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ECONOMÍA CHILENA

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RESÚMENES

BURBUJAS, CRISIS, RECUPERACIÓN DEL EMPLEO Y DESEMPLEO INVOLUNTARIO, CON UN ENFOQUE DE LIQUIDEZ

Guillermo Calvo

El trabajo muestra que las consideraciones de liquidez entregan un fundamento sencillo para la creación y destrucción de burbujas y los trastornos relacionados en el mercado de crédito, en particular la pérdida de valor de las garantías. Se presenta un marco en el que las perturbaciones del crédito pueden explicar las recuperaciones del empleo y el desempleo involuntario. La recuperación del empleo surge del supuesto de que crear empleo es menos ventajoso que invertir en capital físico, ya que este produce su propia garantía. El desempleo involuntario surge porque, debido a fuertes restricciones al capital de trabajo, el salario real de pleno empleo puede destruir la ética laboral hasta tal punto que resulte más rentable para las empresas fijar sus remuneraciones por encima del nivel de pleno empleo, aun si los salarios nominales son flexibles a la baja. Los modelos son simples e intuitivos, y proporcionan un enfoque alternativo adecuado para la comprensión de algunas de las características básicas y típicas de toda crisis financiera.

¿POR QUÉ LOS PAÍSES ADOPTAN UNA REGLA FISCAL?

Ibrahim Elbadawi / Klaus Schmidt-Hebbel / Raimundo Soto

Las reformas a las instituciones fisacles y las reglas fiscales persiguen diversos objetivos: fortalecer la solvencia y la sostenibilidad fiscal, contribuir a la estabilización macroeconómica, y estimular la resiliencia frente a la corrupción estatal y el cabildeo del sector privado. Estos objectivos fiscales son compartidos por la mayoría de los países del mundo. La pregunta que surge es: ¿Por qué unos países adoptan una regla fiscal y otros países no? Responderla pasa por identificar bajo qué condiciones ciertos países han decidido implementar una regla fiscal y mantenerla en el tiempo.

TRANSMISIÓN ENDÓGENA DEL TIPO DE CAMBIO Y REGÍMENES CAMBIARIOS AUTOVALIDADOS

Giancarlo Corsetti / Paolo Pesenti

Un dilema de larga data en las economías abiertas se refiere a la moneda en que se denominan los precios nominales y los contratos. Este trabajo analiza la interacción entre los precios de exportación de las empresas y la política monetaria, y sus posibles implicancias macroeconómicas en la sincronización de los ciclos económicos y la elección de régimen cambiario. En el marco de un modelo monetario muy estilizado, proponemos una caracterización analítica de la fijación óptima de precios de exportación por parte de un monopolio imperfecto sujeto a rigideces nominales. Se demuestra que, al momento de elegir la moneda de denominación de sus exportaciones, las empresas optimizan la covarianza entre el logaritmo del tipo de cambio y el inverso del margen de ventas. Como dicta la intuición, la moneda de denominación de las exportaciones afecta la exposición del ingreso marginal de las empresas a *shocks* que mueven el tipo de cambio y la demanda en los mercados de destino.

ABSTRACTS

THE LIQUIDITY APPROACH TO BUBBLES, CRISES, JOBLESS RECOVERIES, AND INVOLUNTARY UNEMPLOYMENT

Guillermo Calvo

The paper shows that liquidity considerations provide a simple rationale for the creation and destruction of bubbles, and related disturbances in the credit market—the fall in collateral values, in particular. It presents a framework in which credit disturbances can explain jobless recoveries and involuntary unemployment. Jobless recovery follows from the assumption that job creation is at a disadvantage with respect to physical capital investment projects, because the latter furnish their own collateral. Involuntary unemployment arises because, due to severe working capital constraints, the full-employment real wage would ravage work ethic to such an extent that firms find it more profitable setting their wages above the full-employment level—even though nominal wages are perfectly downward flexible. The models are simple and intuitive, and provide an alternative approach which the paper claims is well suited for understanding some basic and common features of financial crises.

WHY DO COUNTRIES HAVE FISCAL RULES?

