rest of the world via financial linkages, whereas the evidence in the literature thus far is mixed (even our own table 2, which uses less time variation, does not have this result).

17.. The bilateral trade index is the sum of the logs of real bilateral exports and imports between the two countries in each quarter. Data are from the OECD monthly statistical database on trade.

18.. Rose and Spiegel (2004) and Aviat and Coeurdacier (2007) show that trade has a significantly positive effect on business cycle synchronization. Yet in the high-frequency quarterly dimension, there is no significant within-country correlation between goods trade and business cycle synchronization. The negative effect of trade at the time of crisis might be due to switching trade partners.

Table 2. Bilateral Financial Linkages and Output Correlations: Total Linkage Measure

Variable	*All country pairs*			*Emerging-emerging and emerging-advanced country pairs*		
	(1) *All*	*(2)* *All*	*(3)* *No LUX, CHE*	*(4)* *All*	*(5)* *All*	*(6)* *No LUX, CHE*
A. With country-pair fixed effects						
Crisis indicator	0.3801***	0.4484***	0.4716***	0.6366***	0.8184***	0.5978**
	(0.0555)	(0.0672)	(0.0716)	(0.1951)	(0.2666)	(0.2703)
Linkages/Total linkages	−0.0529*	−0.0585**	−0.0690**	0.0119	0.0050	−0.0139
	(0.0281)	(0.0281)	(0.0291)	(0.0529)	(0.0533)	(0.0531)
Linkages/Total linkages x Crisis		0.0213*	0.0229*		0.0375	0.0119
		(0.0120)	(0.0129)		(0.0375)	(0.0387)
Country-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.690	0.694	0.716	0.688	0.694	0.712

Table 2. (continued)

Variable	*All country pairs*			*Emerging-emerging and emerging-advanced country pairs*		
	(1) *All*	*(2)* *All*	*(3)* *No LUX, CHE*	*(4)* *All*	*(5)* *All*	*(6)* *No LUX, CHE*
B. Without country-pair fixed effects						
Crisis indicator	0.3754***	0.4047***	0.4256***	0.4344***	0.3336**	0.2615
	(0.0174)	(0.0540)	(0.0593)	(0.0375)	(0.1652)	(0.1672)
Linkages/Total linkages	0.0214***	0.0184**	0.0201**	–0.0077	0.0027	0.0072
	(0.0066)	(0.0086)	(0.0094)	(0.0133)	(0.0211)	(0.0215)
Linkages/Total linkages x Crisis		0.0059	0.0068		–0.0156	–0.0277
		(0.0100)	(0.0108)		(0.0249)	(0.0252)
Country-pair fixed effects	No	No	No	No	No	No
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.667	0.669	0.683	0.655	0.648	0.663
No. observations	535	535	443	193	193	172
Country pairs	310	310	260	138	138	124

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
Note: The table reports panel (country-pair) fixed-effect coefficients estimated in two non-overlapping five-year periods: 2002:4–2007:3 and 2007:4–2012:3. The dependent variable is the pairwise correlation of real per capita GDP growth between country i and country j in each of the two periods. The crisis indicator equals one in the second period (and zero in the first-period). Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in quarter t relative to the sum of the two countries' external assets and liabilities in the entire world at the beginning of each period (linkages/total linkages). Columns (3) and (6) omit Luxembourg and Switzerland. All specifications include the log of the product of the two countries' GDP at the beginning of each period and the log of the product of the two countries population. Heteroskedasticity-robust standard errors are reported in parentheses.

Table 3. Bilateral Financial Linkages and Output Correlations: GDP Measure

	All country pairs			*Emerging-emerging and emerging-advanced country pairs*		
Variable	*(1)* *All*	*(2)* *All*	*(3)* *No LUX, CHE*	*(4)* *All*	*(5)* *All*	*(6)* *No LUX, CHE*
A. With country-pair fixed effects						
Crisis indicator	0.4121***	0.4260***	0.4558***	0.6291***	0.7060***	0.4938**
	(0.0551)	(0.0582)	(0.0625)	(0.1941)	(0.2378)	(0.2407)
Linkages/GDP	−0.0431	−0.0457*	−0.0615**	0.0072	0.0073	−0.0111
	(0.0266)	(0.0269)	(0.0289)	(0.0552)	(0.0555)	(0.0556)
Linkages/GDP x Crisis		0.0069	0.0105		0.0173	−0.0116
		(0.0093)	(0.0105)		(0.0306)	(0.0337)
Country-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.689	0.689	0.711	0.688	0.690	0.712

Table 3. (contined)

	All country pairs			*Emerging-emerging and emerging-advanced country pairs*		
Variable	*(1)* *All*	*(2)* *All*	*(3)* *No LUX, CHE*	*(4)* *All*	*(5)* *All*	*(6)* *No LUX, CHE*
B. Without country-pair fixed effects						
Crisis indicator	0.3688***	0.3478***	0.3640***	0.4333***	0.2851**	0.1996
	(0.0172)	(0.0397)	(0.0464)	(0.0375)	(0.1378)	(0.1488)
Linkages/GDP	0.0218***	0.0248***	0.0255***	0.0028	0.0190	0.0237
	(0.0055)	(0.0072)	(0.0080)	(0.0111)	(0.0179)	(0.0192)
Linkages/GDP x Crisis		–0.0045	–0.0038		–0.0236	–0.0373*
		(0.0081)	(0.0089)		(0.0212)	(0.0223)
Country-pair fixed effects	No	No	No	No	No	No
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.667	0.666	0.68	0.654	0.641	0.657
No. observations	535	535	443	193	193	172
Country pairs	310	310	260	138	138	124

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
Note: The table reports panel (country-pair) fixed-effect coefficients estimated in two non-overlapping five-year periods: 2002:4–2007:3 and 2007:4–2012:3. The dependent variable is the pairwise correlation of real per capita GDP growth between country i and country j in each of the two periods. The crisis indicator equals one in the second period (and zero in the first-period). Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in quarter t relative to the sum of the two countries' GDPs at the beginning of each period (linkages/GDP), external assets and liabilities in the entire world at the beginning of each period (linkages/total linkages). Columns (3) and (6) omit Luxembourg and Switzerland. All specifications include the log of the product of the two countries' GDP at the beginning of each period and the log of the product of the two countries population. Heteroskedasticity-robust standard errors are reported in parentheses.

Table 4. Bilateral Financial Linkages and GDP Synchronization

	All country pairs				*Emerging-emerging and emerging-advanced country pairs*				*Emerging-emerging country pairs*			
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
A. With country-pair fixed effects												
Crisis indicator	−0.1999				−0.8906				9.2281**			
	(0.5255)				(1.5697)				(3.5849)			
Linkages/ Total	−0.3220***	−0.2297***	−0.2299***	−0.2377***	−0.0007	0.1221	0.1129	0.1073	−0.0811	0.0428	0.0536	−0.1060
Linkages	(0.0738)	(0.0751)	(0.0784)	(0.0783)	(0.1092)	(0.0971)	(0.0974)	(0.0973)	(0.3394)	(0.2920)	(0.2837)	(0.2888)
Linkages/Total	0.4070***	0.3863***	0.3793***	0.4976***	0.2878	0.3016	0.3107	0.3781	2.2282***	1.9027***	1.8741***	2.5836***
Linkages x Crisis	(0.1046)	(0.1020)	(0.1024)	(0.1170)	(0.2490)	(0.2513)	(0.2505)	(0.2616)	(0.6488)	(0.6461)	(0.6352)	(0.7329)
Trade			0.0041	0.0058			0.0270**	0.0220*			−0.2512**	−0.2743*
			(0.0057)	(0.0060)			(0.0133)	(0.0125)			(0.1218)	(0.1413)
Trade x Crisis				−0.0178***				−0.0217**				−0.7192**
				(0.0048)				(0.0085)				(0.2780)
Country–pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.184	0.256	0.260	0.261	0.201	0.357	0.358	0.358	0.294	0.424	0.424	0.432

Table 4. (continued)

	All country pairs				*Emerging-emerging and emerging-advanced country pairs*				*Emerging-emerging country pairs*			
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
B. Without country-pair fixed effects												
Crisis indicator	0.2385				–1.0570				8.7852**			
	(0.5303)				(1.5346)				(4.0291)			
Linkages/ Total	0.2279***	0.2245***	0.1567***	0.1490**	0.2253***	0.2448***	0.2195***	0.2130**	0.1254	0.1205	0.1428	0.1193
Linkages	(0.0545)	(0.0535)	(0.0577)	(0.0577)	(0.0849)	(0.0832)	(0.0831)	(0.0832)	(0.1567)	(0.1384)	(0.1439)	(0.1385)
Linkages/Total	0.4849***	0.4715***	0.4685***	0.5725***	0.2958	0.3166	0.3146	0.3899	2.2977***	1.9360**	1.9210**	2.2762***
Linkages x Crisis	(0.1037)	(0.1009)	(0.1011)	(0.1156)	(0.2435)	(0.2481)	(0.2478)	(0.2580)	(0.7418)	(0.7025)	(0.6935)	(0.7546)
Trade			0.0109***	0.0122***			0.0116***	0.0139***			–0.0128	0.0043
			(0.0029)	(0.0031)			(0.0025)	(0.0031)			(0.0831)	(0.0902)
Trade x Crisis				–0.0158***				–0.0245**				–0.3436
				(0.0043)				(0.0097)				(0.2498)
Country–pair fixed effects	No	No	No	No	No	No	No	No	No	No	No	No
R squared (within)	0.049	0.117	0.122	0.123	0.057	0.241	0.243	0.243	0.189	0.348	0.349	0.350

Table 4. (continued)

	All country pairs				*Emerging-emerging and emerging-advanced country pairs*				*Emerging-emerging country pairs*			
Variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*
Time fixed effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Country trends	Yes	No	No	No	Yes	No	No	No	Yes	No	No	No
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	19,866	19,866	18,871	18,856	4,894	4,894	4,893	4,892	434	434	433	432

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.