Ibrahim Elbadawi, Klaus Schmidt-Hebbel and Raimundo Soto

Reforms of fiscal institutions and fiscal rules are motivated by several objectives: strengthening fiscal solvency and sustainability, contributing to macroeconomic stabilization, and making fiscal policy more resilient to government corruption and private-sector lobby. These objectives are shared by most fiscal policy makers worldwide. So why do some countries adopt fiscal rules while others do not? This question boils down to identifying the conditions under which some countries decide to adopt fiscal rules and maintain them over time.

ENDOGENOUS EXCHANGE-RATE PASS-THROUGH AND SELF-VALIDATING EXCHANGE RATE REGIMES

Giancarlo Corsetti and Paolo Pesenti

A long-standing question in open macroeconomics concerns the choice of currency denomination of nominal prices and contracts. This paper analyzes the interaction between firms' export pricing and monetary policy, and discusses its potential macroeconomic implications for business cycle synchronization and the choice of an exchange rate regime. In the framework of a highly stylized monetary model, we provide an analytical characterization of the optimal export pricing by imperfectly monopolistic firms subject to nominal rigidities. We show that, when choosing the currency denomination of exports, firms optimize over the covariance between the log of the exchange rate and the inverse of the markup. Intuitively, the currency denomination of exports affects the exposure of firms' marginal revenue to the shocks moving the exchange rate and demand in the destination markets.

THE LIQUIDITY APPROACH TO BUBBLES, CRISES, JOBLESS RECOVERIES, AND INVOLUNTARY UNEMPLOYMENT*

Guillermo Calvo**

I. INTRODUCTION

Future generations will likely remember the turn of the 21st century as the time when mainstream macroeconomics was about to completely remove money and finance from its models, and perished in the attempt. Before the subprime crisis, macroeconomic/monetary theory reached a level of pristine perfection according to which central banks could be masters of the (macro) universe by expertly tweaking a policy interest rate (usually a very short-run interest rate) and/or (some) exchange rate. The hard work was not placed on the shoulders of experienced sleuths that would scour every corner of the financial system in search of structural defects. Rather, the job fell on the shoulders of bright-eyed PhDs whose main task was to develop computer algorithms that would reveal the deep secrets of models in which money and finance were largely emasculated. Money disappeared from the picture as a policy instrument because it was assumed to be an *endogenous* variable. Finance remained but only as a faint shadow of itself; represented by a policy interest rate and a set of inter-temporal arbitrage conditions (which, incidentally, have dubious empirical support). The map was completed by slapping on some exogenous (unexplained and poorly motivated) random shocks and, above all, assuming some kind of expectations' rationality. The latter made the task especially challenging and fit for PhDs in economics (or physics). Don't get me wrong. This is valuable research from a scientific point of view. There is nothing wrong for scientists to explore what may at first look as implausible scenarios (just think of Einstein's theory of relativity!). The problem in this case is that, in my opinion, those models kept central banks from paying enough attention to the workings of the financial system. To be true, central banks were not alone in this struggle. Either inside or outside central banks, there were financial regulators whose countenance better fit that of experienced sleuths. However, financial regulators tended to focus on *micro* issues and, as a general rule, kept their communications with their central banks at a bare minimum (and it seemed to work!).

To be true, for emerging market economies (EMs) the Great Moderation period was much less than tranquil, and it was rather tempting to relabel it Great Immoderation! Sudden Stop crises were the order of the day since the mid 1990s. But this was taken as a reflection of weak domestic institutions involving the

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financial sector, deficient rule of law and sheer corruption. Get your house in order, was the stern advice from multilateral institutions, and the rest will be fine. As a result, EM crises failed to put a dent on the shining models coming from the *North*. On the contrary, EMs felt the pressure to have their own models, with the same characteristics, if they wanted to have a seat at the table of sophisticated world central bankers. The models' disconnect with EM reality was striking. Central phenomena like Sudden Stops and balance-sheet imbalances (e.g., foreign exchange denominated credit, *Liability Dollarization*) were obliterated (see Calvo (2006)). Fortunately, the higher echelons of several EM central banks were less than completely dazzled by those models—and common sense prevailed. EMs that had learned the lessons of past financial crises fared relatively well during the subprime crisis. But this was not enough to generate a new macro/monetary paradigm to challenge conventional wisdom.