Note: The table reports panel (country-pair) coefficients estimated using 17 advanced economies (we exclude Luxembourg and Switzerland) and 11 emerging markets, which would correspond to up to (28x27)/2=378 country pairs in the full sample and (11*10)/2=55 country pairs in the emerging markets sample. A given country does not necessarily report to all other countries in the sample, which is especially true among emerging markets, for which only 26 out of 55 possible country pairs have bilateral financial linkage data. For the advanced countries, the data run from 1977:1 to 2012:4, although for some countries data only start in the 1980s, while for the emerging economies, the data run from 2000:4 to 2012:4, with emerging-emerging country-pair data starting at 2002:4 and five countries reporting only after 2005. The dependent variable (GDP synchronization) is minus one times the absolute value of the difference in the growth rate of GDP between countries i and j in quarter t. Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in the previous quarter relative to the sum of the two countries' external assets and liabilities in the entire world in the previous period (linkages/total linkages). The crisis indicator variable equals one between 2008:3 and 2009:2 (and zero otherwise). All specifications also include the log of the product of the two countries' GDP at the beginning of each period and the log of the product of the two countries population. The specifications in columns (3), (7), and (11) also include the sum of the logs of real bilateral exports and imports between countries i and j in the previous quarter (trade). The specifications in columns (1), (5), and (9) include country-specific linear time-trends. The specifications in columns (2), (3), (4), (6), (7), (8), (10), (11), and (12) include time fixed-effects. Standard errors adjusted for panel-specific (country-pair) autocorrelation and heteroskedasticity are in parentheses.

The results change in our second sample, when we remove the advanced-to-advanced country pairs from the sample and focus on advanced-to-emerging and emerging-to emerging-pairs. There are no significant results in this sample. Finally, when we focus only on emerging-to-emerging links (columns 9–12 in table 4), we find that financial linkages have a positive effect on spillovers during times of crisis. This result is consistent with work by Alvarez and De Gregorio (2013), who show that countries in Latin America that are financially open did not weather the crisis well relative to countries that are less financially open. It is also consistent with Raddatz and Schmukler (2012), who show that mutual funds were a source of instability during the global financial crisis.

Panel B of table 4 runs the same specifications without country-pair fixed effects, again relying on cross-country variation only. As before, the negative normal-time effect of financial linkages disappears for advanced countries, as expected. For advanced-to-emerging and emerging-to emerging pairs, trade becomes an important source of transmission in these cross-sectional specifications, and the effect of total financial linkages is positive. The results mimic cross-sectional results from the literature on the positive effect of trade and finance on international business cycle synchronization. This is clearly a spurious result due to the inability to control for country-pair fixed factors. Given the limited set of time series variation in the emerging-to emerging sample, the results with and without country-pair fixed effects are not that different.

The recent financial crisis started with the problems in the U.S. subprime market in the summer of 2007 and intensified in 2008 when Bear Stearns and Lehman Brothers (and many other banking institutions) experienced massive losses. In table 5, we examine whether output synchronization during the recent financial crisis has been stronger among country pairs that had stronger linkages to the U.S. banking system relative to the pairs that have weaker connections. Controlling for direct exposure to the United States has no major effect on our evidence in table 4, in any of our samples. The coefficient on U.S. banking linkages during the recent financial crisis is negative, highlighting the different timing of countries entering the crisis. Rose and Spiegel (2010), using alternative cross-sectional techniques and data, fail to find a systematic correlation between international linkages to the United States and the magnitude of the recessions across countries in 2007-09. On the other hand, we believe that this negative result is an artifact of measurement (and hence only reflects the timing), since most of the linkages to the United States are via intermediaries. In fact, Kalemli-Özcan, Papaiannou and Perri (2013) show that when we use a broader measure of exposure to the United States—incorporating not only the banking activities of each country pair with the United States, but also linkages to the Cayman Islands, Bermuda, Panama and the Channel Islands—the coefficients on the U.S. linkage measures enter significantly. We do not have the same data to employ here.

For the advanced-to-emerging and emerging-to emerging pairs, U.S. linkages do not matter in general except at the bottom specifications, where we do not use country-pair fixed effects. Here such pairs move with the United States during regular times, a result that again reflects global factors. Finally, table 6 presents specifications with host and partner country fixed effects. Results are similar to the case of no country-pair fixed effects, given that cross-sectional variation is used instead of within-country-pair variation over time.[19]

Can endogeneity concerns explain these results? The answer is no, since the first-order endogeneity will come from country-pair and time effects, as shown in Kalemli-Özcan, Papaioannou and Peydro (2013), and those effects are accounted for here.[20] Reverse causality could be present, but it is not straightforward how that could explain sign reversal during normal and crisis times in certain samples and not in others, unless there is a change in the nature of the shocks that only applies to certain countries and not to others.[21]

19.. Results with country*time fixed effects can be done only for advanced countries, as shown in Kalemli-Özcan, Papaioannou and Peydro (2013). Emerging pairs soak up most of the variation, given the limited country pairs over time.

20.. Sign reversals show that first-order endogeneity problem is due to country-pair factors.

21.. Kalemli-Özcan, Papaioannou and Peydro (2013) perform an instrumental variable (IV) analysis for their advanced country sample using changes in financial laws. We cannot use this strategy here since these changes are specific to European countries. Their analysis shows that reverse causality is not a major concern, as opposed to accounting for country-pair fixed characteristics and common shocks.

Table 5. Bilateral Financial Linkages, U.S. Financial Linkage and GDP Synchonization

	All country pairs		*Emerging-emerging and emerging-advanced country pairs*		*Emerging-emerging country pairs*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Variable	*All*	*All*	*All*	*All*	*All*	*All*
A. With country-pair fixed effects						
Linkages/Total linkages	−0.3514***	−0.2627***	−0.0369	0.0869	−0.0567	0.0601
	(0.0731)	(0.0733)	(0.1215)	(0.1100)	(0.3497)	(0.2957)
Linkages/	0.4183***	0.3980***	0.4328	0.4449	2.2431***	1.9178***
Total linkages x Crisis	(0.1095)	(0.1067)	(0.2712)	(0.2716)	(0.6732)	(0.6568)
U.S. linkages/	2.6349**	2.8041**	0.0492	1.9425	−2.0470	−1.6913
Total linkages	(1.1141)	(1.2408)	(2.4574)	(2.1346)	(3.0137)	(4.4470)
U.S. linkages/	−3.9913**	−3.5548**	−4.0564	−3.9058	1.6858	1.3063
Total linkages x Crisis	(1.7688)	(1.7448)	(2.4896)	(2.5107)	(5.1091)	(5.2640)
Crisis indicator	0.5798		0.8297		8.6904**	
	(0.6425)		(1.9684)		(3.8309)	
Country-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.191	0.266	0.209	0.373	0.295	0.424

Table 5. (continued)

Variable	*All country pairs* (1) *All*	(2) *All*	*Emerging-emerging and emerging-advanced country pairs* (3) *All*	(4) *All*	*Emerging-emerging country pairs* (5) *All*	(6) *All*
B. Without country-pair fixed effects						
Linkages/Total linkages	0.2321***	0.2334***	0.1847**	0.2012***	0.1174	0.1096
	(0.0577)	(0.0569)	(0.0759)	(0.0729)	(0.1622)	(0.1420)
Linkages/	0.4609***	0.4456***	0.3753	0.4036	2.3400***	1.9751***
Total linkages x Crisis	(0.1096)	(0.1064)	(0.2563)	(0.2598)	(0.7507)	(0.7064)
U.S. linkages/	1.5816***	1.5265**	3.0137***	3.0606***	0.8229	0.9349
Total linkages	(0.6005)	(0.6152)	(0.6999)	(0.6653)	(1.0461)	(1.0810)
U.S. linkages/	–3.9304**	–3.4810**	–4.5327*	–4.2796*	3.3189	1.9285
Total linkages x Crisis	(1.7301)	(1.7105)	(2.4155)	(2.4413)	(4.4653)	(4.3516)
Crisis indicator	0.7798		0.2595		7.9993**	
	(0.6641)		(1.8516)		(3.8491)	
Country-pair fixed effects	No	No	No	No	No	No
R squared (within)	0.052	0.124	0.073	0.267	0.191	0.350

Table 5. (continued)

	All country pairs		*Emerging-emerging and emerging-advanced country pairs*		*Emerging-emerging country pairs*	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Variable	*All*	*All*	*All*	*All*	*All*	*All*
Time fixed effects	No	Yes	No	Yes	No	Yes
Country trends	Yes	No	Yes	No	Yes	No
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
No. observations	17,273	17,273	4,305	4,305	434	434

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
Note: The table reports panel (country-pair) coefficients estimated using 17 advanced economies (we exclude Luxembourg and Switzerland) and 11 emerging markets, which would correspond to up to (28x27)/2=378 country pairs in the full sample and (11*10)/2=55 country pairs in the emerging-emerging sample. A given country does not necessarily report to all other countries in the sample, which is especially true among emerging economies, for which only 26 out of 55 possible country pairs have bilateral financial linkage data. For the advanced countries, the data run from 1977:1 to 2012:4, although for some countries data only start in the 1980s, while for the emerging economies, the data run from 2000:4 to 2012:4, with emerging-emerging country-pair data starting at 2002:4 and five countries reporting only after 2005. The dependent variable (GDP synchronization) is minus one times the absolute value of the difference in the growth rate of GDP between countries i and j in quarter t. Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in the previous quarter relative to the sum of the two countries' external assets and liabilities in the entire world in the previous period (linkages/total linkages). We measure U.S. linkages by the log of the share of the stock of bilateral assets and liabilities between each country and the United States in the previous quarter relative to the sum of the two countries' external assets and liabilities in the entire world in the previous period (U.S. linkages/Total linkages). The crisis indicator variable equals one between 2008:3 and 2009:2 (and zero otherwise). All specifications also include the log of the product of the two countries' GDP at the beginning of each period and the log of the product of the two countries population. Specifications in columns (1), (3) and (5) include country-specific linear time-trends. The specifications in columns (2) (4), and (6) include time fixed-effects. Standard errors adjusted for panel-specific (country-pair) autocorrelation and heteroskedasticity are in parentheses.

Table 6. Bilateral Financial Linkages and Output Correlations

	All country pairs			*Emerging-emerging and emerging-advanced country pairs*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Sample	*All*	*All*	*No LUX, CHE*	*All*	*All*	*No LUX, CHE*
A. With host-country fixed effects						
Crisis indicator	0.3756***	0.4069***	0.4318***	0.4598***	0.4119**	0.3370**
	(0.0176)	(0.0534)	(0.0585)	(0.0399)	(0.1685)	(0.1705)
Linkages/Total linkages	0.0183***	0.0150*	0.0152	−0.0158	−0.0110	−0.0053
	(0.0069)	(0.0089)	(0.0095)	(0.0153)	(0.0226)	(0.0231)
Linkages/		0.0062	0.0074		−0.0074	−0.0204
TotalLinkages x Crisis		(0.0099)	(0.0106)		(0.0253)	(0.0256)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.668	0.67	0.685	0.655	0.653	0.667

Table 6. (continued)

	All country pairs			*Emerging-emerging and emerging-advanced country pairs*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Sample	*All*	*All*	*No LUX, CHE*	*All*	*All*	*No LUX, CHE*
B. With partner-country fixed effects						
Crisis indicator	0.3854***	0.4301***	0.4509***	0.4112***	0.4683***	0.3810***
	(0.0179)	(0.0527)	(0.0567)	(0.0356)	(0.1459)	(0.1466)
Linkages/TotalLinkages	0.0049	−0.0000	0.0043	−0.0027	−0.0086	−0.0005
	(0.0070)	(0.0089)	(0.0093)	(0.0120)	(0.0190)	(0.0192)
Linkages/		0.0089	0.0102		0.0089	−0.0050
TotalLinkages x Crisis		(0.0099)	(0.0104)		(0.0220)	(0.0220)
Country fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls (GDP, population)	Yes	Yes	Yes	Yes	Yes	Yes
R squared (within)	0.672	0.674	0.69	0.655	0.658	0.67
No. observations	535	535	443	193	193	172
Country pairs	310	310	260	138	138	124

* Statistically significant at the 10 percent level.
** Statistically significant at the 5 percent level.
*** Statistically significant at the 1 percent level.
Note: The table reports panel (country-pair) fixed-effect coefficients estimated in two nonoverlapping five-year periods: 2002:4–2007:3 and 2007:4–2012:3. The dependent variable is the pairwise correlation of real per capita GDP growth between country i and country j in each of the two periods. The crisis indicator equals one in the second period (and zero in the first period). Financial integration is measured by the log of the share of the stock of bilateral assets and liabilities between countries i and j in quarter t relative to the sum of the two countries' external assets and liabilities in the entire world at the beginning of each period (linkages/total linkages). Columns (3) and (6) omit Luxembourg and Switzerland. All specifications include the log of the product of the two countries' GDP at the beginning of each period and the log of the product of the two countries population. Heteroskedasticity-robust standard errors are reported in parenthesis.

3. Conclusion

We study the role of global banks in transmitting the global crisis to emerging markets. We use quarterly data on country-pair banking linkages from a sample of 17 developed countries and 11 emerging markets between 1977 and 2012 to examine the effect of cross-border banking integration on business cycle synchronization. We find that while the relationship between banking linkages and output synchronization was negative for almost all of the years before the recent crisis, the partial correlation turned positive during the recent crisis. However, this result is mainly driven by advanced-to-advanced linkages, which is consistent with the theory that with more complete financial markets, financial integration creates divergence under real shocks (normal times), and convergence under financial or credit shocks (shocks to financial sector).

When we focus on a sample of only emerging-to-emerging pairs, the negative effect in normal times disappears, consistent with the existence of frictions in the international financial markets that hinder capital flows. The crisis-times effect (that is, the positive relation between output comovement and financial linkages conditional on the period of global financial crisis) stays positive. These results are conditional on controlling for bilateral trade links and removing financial centers from the data. Our interpretation is that there was contagion among the emerging markets that are financially linked, although the crisis did not seem to be transmitted to them from advanced economies via financial linkages. One explanation for this may be that increased uncertainty led to investor panic and a synchronized slowdown in emerging markets, where such a common shock was amplified more for the countries that are more financially linked. However, because there are few observations, the predictive power is low when we restrict the sample to emerging markets.

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Appendix A

Country-Pair Data

To construct the bilateral financial linkage measures, we use proprietary data from the Bank for International Settlements (BIS) locational banking statistics database. The database reports investments from banks located in up to 40 countries (the reporting area) into more than 200 countries (the *vis-à-vis* area) on a quarterly basis from the late 1970s to the present. For our sample, we use 17 advanced and 11 emerging economies, as follows:

—Advanced economies (excluding Luxembourg and Switzerland): Australia, Austria, Belgium, Canada, Denmark, Germany, Finland, France, Ireland, Italy, Japan, Netherlands, Portugal, Spain, Sweden, the United Kingdom and the United States.

—Emerging markets: Brazil, Chile, Cyprus, Greece, India, Indonesia, South Korea, Malaysia, Mexico, South Africa and Turkey.

We never replace data, meaning that if a country pair has data, then both countries are reporting. That is, both countries must have reported their assets and liabilities in order to be included in our data on financial linkages. If only one country reported, the data are not included in our sample.

To explain further, the 11 emerging countries in the sample start reporting in the following quarters: Brazil (2002:4), Chile (2002:4), Cyprus (2008:4), Greece (2003:4), India (2001:4), Indonesia (2010:4), South Korea (2005:1), Malaysia (2007:4), Mexico (2003:4), South Africa (2009:3) and Turkey (2000:4). This yields 26 country pairs among those countries for which we have any data: TUR-ZAF, TUR-CYP, TUR-KOR, TUR-IDN, GRC-CYP, ZAF-BRA, ZAF-CHI, ZAF-MEX, ZAF-CYP, ZAF-IND, ZAF-IDN, ZAF-KOR, ZAF-MYS, BRA-CHI, BRA-MEX, BRA-KOR, CHI-IND, CHI-KOR, CYP-IND, CYP-KOR, IND-IDN, IND-KOR, IND-MYS, IDN-KOR, IDN-MYS and KOR-MYS.

So, 11 countries would initially give us (11*10)/2=55 country pairs, and we have data for about half of those. Given the average data availability for emerging markets, we have 434/26=16.7 quarters on average per country pair, or a little bit over four years. The emerging-to-emerging country pair data start in 2002:4, with BRA-CHI and CHI-IND. Although Turkey starts reporting in 2000:4, it only reports linkages to advanced economies, and the first country pair involving Turkey and another emerging market is TUR-KOR in 2005:1. However, we have much more data for emerging-to-advanced country pairs (4,894 observations versus 434 observations on emerging-to-emerging linkages), since the advanced countries almost always report (see tables 2 through 6).

When we have all country pairs (17 or 19 advanced economies and 11 emerging economies), we could potentially have up to (30x29)/2=435 country pairs, but we only have 310 given some missing years. With 310 country pairs, we could have up to 620 observations in tables 2, 3 and 6, but we only have 535, again given missing years. The missing years are due to differences in initial reporting dates. In tables 4 to 6, with all pairs, we should have (28x27)/2=378 country pairs, but we only have 260, given missing years. Since we have 30 years and hence 120 quarters, we should have around 30,000 observations, but again given missing years we have around 20,000 in the full sample. The other samples will have a similar comparison.

Asset Bubbles and Sudden Stops in a Small Open Economy

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One of the most striking features of the world economy over the last twenty-five years has been the sharp decline in the real interest rate from approximately 4% in the early 1990s to -1.5% in 2013 (figure 1). During this period, there have been two waves of large capital inflows into emerging economies (figure 2). In the first wave, which began in the early 1990s and ended with the Asian crisis of 1997, net capital flows to these economies went from zero to approximately 3.5% of their combined GDP. The second wave started in the early 2000s and peaked in 2007 as inflows reached approximately 5% of emerging-market GDP. Capital inflows contracted sharply during the financial crisis of 2008-2009, but they have rebounded since.

At first glance, both pieces of evidence appear to be positive news for emerging markets, which have enjoyed increased access to foreign financing at lower interest rates. And yet, there is much debate regarding the desirability of low interest rates and surges in capital inflows.

* The analytical framework used in this article was developed in our papers "Managing Credit Bubbles" and "The International Transmission of Credit Bubbles: Theory and Policy". We refer the reader to these papers for formal derivations and many additional results. We would like to thank Fernando Broner for useful comments and Francisco Queiros and Tom Schmitz for excellent research assistance. Martin: CREI and Universitat Pompeu Fabra, amartin@crei.cat. Ventura: CREI and Universitat Pompeu Fabra, jventura@crei.cat. CREI, Universitat Pompeu Fabra, Ramon Trias Fargas 25-27, 08005-Barcelona, Spain. We acknowledge support from the Spanish Ministry of Science and Innovation (grant ECO2011-23197), and the Generalitat de Catalunya-AGAUR (grant 2014SGR-830). In addition, Ventura acknowledges support from the ERC (Advanced Grant FP7-249588-ABEP), and Martin the ERC (Consolidator Grant FP7-615651-MacroColl), and the IMF Research Fellowship.

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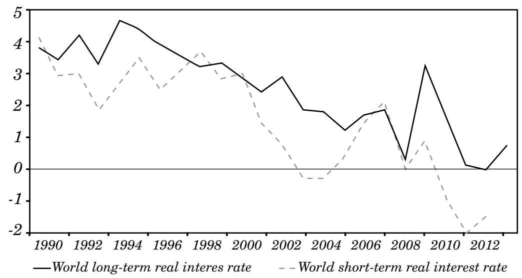
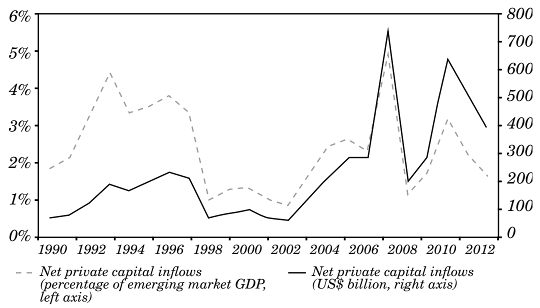
Figure 1. World interest rates, 1990-2013



Source: OECD. Stat. World Series are real GDP-weighted averages for the short-and long-term real interest rates in the G7 countries. The series for short-term real interest rates excludes, for data availability reasons, Japan from 1990 to 2002, while the long-term real interest rate series excludes Italy from 1990 to 1991.

Figure 2. Net capital inflows to emerging economies



Source: IMF, Balance of Payments Statistics. Emerging economies are defined as in Cardarelli *et al.* (2009).