A prominent characteristic of financial crises is that they seem to come from nowhere and spread like wildfire. Moreover, far from staying within the boundaries of the financial sector, these crises deal a severe blow on the *real* economy: output, expenditure and employment suffer major blows. These characteristics are not easily supported by mainstream macro models in which features like the *permanent income hypothesis* are assumed to prevail, and the financial sector is not at the heart of macroeconomic disturbances. Microeconomics, in turn, was much more alert about liquidity issues. There is a long and distinguished literature focusing on bank runs, for example (see Allen and Gale (2007)). Existence of multiple equilibria is a salient characteristic of those models, a situation that arises because of liquidity considerations. In the seminal paper by Diamond and Dybvig (1983), for instance, banks create liquidity by offering demand deposits, which proceeds are employed to finance long-maturity projects. Depositors are able to withdraw their deposits any time they wish, which is attractive because it helps depositors meet random contingencies. On the other hand, investment in productive projects induces a competitive bank to offer a positive return on those deposits. The resulting risk-sharing arrangement dominates those in a bank-less economy (with incomplete capital markets) and can even help reaching a Pareto Optimum. A major problem is that those banks are subject to bank runs, because if depositors believe that a bank run is in the offing, they will rush to withdraw all of their deposits. Banks would then be unable to fulfill their obligations because part of the funds would have been employed to finance long-term maturity projects. One way to prevent bank runs from happening would be to establish a Lender of Last Resort (LOLR) and other similar arrangements. But the point that I wish to stress here is that the micro-finance literature had a rich arsenal of models which, once again, macroeconomists ignored. A proof of this is that if the bank-run literature had been taken into account, central banks would have realized that "shadow banks"—central factors behind the subprime crisis—were, in principle, bereft of a LOLR, and could easily be toppled by a wave of negative self-fulfilling expectations.

In the present paper I will argue that liquidity can help to rationalize the creation and destruction of "bubbles" in an intuitive manner, and without having to assume that they stem from highly unlikely *real* supply shocks ("tail

risks"). To illustrate this, I will employ a model in which liquidity services have a role to play (e.g., facilitating market transactions). But, in contrast with the conventional models in which liquidity is represented by "money" only, I will assume that real goods can also provide liquidity services. This is not a novel assumption. However, it seems to me that the importance of this assumption for understanding the significance of a liquidity crunch in explaining central features of financial crises has been largely overlooked.

To study the implications of this assumption, I will initially focus on the case in which the only available real asset is inelastically supplied land. This setup is enough to demonstrate that the relative price of land in terms of output increases as land becomes more liquid. Thus, for instance, financial innovation that enhances land's liquidity may help to explain a real estate "bubble." This is not an irrational bubble because it would stem from a *fundamental*, i.e., financial innovation. This effect is altogether missed by mainstream macro because liquidity of real assets is not part of the story; in fact, for someone sticking to the conventional approach, the increase in the price of land would have no explanation in terms of his model's smaller set of fundamentals.

Since conventional money is part of the model discussed here, I will be able to test the effects of standard monetary variables. To highlight the role of liquidity, I will conduct the analysis under the assumption that prices and wages are perfectly flexible. I will show that variables like the policy interest rate and the rate of inflation have an impact on the relative price of land that would be absent if land's liquidity was abstracted from. For example, a fall in the policy interest rate boosts land's price; this supports the view that Greenspan's low interest rates after 2001 may have fueled the boom in U.S. real estate prices (see Taylor (2009)). On the other hand, "helicopter money" which increases the supply of, say, high-powered money without touching the policy interest rate has no impact on the relative price of land. Therefore, simply expanding the balance sheet of the central bank may not cushion the economy from the fall in collateral values in terms of output.

The fall in collateral values implied by a liquidity crunch is then employed to argue that a liquidity shock could bring about significantly lower credit flows. This is bound to have negative effects on employment and output, as it drains working capital credit. The fall in collateral values does not affect all projects alike. I will argue that projects involving new labor hires are hard to finance relative to those involving physical capital, because the latter come with their own collateral, whereas the former require posting collateral not directly linked to hiring. This helps to explain so-called jobless recovery. In addition, I will explore a situation in which the credit crunch is so severe that full employment would call for a major collapse in real wages. This may be seriously detrimental to workers' morale to such an extent that firms will find it optimal not to lower wages below a certain critical point, even though unemployed laborers are willing to work for a smaller wage. This type of involuntary unemployment cannot be cured with monetary policy unless substantial credit flows can be unleashed to credit-constrained sectors or labor subsidies are enacted. Open market operations may be highly ineffective in this respect.