One of the main reasons is that these episodes may end in so called "sudden stops," sharp reversals in capital flows that are typically accompanied by falling asset prices and deep recessions. This narrative is often invoked to explain the events that transpired across many emerging markets during the 1990s, in particular, the Mexican crisis of 1994 and the East Asian crisis of 1997. As we write this article, it is also invoked to warn of the dangers that lie ahead once the Federal Reserve decides to tighten its monetary policy and increase interest rates in the United States, attracting part of the capital flows that are now heading to the emerging world. This preoccupation with the downside risks of capital inflows has been accompanied by a growing endorsement of policy intervention in the form of capital controls.

But what is the role of capital controls in a world of financial globalization and low interest rates? How do capital flows behave in such a world, and what are the market failures that should be addressed through intervention? In this paper, we provide a simple framework to think about these questions.

To do so, we first develop a standard model of a small open economy with borrowing constraints. In our model, agents need to borrow from foreigners in order to invest. Due to weak enforcement institutions, however, foreign borrowing must be backed by the value of domestic firms. Our key innovation is to note that, in low interest rate environments, the value of firms has both a fundamental and bubble component. The fundamental component corresponds to the capital that is owned by the firm, i.e., it is the part of the firm's value that is backed by expectations of future production. The bubble component instead corresponds to the part of the firm's value that is positive today only because it is expected to be positive tomorrow, i.e., it is the part of the firm's value that is backed by expectations of the future bubble. The literature on capital flows in the presence of borrowing constraints has focused exclusively on the fundamental component of asset prices. Whenever the interest rate is low enough, however, we show that this view is incomplete. In this case, there is room for investor optimism to sustain bubbles that relax the country's borrowing constraint and fuel capital inflows.

A first contribution of our paper is to characterize the effects of bubbles on capital flows, investment and growth. By definition, bubbles enable domestic borrowers to obtain foreign credit in excess of the fundamental value of their firms. Intuitively, the international financial market is willing to lend in excess of this value because it anticipates that firms will have a bubble component in the future as well. In this sense, bubbles have a crowding-in effect, which raises gross capital inflows, investment and growth. But the bubble component has also fueled "excess" credit in the past, which requires diverting some of today's resources away from investment to pay foreign creditors. This is the crowding-out effect of bubbles, which raises gross capital outflows and reduces investment and growth.

The net effect of bubbles depends on the relative strength of these two effects. In particular, we find that the crowding-in effect dominates during "normal times," when the small open economy faces an elastic supply of funds from the international financial market. At these times, it is the value of domestic firms that constrains foreign borrowing, and bubbles relax this constraint by raising the value of firms. In contrast, during "sudden stops," it is the supply of funds from the international financial market that constrains foreign borrowing. At these times, bubbles cannot raise gross capital inflows but they do raise gross outflows because foreign creditors must be repaid, and the crowding-out effect of bubbles dominates. Thus, the bubble that attains the optimal level of investment grows during normal times and shrinks during sudden stops.

A second contribution of our paper is to explore the role of capital controls in this environment. An essential feature of bubbles is that they are driven by investor sentiment or market expectations. Their value today depends on market expectations about their value tomorrow, which in turn depends on tomorrow's market expectations about their value on the day after, and so on. Because of this, the bubble provided by the market may be too small—and gross capital inflows insufficient—during normal times, while it may be too large—and gross capital outflows excessive—during sudden stops. We show that a government that can impose taxes and subsidies on gross capital flows can use such controls to replicate the bubble allocation that maximizes output. To do so, it must subsidize gross capital outflows during normal times but tax them during sudden stops.

The view of capital controls that emerges here seems to contradict the recent literature on capital flows and pecuniary externalities, which emphasizes the precautionary nature of controls.[1] This may seem odd because both frameworks are similar, but they differ in two important respects. First, we consider low interest rate environments in which bubbles may arise. These bubbles provide collateral and make it possible for foreign borrowing to expand in normal times. If the bubbles supplied by the market are small, however, the government can complement them by subsidizing gross capital outflows, which amounts to a public guarantee of private

1. See, for instance, Caballero and Krishnamurthy (2001), Mendoza (2010), Bianchi (2011), and Korinek (2011). In most of these models, foreign borrowing is constrained by the value of domestic assets in terms of tradable goods. When a sudden stop occurs, foreign borrowing declines for two reasons: there is the direct effect of the shock that gives rise to the sudden stop (e.g., increased risk aversion of international investors), but there is also an indirect effect because asset prices fall and/or the real exchange rate depreciates. Because domestic agents do not internalize this last effect when they make their borrowing decisions, there is over-borrowing in equilibrium and "prudential" capital controls that reduce net inflows that may be welfare-enhancing.

loans. By doing so, it relaxes the economy's borrowing constraint, and low interest rates ensure that the policy is sustainable. A second difference with the literature is that borrowing constraints in our model depend on expected—as opposed to contemporaneous—asset prices. This means that, in our framework, a fall in asset prices during sudden stops is actually good for economic activity: given expected asset prices, such a fall reduces payments to foreigners and increases domestic resources available for investment.

The rest of the paper is structured as follows. Section 1 develops a stylized model of an emerging market that faces borrowing constraints. Sections 2 and 3 explore bubbly equilibria in low interest rate environments and study the implications of bubbles for capital flows, investment and growth. Section 4 introduces a government and shows how capital controls can be used to maximize investment. Section 5 concludes.

1. A STYLIZED MODEL OF AN EMERGING MARKET

We next describe an economy that is only a very small part of a large world. We refer to the citizens of this economy as domestic residents, and to the citizens of the rest of the world as foreigners. Domestic residents work for domestic firms and manage them. Foreigners cannot do this. Domestic residents and foreigners interact in the credit market, where they exchange consumption goods for promises to deliver consumption goods in the future.

Domestic firms produce consumption goods using capital and labor with a standard Cobb-Douglas technology:

$$y_t = A \cdot k_t^{\alpha} \cdot l_t^{1-\alpha} \tag{1}$$

with $A > 0$ and $\alpha \in (0.1)$; and y_t, k_t and l_t denote output, the capital stock and the labor force, respectively. The capital stock evolves as follows:

$$k_{t+1} = i_t + (1-\delta) \cdot k_t \tag{2}$$

where i_t is investmentand $\delta \in (0.1)$ is the depreciation rate. The labor force is constant and equal to one. Workers are paid their marginal product and, as a result, they receive a fraction $1-\alpha$ of output. The remaining output is distributed to firm owners. Domestic residents trade old firms and they can also create new ones at zero cost. Let

v_t be the market value of all firms after output has been distributed and before new investments have been made. Thus, v_t is the market value of firms that contain the undepreciated capital left after production, i.e. $(1-\delta)\cdot k_t$.

There are overlapping generations of domestic residents that live for two periods. All generations have a size of one and contain a fraction μ of patient residents that maximize expected consumption during old age, and a fraction $1-\mu$ of impatient residents that maximize consumption during youth. Patient residents save, own firms and consume when old. Impatient residents consume when young and never own firms. These assumptions imply the following aggregate consumption and investment:

$$c_t = (1-s)\cdot y_t + v_t - R_t^* \cdot f_{t-1} \tag{3}$$

$$i_t = s\cdot y_t + f_t - v_t \tag{4}$$

where c_t is consumption, f_t foreign borrowing and R_t^* the interest rate paid on foreign borrowing, and $s \equiv \mu\cdot(1-\alpha)$. In this economy, the impatient young and the patient old are the domestic consumers. Thus, equation (3) says that aggregate consumption equals their combined income which consists of a fraction $1-s$ of the economy's output, plus the price obtained by the old when they sell their firms, minus their foreign interest payments. In this economy, the patient young are the domestic investors. Thus, equation (4) says that aggregate investment equals the income of the patient young, which is a fraction s of the economy's output, plus their foreign borrowing less the price they pay for their firms.

There are two frictions that limit foreign borrowing: one of them originates abroad, and the other at home. The foreign friction is the possibility of sudden stops.[2] In particular, there are two possible states: $z_t \in \{N, S\}$ which we refer to as normal times and sudden stops. In normal times, foreigners provide credit to domestic residents at an expected return $E_t R_{t+1}^* = \rho$, up to a maximum of F. We think of F as being large, which makes this assumption inconsequential for most of the paper. It is nonetheless useful because it ensures that

2. From the perspective of our economy, this is not really a friction but simply a description of the environment in which it operates. We refer nonetheless to the assumption that the supply of funds is volatile as a foreign friction because we think that this volatility stems from an (unmodeled) imperfection in the international financial market.

the small-open-economy assumption is sensible by guaranteeing that foreign borrowing is always bounded in equilibrium. During sudden stops, foreigners do not lend to domestic residents. Let σ be the probability of a sudden stop starting, i.e. $\sigma = Pr\ (z_{t+1}=S/z_t = N)$; and let η be the probability of a sudden stop ending $\eta = Pr\ (z_{t+1} = N/z_t = S)$. Domestic residents can always lend to the rest of the world at the interest rate ρ.

The domestic friction is insufficient collateral. In particular, domestic courts can seize the price that firm owners obtain when they sell their firms, but not the output that these firms distribute to their owners. As a result, firm owners can only promise a payment of v_{t+1} to their foreign creditors. Define the economy's collateral as the maximum value of payments tomorrow that can be promised today. Since contingent contracts are possible, the economy's collateral equals $E_t v_{t+1}$.[3]

Combining foreign and domestic frictions, we obtain the country's borrowing limit:

$$\bar{f}_t = \begin{cases} \dfrac{E_t v_{t+1}}{\rho} & \text{if } z_t = N \\ 0 & \text{if } z_t = S \end{cases} \tag{5}$$

In normal times, the borrowing limit equals the discounted value of the economy's collateral. During sudden stops, the borrowing limit drops to zero.[4]

Ideally, the country would borrow (or lend) until the return on investment equals the borrowing rate. This is only possible, though, if the borrowing required to achieve this does not exceed the borrowing limit. Otherwise, the country borrows up to the limit. This implies the following dynamics for the capital stock:

$$k_{t+1} = \min\left\{ s \cdot A \cdot k_t^{\alpha} + \bar{f}_t - v_t + (1-\delta) \cdot k_t, \left(\frac{\alpha \cdot A}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}} \right\} \tag{6}$$

3. If courts could also seize the output that firms distribute to their owners, the economy's collateral would be $\alpha \cdot y_{t+1} + E_t v_{t+1}$. If credit contracts could not be contingent, the economy's collateral would be $\min v_{t+1}$.

4. Equation (5) incorporates our assumption that F is arbitrarily large and that it, therefore, always exceeds the discounted value of the economy's collateral.

For a given borrowing limit, equation (6) shows that high firm prices divert resources away from investment. This is the crowding-out effect of current firm prices, which is always present. But equation (5) shows that high expected firm prices expand the borrowing limit and provide additional resources for investment. This is the crowding-in effect of future firm prices, which operates in normal times when foreign borrowing is constrained by the lack of domestic collateral. To understand the dynamics of capital accumulation and foreign borrowing we must therefore establish how firm prices behave. We turn to this task next.

2. Asset bubbles and their effects

It might surprise some readers that there exist equilibria in which the prices of firms exceed the price of the capital these firms contain. When this is the case, we say that there is a bubble in firm prices. In particular, the appendix shows that there are many equilibria in which firm prices take the following form:

$$v_t = (1-\delta) \cdot k_t + b_t \tag{7}$$

Equation (7) says that the price of firms can be thought of as the sum of two components, which we refer to as the fundamental and the bubble.

The first component of the price of firms is the price of the capital that firms contain, or fundamental: $(1-\delta) \cdot k_t$. Investors are willing to pay this price for the capital contained in the firm since this is exactly what it would cost them to produce such an amount of capital through investment.

The second component of the price of firms is an "overvaluation" or bubble: b_t. At first glance, the existence of this bubble might seem inconsistent with maximization. If firms are bubbly, wouldn't investors prefer to create new firms at zero cost and then obtain the same amount of capital by investing in them? Whether this is a preferable strategy or not depends on how the bubble evolves over time. If the bubble grows fast enough, investors might even prefer purchasing bubbly firms over creating new ones at zero cost.

The question is then: how does the bubble component evolve in equilibrium? The appendix shows that the following bubble dynamics are consistent with maximization and market-clearing:

$$b_{t+1} = \begin{cases} \left(\rho + u_{t+1}\right) \cdot b_t + n_{t+1} & \text{if } z_t = N \\ \left(\alpha \cdot A \cdot k_{t+1}^{\alpha-1} + 1 - \delta + u_{t+1}\right) \cdot b_t + n_{t+1} & \text{if } z_t = S \end{cases} \tag{8}$$

such that $E_t u_{t+1} = 0$ and $n_{t+1} > 0$. Equation (8) says that the bubble has two sources of dynamics. The first one is the growth of pre-existing bubbles, while the second one is the creation of new bubbles. The first term of the right-hand side of equation (8) measures the growth rate of pre-existing bubbles. Since the return to the bubble is its growth, in equilibrium this growth is determined by supply and demand. In normal times, bubbles can be used as collateral to borrow, and their expected growth must equal the world interest rate: ρ. If bubbles grew faster, the demand for bubbly firms would be unlimited, since borrowing to purchase bubbly firms would deliver a net profit. If bubbles grew less, the demand for bubbly firms would be zero, since borrowing to purchase bubbles would produce a loss. During sudden stops, bubbles cannot be used as collateral to borrow and their expected growth must equal the opportunity cost of funds, which is the return to investment: $\left(\alpha \cdot A \cdot k_{t+1}^{\alpha-1} + 1 - \delta\right) \cdot b_t$. The second source of bubble dynamics is the creation of new bubbles: n_{t+1}. The new set of bubbles that are created or initiated by generation t of investors constitute net wealth for them.

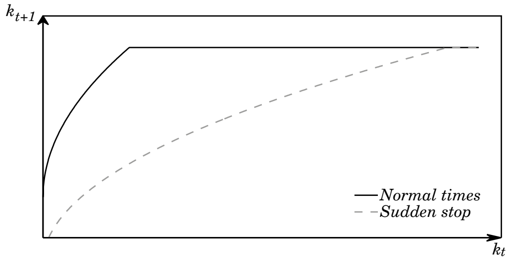
The argument above explains why the demand and supply for firms match at the proposed firm prices. But this argument is incomplete because we have implicitly assumed that the foreign borrowing associated with the bubble dynamics in equation (8) never exceeds the maximum F. For this to be the case, the bubble process must not explode and this requires that ρ be low enough. This is a key observation: bubbly equilibria are only possible in low interest rate environments. If ρ is high enough, there is a unique equilibria with $b_t = 0$ always.

Using equations (7) and (8), we can re-write equations (5) and (6) as follows:

$$k_{t+1} = \min\left\{ s \cdot A \cdot k_t^{\alpha} + \bar{f}_t - b_t, \left(\frac{\alpha \cdot A}{\rho + \delta - 1}\right)^{\frac{1}{1-\alpha}} \right\} \tag{9}$$

$$\bar{f}_t = \begin{cases} \dfrac{(1-\delta) \cdot s \cdot A \cdot k_t^{\alpha} + E_t n_{t+1}}{\rho + \delta - 1} + b_t & \text{if } z_t = N \\ 0 & \text{if } z_t = S \end{cases} \tag{10}$$

Figure 3. The law of motion for capital



Equations (9) and (10) jointly describe the law of motion of the capital stock. Figure 3 shows that this law of motion contains three differentiated regions. For high levels of capital stock, the law of motion is flat and independent of whether there is a sudden stop or not. In this range of capital stocks, the borrowing limit is never binding. The economy is capital-abundant and it exports savings until the return on investment equals the world interest rate. Sudden stops are irrelevant because the economy does not borrow abroad.

For intermediate levels of the capital stock, the law of motion is flat in normal times but upward-sloping during sudden stops. In this range of capital stocks, the borrowing limit is binding during sudden stops only. The economy is no longer capital-abundant but it has enough collateral to import savings until the return on investment equals the world interest rate in normal times. During sudden stops, however, domestic investors cannot borrow abroad and investment equals domestic savings. As a result, the capital stock drops and the return on investment increases above the world interest rate.

For low levels of the capital stock, the law of motion is upward-sloping both in normal times and during sudden stops. In this range of capital stocks, the borrowing limit is always binding. The economy does not have enough collateral to import savings until the return on investment equals the world interest rate. The law of motion in normal times is above that of sudden stops because domestic investors can supplement domestic savings with foreign savings in normal times, but this is not possible during sudden stops.

Equations (9) and (10) show that asset bubbles only affect capital accumulation if the borrowing limit is binding. Interestingly, the effects of bubbles on capital accumulation differ in normal times and during sudden stops. In normal times, bubble creation provides collateral that raises foreign credit and investment. This raises capital accumulation. During sudden stops, pre-existing bubbles divert part of the economy's savings away from investment. This lowers capital accumulation. To determine the relative importance of these two effects, we must look at specific equilibria.

To find equilibria of this economy, we take an initial condition $\{k_0, b_0, z_0\}$ and a joint stochastic process for $\{u_t, n_t, z_t\}$ such that $Pr\ (z_{t+1}{=}S/z_t = N) = \sigma$, $Pr\ (z_{t+1} = N/z_t = S) = \eta$, $E_t u_{t+1} = 0$ and $n_{t+1} \geq 0$. If all possible sequences for $\{k_t, b_t, z_t\}$ generated in this way are such that $b_t \geq 0$ and $k_t \geq 0$, then we have found an equilibrium of the model. It turns out that this simple model can give rise to a large set of equilibria. A full analysis of this set is beyond the scope of this paper, and we refer the reader to our earlier work. Here, we just show some examples to build intuition.

3. Examples

We now construct a set of examples to illustrate the effect of bubbles. First, we simplify by assuming that η=1. That is, sudden stops only last one period. Second, we assume a very simple bubble process. During normal times the bubble is constant and equal to b. Bubble creation adjusts to ensure this. During sudden stops the bubble drops by a fraction d and there is no bubble creation.[5]

5. In particular, we assume the economy starts in $k_t = k_0$, $b_t = b$ and $z_t = N$ and $\{u_t, n_t\}$ follows this stochastic process:

$$n_{t+1} = \begin{cases} \left(1 - \rho - d \cdot \dfrac{\sigma}{1-\sigma}\right) \cdot b & \text{if } z_t = N \text{ and } z_{t+1} = N \\ 0 & \text{if } z_t = N \text{ and } z_{t+1} = S \\ \left[1 - \left(\alpha \cdot A \cdot k_{t+1}^{\alpha-1} + 1 - \delta\right) \cdot \left(\rho - d\right)\right] \cdot b & \text{if } z_t = S \end{cases}$$

$$u_{t+1} = \begin{cases} d \cdot \dfrac{\sigma}{1-\sigma} & \text{if } z_t = N \text{ and } z_{t+1} = N \\ -d & \text{if } z_t = N \text{ and } z_{t+1} = S \\ 0 & \text{if } z_t = S \end{cases}$$

There are thus two key parameters that drive the example: the size of the bubble b, and its reaction to a sudden stop d. A higher value of b implies more bubble creation and thus greater borrowing and investment during normal times, but it also diverts more resources away from investment during sudden stops. A higher value of d means that the bubble becomes smaller during sudden stops and reduces its negative impact on investment at these times.

Based on these observations, we consider five different equilibria that are defined as follows:

Size\Reaction to Sudden Stop	d=0	d=ρ
b=0	1	1
$b=b_L$	2	3
$b=b_H$	4	5

We analyze each equilibrium under the assumption that $\rho < 1-\sigma$ (i.e., that the probability of experiencing a sudden stop is sufficiently low). In equilibria 2 and 4 the size of the bubble does not change during sudden stops, whereas in equilibria 3 and 5 the bubble disappears during sudden stops.

We simulate each of these equilibria by assuming that the economy starts in the steady state that corresponds to normal times and then simulating it forward for 100,000 periods. Table 1 reports the parameter values used in these simulations. Table 2 reports the mean and the standard deviation of k_t, y_t, c_t, f_t, and v_t for each simulation. Figure 4 plots the simulated time series of k_t, c_t and f_t during a window of 20 periods. These simulations offer an excellent summary of the main effects of bubbles in our economy.

Table 1. Parameter values

Parameter	*Value*	*Parameter*	*Value*
A	1	δ	0.8
α	0.47	b_L	$1.25k_A^*$
μ	0.9	b_H	$2.5k_A^*$
ρ	0.6	σ	0.15

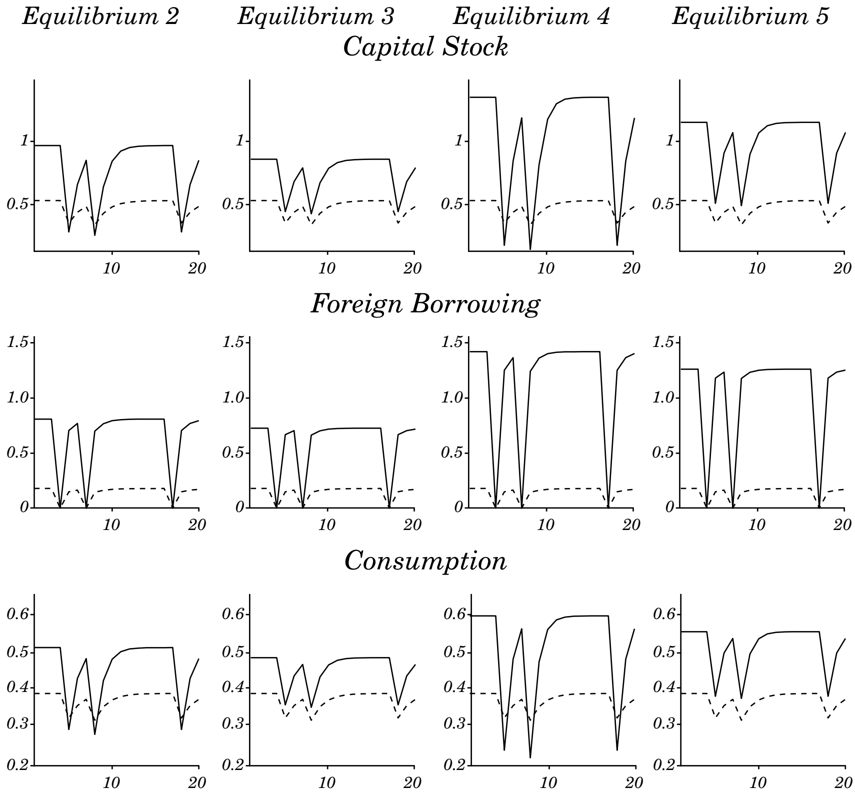
Notes: k_A^* stands for the steady-state capital stock that would prevail in autarky (that is, $k_A^* = (sA)^{\frac{1}{1-\alpha}}$).

Table 2. Summary statistics

Equilibrium	*1*	*2*	*3*	*4*	*5*
k_t					
Mean	0.485	0.813	0.768	1.097	1.020
Standard deviation	0.063	0.238	0.144	0.406	0.219
y_t					
Mean	0.710	0.894	0.879	1.011	1.002
Standard deviation	0.046	0.150	0.086	0.248	0.116
c_t					
Mean	0.372	0.467	0.460	0.529	0.524
Standard deviation	0.024	0.079	0.045	0.130	0.061
f_t					
Mean	0.147	0.680	0.617	1.200	1.079
Standard deviation	0.058	0.267	0.241	0.471	0.421
v_t					
Mean	0.097	0.456	0.422	0.805	0.741
Standard deviation	0.013	0.059	0.105	0.108	0.208

First, bubbles improve the workings of the economy in normal times but worsen them during sudden stops. In normal times, the collateral that bubbles provide raises foreign borrowing and investment; during sudden stops, these same bubbles divert resources away from investment in what could be termed a "bubble overhang" effect. Thus, bubbles create additional volatility. Table 2 indeed shows that the mean values and standard deviations of k_t, y_t, c_t, f_t, and v_t are highest in equilibria 4 and 5, followed by equilibria 2 and 3 (in which b=b_L) and, finally, by equilibrium 1 (in which b=0). Figure 4 also illustrates this point for a given subsample of the simulation. In each panel, the solid line depicts the simulated time series of the specific equilibrium being analyzed, whereas the dashed line depicts the simulated time series for equilibrium 1. The figure shows how bubbles raise volatility by increasing economic activity in normal times and, in equilibria, by lowering it during sudden stops.

Figure 4. Simulated time series



Note: Dashed lines show the time series for Equilibrium 1 (no bubble).

Second, all bubbles are not alike. In terms of economic activity, the best bubbles are those that maximize investment in normal times while hurting it as little as possible during sudden stops. Intuitively, these are bubbles that are large on average but small during sudden stops. In our examples, we have already mentioned that the average values of k_t, c_t and y_t are in fact maximized in equilibria 4 and 5, in which $b=b_H$. Among these, equilibrium 4 displays both a higher average and volatility of these variables. In particular, even though the values of k_t, c_t and y_t are substantially higher in equilibrium 4 than in 5 during normal times, the opposite is true during sudden stops. The reason is that $d > 0$ in economy 5. This reduces volatility by making the bubble smaller during sudden stops, but it also reduces investment and output by reducing bubble creation during normal times.

This second result is important to contrast our conclusions with those obtained from related models in the literature. In our model, a fall in asset prices during sudden stops is actually good for economic activity: given expected asset prices, such a fall reduces payments to foreigners and increases domestic resources available for investment. This follows in our setup because credit contracts are contingent and borrowing constraints depend on expected asset prices. This is contrary to most other models in the literature, which assume that borrowing constraints depend on contemporaneous asset prices. Thus, a fall in asset prices during sudden stops tightens borrowing constraints even further, and leads to an even more severe drop in investment.

A third important point illustrated by our example is that, even though all bubbles are different, it is not possible to determine whether the market will select any specific one over the rest. Thus, sometimes the bubble sustained by market expectations may be too small, preventing the country from taking advantage of foreign borrowing; at other times the bubble may be too large, generating large recessions during sudden stops. This raises the question of whether policy can be used to improve upon the market equilibrium. We now turn to his question, focusing on the specific role of capital controls.

4. MANAGING CAPITAL FLOWS

We introduce a government that manages capital flows by introducing capital controls, i.e., taxes and/or subsidies to foreign borrowing and/or repayment. We then use this modified model to ask two key questions: Can capital controls be used to replicate a desired equilibrium bubble? If so, what should they look like?

To address these questions, let us revisit the role played by the bubble in our economy. The bubble creates a series of transfers between individuals. Current borrowers use b_t of the funds borrowed today to buy the bubble from previous borrowers, which in turn use this income to make payments to foreigners. But the bubble also allows current borrowers to increase their foreign borrowing by $\frac{E_t b_{t+1}}{\rho}$, since they will sell the bubble to future borrowers for a price of b_{t+1}, and they will use this income to make additional payments to foreigners. Of course, this last effect is absent during a sudden stop. Thus, from the perspective of the country as a whole these transfers generate the following funds for investment:

$$v_t^b = \begin{cases} \frac{1}{\rho+\delta-1}\cdot\left(\frac{E_t b_{t+1}}{\rho} - b_t\right) & \text{if} \quad z_t = N \\ -b_t & \text{if} \quad z_t = S \end{cases} \tag{11}$$

Equation (11) summarizes the effect of a bubble on investment. In normal times, the country as a whole is paying foreigners with a fraction of the funds that it's borrowing from them. The bubble therefore raises both gross inflows and outflows (i.e., payments from foreigners to domestic residents and vice-versa). The bubble also raises the difference between the two, i.e., the increase in net inflows provides resources that can be leveraged to boost investment. During sudden stops, the presence of the bubble does not increase foreign borrowing, but it does mean that the patient young must divert part of their resources towards purchasing the bubble from the old. Thus, equation (11) restates the main result of our examples: the bubble raises investment in normal times but detracts from it during sudden stops. In terms of maximizing investment, therefore, the ideal bubble is one that entails the most bubble creation during normal times while being as small as possible during sudden stops. Of course, nothing guarantees that the market will deliver this bubble, and this is where capital controls may be of help.

Assume that the government imposes a lump-sum tax on foreign borrowing (or gross capital inflows) equal to p_t, where p_t can be state contingent and p_t<0 indicates a subsidy on borrowing. We assume initially that these tax revenues are transferred to previous borrowers so that they can make payments to foreigners, i.e., taxes on gross capital inflows go hand-in-hand with subsidies on gross capital outflows. In order to establish an analogy with the dynamics of the bubble, we can express the evolution of p_t as:

$$p_{t+1} = \begin{cases} \left(\rho + e_{t+1}\right)\cdot p_t + m_{t+1} & \text{if } z_t = N \\ \left(\alpha\cdot A\cdot k_{t+1}^{\alpha-1} + 1 - \delta + e_{t+1}\right)\cdot p_t + m_{t+1} & \text{if } z_t = S \end{cases}, \tag{12}$$

such that $E_t e_{t+1}$ and $m_{t+1} \lesseqgtr 0$ reflects the net wealth that the policy transfers to patient individuals of generation t. To see this, consider an individual of generation t that pays a tax p_t when borrowing during youth but expects to receive a subsidy p_{t+1}, to be used for the repayment of creditors, during old age. For such an individual, the policy represents a transfer of present-value wealth equal to,

$$\begin{aligned} \frac{E_t m_{t+1}}{\rho} &= \frac{E_t p_{t+1}}{\rho} - p_t & \text{if } z_t = N \\ \frac{E_t m_{t+1}}{\alpha \cdot A \cdot k_{t+1}^{\alpha-1} + 1 - \delta} &= \frac{E_t p_{t+1}}{\alpha \cdot A \cdot k_{t+1}^{\alpha-1} + 1 - \delta} - p_t & \text{if } z_t = S \end{aligned}.$$

Although equation (12) has been deliberately written so that the evolution of p_t mimics the evolution of b_t in equation (8), both processes are not subject to the same constraints. In particular, whereas b_t and n_t must be non-negative, p_t and m_t can be either positive or negative: $p_t<0$ means that the policy prescribes a subsidy on gross capital inflows at time t, and $E_t m_{t+1}<0$ means that—in expectation—the policy extracts wealth from generation t.

We are now ready to analyze the main effects of capital controls on our economy. First, the expectation of subsidies on gross capital outflows tomorrow enables patient individuals to expand their borrowing today, i.e., current borrowers can pledge both the expected value of their firms and the expected value of subsidies. Taking this into account, we can re-write equations (5) and (6) as follows:

$$k_{t+1} = \min\left\{ s \cdot A \cdot k_t^{\alpha} + \bar{f}_t - b_t - p_t, \left(\frac{\alpha \cdot A}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}} \right\} \tag{13}$$

$$\bar{f}_t = \begin{cases} \dfrac{E_t v_{t+1} + E_t p_{t+1}}{\rho} & \text{if } z_t = N \\ 0 & \text{if } z_t = S \end{cases} \tag{14}$$

Equations (13) and (14) are natural generalizations of equations (9) and (10) and they illustrate the conflicting effects of policy on capital accumulation. Every period, the policy imposes taxes on current borrowers and gives it to previous borrowers so that they can make payments to foreigners. This is the crowding-out effect of the policy. During normal times, though, the policy also has a crowding-in effect because it allows current borrowers to expand their foreign borrowing against the expected subsidies that they will receive at the time of repayment $\frac{E_t p_{t+1}}{\rho}$, which will be funded with the taxes of future borrowers. In the aggregate, this policy generates the following funds for investment:

$$v_t^p = \begin{cases} \frac{1}{\rho+\delta-1} \cdot \left(\frac{E_t p_{t+1}}{\rho} - p_t \right) & \text{if } z_t = N \\ -p_t & \text{if } z_t = S \end{cases} \tag{15}$$

To find equilibria in this economy, we take an initial condition $\{k_0, b_0, z_0, p_0\}$ and a stochastic process for $\{u_t, n_t, e_t, m_t\}$ such that $E_t u_{t+1}=0$, , and $n_{t+1} \geq 0$ for all t. If all possible sequences for $\{k_t, b_t, z_t, p_t\}$ generated in this way are such that $b_t \geq 0$ and $k_t \geq 0$, then we have found an equilibrium of the model.

What can a government achieve by adopting capital controls? A crucial result, which follows directly from comparing equations (9) and (10) with equations (13) and (14), is that taxes and subsidies on gross capital flows can be used to complement or counteract fluctuations in the bubble. If the bubble is not high enough to take full advantage of foreign funds during normal times, a policy that sets $E_t m_{t+1}>0$ by taxing gross capital inflows and subsidizing gross capital outflows helps raise foreign borrowing. Such a policy amounts to a government guarantee on foreign payments and, as long as the rate of economic growth is higher than the interest rate, it can be designed to raise the wealth of borrowers at each point in time. During sudden stops, if the bubble is positive, thereby diverting funds from investment, a policy that sets $p_t<0$ and taxes gross capital outflows is also useful. By reducing foreign payments and transferring resources to the patient young, such a policy raises the availability of domestic resources for investment and fuels growth. Thus, although capital controls do not directly affect the equilibrium value of the bubble, they do enable the government to “select” an equilibrium allocation among those that are feasible.

We return to our example with $\eta=1$ to see how this can be done. In particular, we choose a policy rule that maximizes output. In normal times, this policy injects sufficient collateral to allow the economy to borrow until the return on investment equals the world interest rate. During sudden stops, borrowing is not possible and the goal of policy is to offset the bubble and ensure that all domestic savings are used for capital accumulation.[6]

The effects of this policy rule can be analyzed by simulating the economy for each of the equilibria considered in section 3. Table 3 reports the mean and the standard deviation of k_t, y_t, c_t, f_t, and v_t for these simulations, where as figure 5 and 6 plots the simulated series for k_t, c_t and f_t, v_t and p_t over a window of 20 periods. The main result here is that, as figure 5 shows, the evolution of k_t, c_t and f_t is the same for all equilibria.

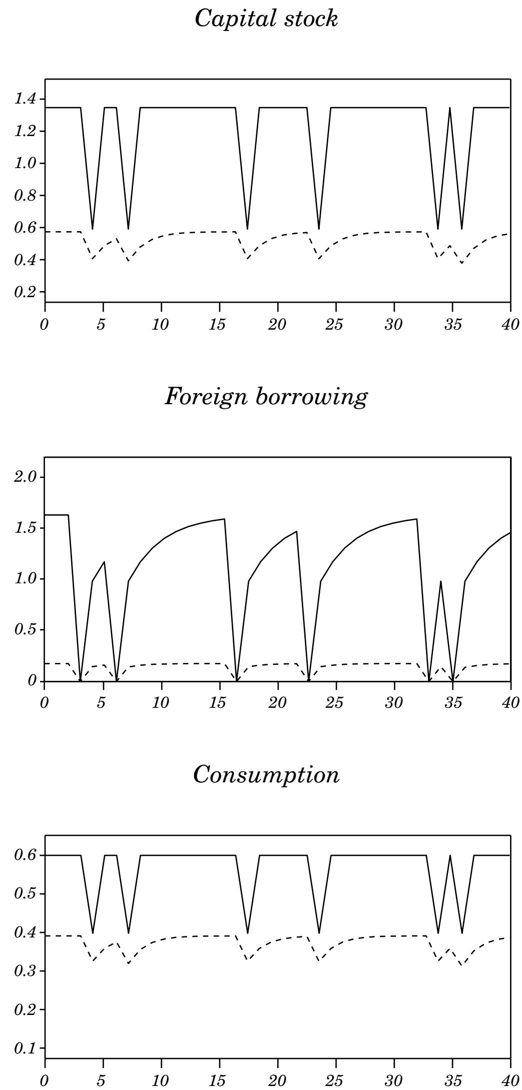
Figure 6 shows that, to attain the policy goals, taxes on gross inflows and outflows are contingent on the evolution of the bubble. In particular, taxes on gross capital inflows are used to complement bubble creation during normal times, raising collateral and thus foreign borrowing. Taxes on gross capital outflows are used instead during sudden stops to reduce payments to foreigners in an amount equal to the size of the bubble. By doing so, they redirect resources away from foreign creditors and towards young borrowers, enabling them to purchase the bubble without reducing investment.

This example shows how bubbles provide a new rationale for capital controls. When foreign borrowing is limited by the demand for funds, the government can complement the existing bubble with subsidies to capital outflows. When foreign borrowing is instead limited by the external supply of funds, the government can reduce the bubble's impact on investment by taxing capital outflows. Note that this policy can be loosely interpreted as an insurance or "counter-cyclical" fund, to which patient individuals contribute during youth in the expectation of receiving a transfer during old age if the bubble turns out to be low. But this insurance is not actuarially fair, and this is a crucial aspect of the policy. If $E_t m_{t+1} > 0$, as our proposed policy is during normal times, it provides net resources to the patient individuals of generation , thereby enabling them to expand their foreign borrowing. If $E_t m_{t+1} < 0$, it extracts net resources from the patient individuals of generation t.

This policy might seem at odds with the type of capital controls usually stressed in the literature, which are used in a "prudential" fashion to reduce capital inflows during normal times. In those models, as we have mentioned, capital inflows are inefficiently high during normal times and controls can be useful to reduce them. In our model, instead, capital inflows are inefficiently low during normal times because the economy suffers from a constant lack of collateral.

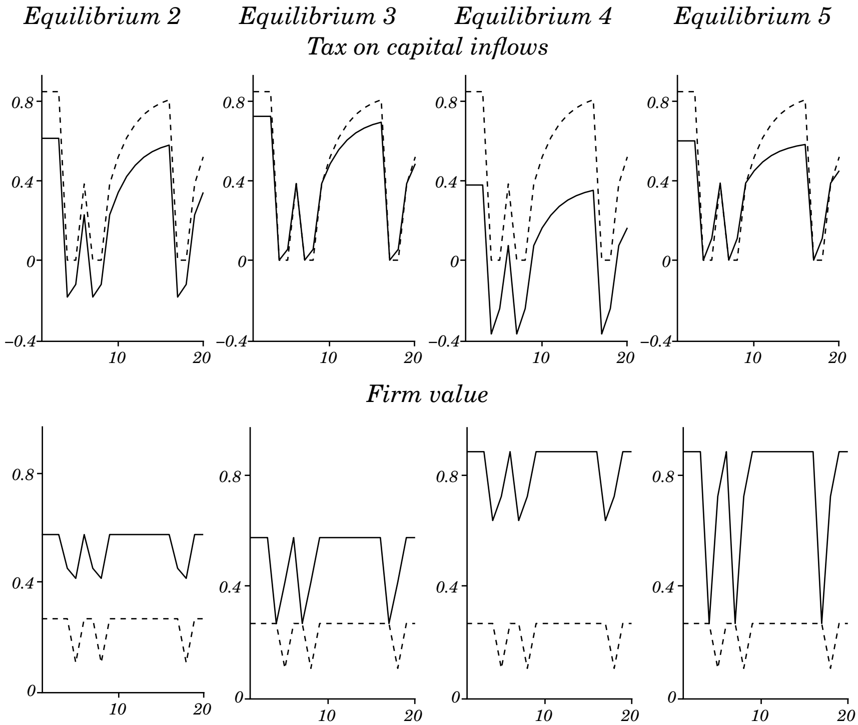
6. In particular, we assume that the economy starts in $k_t = k_0$, $b_t = b$ and $z_t = N$, and for a given stochastic process $\{u_t, n_t\}$, we define the following policy rule:

Figure 5. Simulated time series with capital controls



Notes: Dashed lines show the time series for Equilibrium 1 (no bubble) without capital controls.

Figure 6. Tax on capital inflows and firm values



Note: Dashed lines show the time series for Equilibrium 1 (no bubble).

The same low interest rate environment that gives rise to bubbles, however, makes it possible for the government to “inject” collateral during normal times by taxing gross capital inflows and subsidizing gross capital outflows. If ρ was higher than one, the tax dynamics in equation (12) would require p_t to explode during normal times, and this would violate our implicit assumption that foreign borrowing cannot exceed the maximum $\boldsymbol{F}$.

A final consideration refers to the robustness of our results. We have assumed throughout that the government runs a balanced budget in the sense that subsidies on capital outflows are fully financed by levying taxes on capital inflows. Nothing depends on this assumption, however, and it is possible to show that all of the results of this section go through if the government finances subsidies by issuing debt.

Table 3. Summary statistics

Equilibrium	*1*	*2*	*3*	*4*	*5*
k_t					
Mean	1.250	1.250	1.250	1.250	1.250
Standard deviation	0.272	0.272	0.272	0.272	0.272
y_t					
Mean	1.101	1.101	1.101	1.101	1.101
Standard deviation	0.135	0.135	0.135	0.135	0.135
c_t					
Mean	0.576	0.576	0.576	0.576	0.576
Standard deviation	0.071	0.071	0.071	0.071	0.071
f_t					
Mean	1.220	1.321	1.440	1.423	1.659
Standard deviation					
v_t					
Mean	0.521	0.544	0.582	0.572	0.654
Standard deviation	0.055	0.064	0.110	0.093	0.208

Although we refer the reader to our earlier work for a thorough treatment of this issue, the intuition behind this result is that debt has the same effects on investment as the bubble does.[7] During normal

7. For a full treatment of the effects of debt in this kind of model, see Martin and Ventura (2014a).

$$m_{t+1} = \begin{cases} \dfrac{\rho}{1-\sigma} \cdot \max\left\{ \left(\dfrac{\alpha \cdot A}{\rho + \delta - 1} \right)^{\frac{1}{1-\alpha}} \cdot \dfrac{\rho + \delta - 1}{\rho} - s \cdot A \cdot k_t^{\alpha} - \dfrac{E_t n_{t+1}}{\rho}, 0 \right\} & \text{if } z_t = N \text{ and } z_{t+1} = N \\ 0 & \text{if } z_t = S \text{ or } z_{t+1} = S \end{cases}$$

$$e_{t+1} = \begin{cases} \dfrac{\sigma}{1-\sigma} \cdot \left(\dfrac{b_{t+1}}{p_t} + \rho \right) & \text{if } z_{t+1} = N \\ -\dfrac{b_{t+1}}{p_t} - \rho & \text{if } z_{t+1} = S \end{cases}$$

times, a high expected value of debt allows borrowers to obtain more financing today, because—all else being equal—higher expected debt means that they will receive higher subsidies during old age. This is the crowding-in effect of debt. During sudden stops, however, debt has also a crowding-out effect: although foreign borrowing collapses, the existing stock of debt must still be purchased by the patient young and it therefore diverts resources away from investment.

5. Concluding remarks

We live in a world of financial globalization and historically low interest rates. These interest rates create the conditions for bubbles to exist, which in turn affect the size and direction of capital flows. In this paper, we have developed an analytical framework to think about this interplay, with three main results. First, the effects of bubbles on economic activity depend on the circumstances at hand. During "normal times," when the supply of funds from the international financial market is high, bubbles raise net capital inflows, investment and growth. During sudden stops, when foreign funding dries up, bubbles instead have a negative effect on net capital inflows and economic activity. Second, the bubble that attains the optimal level of investment should therefore be large during normal times and small during sudden stops. But bubbles are driven by market expectations, and nothing guarantees that the equilibrium bubble will behave in the way that it is desired. This leads to our third result, which says that the government can replicate the desired bubble allocation through the appropriate use of capital controls. In particular, we show that it can maximize investment by subsidizing gross capital outflows and taxing gross capital inflows during normal times while adopting the opposite policy during sudden stops.

The framework developed here is closely related to models of financial frictions that have been recently used to advocate the usefulness of capital controls.[8] And yet, its implications for policy are quite different. The literature stresses the use of capital controls in a "prudential" fashion to reduce capital inflows during normal times. Our model instead suggests that policy interventions should be used to boost inflows even further during normal times. The main reason behind this difference is that we focus on a low interest rate

8. For a survey of this literature, see Korinek (2011).

environment, in which bubbles are possible. This same assumption guarantees that the government can boost net capital inflows, and thus foreign liabilities, beyond their equilibrium level. Basically, it can do so by using subsidies on gross capital outflows to roll over foreign liabilities during normal times. Once the sudden stop comes, the policy is reverted and gross capital outflows are taxed to raise domestic resources for investment.

These results provide a rich view of the relationship between bubbles and capital flows, and their implications for the design of policy. The framework has an important limitation, however: it considers only the case of a small open economy. Relaxing this assumption has crucial implications, both from the perspective of the economy that we are considering and of the world as a whole. From the perspective of our economy, abandoning this assumption means that it no longer faces a fully elastic supply of funds during normal times. This means that bubbles are unable to replicate the optimal level of investment even during normal times, because they raise the interest rate faced by the country so that there is always both a crowding-in and a crowding-out effect. From the perspective of the world as a whole, abandoning the small-open economy assumption means that capital controls have effects on third countries. When an economy adopts the policy analyzed here, it boosts capital inflows for instance, thereby reducing the availability of funds in the rest of the world and raising the international interest rate. This lowers investment and growth in other countries and, in a low-interest rate environment like the one that we consider, it may generate severe crises in the rest of the world by bursting existing bubbles. These global or systemic issues are fundamental. In Martin and Ventura (2014b), we develop a general equilibrium model of the world economy in order to address them appropriately.

APPENDIX

Let $j = 1,...,J$ be the patient young, and let $l = 1,..., L$ be the patient old. The old sell their firms to the young. The equilibrium prices of these firms is v_t^l and they contain undepreciated capital $(1-\delta)\cdot k_t^l$. Since there is one firm per old, they have the same index: $l = 1,..., L$. The young purchase these firms and make additional investments to build their own firms. Since there is one firm per young, they also have the same index: $j = 1,...,J$. L_j now defined as the set of firms that young purchases. He/she chooses i_t^j, f_t^j and L_j so as to maximize:

$$E_t c_{t+1}^j = R_{t+1}^K \cdot k_{t+1}^j + E_t v_{t+1}^j - \rho \cdot f_t^j \tag{16}$$

where $R_{(t+1)}^K = \alpha \cdot A \cdot k_{t+1}^{\alpha-1}$. Maximization is subject to these constraints:

$$w_t = i_t^j + \sum_{l \in L_j} v_t^l - f_t^j \tag{17}$$

$$k_{t+1}^j = i_t^j + \sum_{l \in L_j} (1-\delta) \cdot k_t^l \tag{18}$$

$$f_t^j \leq \begin{cases} \dfrac{E_t v_{t+1}^j}{\rho} & \text{if } z_t = N \\ 0 & \text{if } z_t = S \end{cases} \tag{19}$$

These constraints are self-explanatory.

We need to find a price process such that, given this price process, maximization leads to market-clearing. We propose the following one:

$$v_t^j = (1-\delta) \cdot k_t^j + b_t^j \tag{20}$$

$$b_{t+1}^j = \begin{cases} \left(\rho + u_{t+1}^j\right) \cdot b_t^j + n_{t+1}^j & \text{if } z_t = N \\ \left(R_{t+1}^K + 1 - \delta + u_{t+1}^j\right) \cdot b_t^j + n_{t+1}^j & \text{if } z_t = S \end{cases} \tag{21}$$

with $E_t u_{t+1}^j = 0$ and $n_{t+1}^j > 1$. Everybody expects this stochastic process to drive prices. Let us see if markets clear when individuals maximize.

The old are willing to sell at any price. What about the young? We show next that they are also willing to buy since they are indifferent about L_j.

Assume first that $R^K_{t+1}>\rho$ and the collateral constraint is not binding. Then, using this price process and substituting constraints (17)-(19) into the objective function (16), we find that:

$$E_t c^j_{t+1} = \rho \cdot \left(i^j_t + \Sigma_{l \in L_j} \left(1-\delta\right) \cdot k^l_t \right) + \rho \cdot \Sigma_{l \in L_j} b^l_t + E_t n^j_{t+1}$$
$$- \rho \cdot \left(i^j_t + \Sigma_{l \in L_j} \left(\left(1-\delta\right) \cdot k^l_t + b^l_t \right) - w_t \right) = \rho \cdot w_t + E_t n^j_{t+1}$$

With these prices, young j is indifferent about L_j. The old are happy to sell.

Assume next that $R^K_{t+1}>\rho$ and the collateral constraint is binding. There are two subcases here. First, assume we are in a sudden stop and $f_t=0$. Using the price process and substituting constraints (17), (18) and (19) into the objective function (16), we find that:

$$E_t c^j_{t+1} = R^K_{t+1} \cdot \left(w_t - \Sigma_{l \in L_j} b^l_t \right) + \left(1-\delta\right) \cdot \left(w_t - \Sigma_{l \in L_j} \quad b^l_t \right) +$$
$$\left(R^K_{t+1} + 1 - \delta \right) \cdot \Sigma_{l \in L_j} b^l_t + E_t n^j_{t+1} = \rho \cdot w_t + E_t n^j_{t+1}$$

Again, with these prices young j is indifferent about L_j.

Second, assume that we are in normal times and $f_t = \frac{E_t v^j_{t+1}}{\rho}$. Using the price process and substituting constraints (17), (18) and (19) into the objective function (16), we find:

$$E_t c^j_{t+1} = R^K_{t+1} \cdot \left(w_t - \Sigma_{l \in L_j} b^l_t + \Sigma_{l \in L_j} b^l_t + \frac{E_t n^j_{t+1}}{\rho} \right) = R^K_{t+1} \cdot \left(w_t + \frac{E_t n^j_{t+1}}{\rho} \right)$$

Again, with these prices, young j is indifferent about L_j. Thus, we have reached the conclusion that this price process is consistent with maximization.

Is this price process also consistent with market-clearing? It follows from the previous discussion that demand and supply for firms match with this price process, but there is a loose end in the discussion. In particular, we have implicitly assumed that the upper limit on foreign borrowing F is never binding. To ensure this, firm prices cannot grow too much. And this, in turn, requires that ρ be sufficiently low. We assume throughout that this is the case.

Having proved now that this price process is consistent with both maximization and market-clearing, we can aggregate over j and l, obtaining equations (7) and (8) in the text.

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Global Liquidity, Spillovers to Emerging Markets and Policy Responses

This book addresses one of the most prominent macroeconomic issues of our times: How do the extraordinary measures adopted by the central banks of the North in response to their recent financial crises, impact emerging market economies? The book is a tour the force covering a wide array of theoretical and applied themes that shed light on this central question, as well as on other episodes of large capital flows and global imbalances.

Ricardo Cabellero
Massachusetts Institute of Technology

The chapters in this book present thought-provoking analyses of various dimensions of what falls under the popular heading of "global liquidity." The contributors are leading scholars and policymakers in their fields. The narratives alternate between examining the determinants and consequences of global liquidity and connect key themes in macroeconomics, international finance, and monetary and exchange rate policymaking in open economies. The collection is a must-read for academics, policymakers and financial market participants seeking to sharpen their grasp of the interconnected world of global finance.

Carmen M. Reinhart
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The financial crises of the last twenty-five years, and specially the recent global financial crisis, have illustrated the important role that capital flows and global financial liquidity have played in these episodes. Thus, is not surprising that the study of the causes and management of capital flows and global liquidity have become a central theme in macro financial stability and management both at the country and at the global level. This book provides a good selection of key aspects in relations to the causes and consequences of global liquidity. The book is a timely addition to this literature and should be of much interest to policy makers and financial analysts alike, I strongly recommend it to both types of audience.

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