Identifying liquidity as an important factor in financial crisis episodes is very different from claiming that liquidity is the missing piece of the puzzle that will henceforth give us a solid foundation for macroeconomic policy. Liquidity is a subtle phenomenon that cannot be measured in terms of, say, "mass" or "energy." An asset's liquidity depends very much on social convention, market makers and the availability of a LOLR. This makes liquidity hard to pinpoint and potentially unstable.[1] Liquidity's capacity to rationalize bubbles and sudden crashes derives from its relative inscrutability and surprising dynamics. This has to be faced point blank by macroeconomics. Liquidity will not easily submit to the concavity and continuity assumptions that conventional theory calls for, unless we find a way to tame it without destroying much of the energy of market economies. To stress this point the paper will start in section 1 by discussing Liquidity Illusion, and then analyze how its creation and destruction can affect the real economy. Section 2 will examine the phenomenon of jobless recovery and involuntary unemployment, where both are depicted as stemming from credit-market malfunction. Section 3 concludes.

Foundations of the liquidity approach

One of the most revolutionary and enduring contributions of the *General Theory* (Keynes (1961)) is the central role given to *liquidity* and *liquidity preference*, a topic later elaborated and expanded by Minsky in an important body of work, which has only recently been widely recognized by the profession (see, e.g., Minsky (2008)). The reader will find some echoes of those books in the present paper and conclude, perhaps, that what I offer in section 2 is a bare-bones version of some of their ideas (which would be good enough for me!). In my view, however, the main contribution of that part of the paper is that it focuses on liquidity issues, almost exclusively, leaving aside many other financial issues discussed by Keynes and Minsky that, although highly relevant, may make it much more difficult to appreciate the power liquidity considerations have for explaining the mechanics of financial crises. Moreover, while I think the liquidity approach is fundamental for understanding financial crises, I am less sure that it is fundamental for explaining what might be called the *poverty of nations*, as the *General Theory* seems to suggest.[1] Section 3, in turn, stands mostly on its own.

II. LIQUIDITY ILLUSION AND DISILLUSION

The topic of *Money* Illusion has been at the center stage of monetary theory for many long years now (see, e.g., Fisher (1928)). Money illusion is a situation in which a substantial number of economic agents miscalculate the *real* (or output) value of nominal flows (e.g., wages) or stocks (e.g., high-powered money). To illustrate, let W denote the nominal wage and P the price level.

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1 For an up-to-date discussion of liquidity issues stressing relevant institutional aspects, see Mehrling (2011).

Therefore, the real wage $w = W/P$. The explicit or implicit assumption in the money-illusion literature is that agents have a much more accurate assessment about W than about P; hence, they are bound to miscalculate w because they base their computations on the wrong price level, which I will denote P^e (e for "expected"). Keynes in the *General Theory*, for example, claims that workers resist a fall in W because they have a relatively fixed notion about P^e. This induces workers to reject lower nominal wages, resulting in high real wages and unemployment during a price-deflation episode. This *expectations stickiness* is still high in policymakers' minds, and it is a major factor in their aversion to price deflation.[2] Another popular example of money illusion that is more akin to the ensuing discussion involves the stock of *money*. Denoting the stock of money in nominal terms by M, I define real monetary balances, m, by $m = M/P$. Again, money illusion in this instance is defined as a situation in which a significant number of economic agents miscalculate m. Thus, assuming expectations stickiness, an increase in M will make some agents feel richer even though the price level rises in the same proportion as M (keeping actual m constant). The seminal rational expectations model in Lucas (1972) portrays this feature. A feature shared by the above examples is that money illusion arises because individuals make mistakes in estimating the *denominator* in the definition of w or m—not the numerator.

Henceforth, I will focus on M. I will consider situations in which individuals know M, but dividing M by P does not necessarily give a correct assessment about *real* monetary balances. An example may help to motivate the discussion. Consider the case in which M is equated to M1, which includes bank deposits, and is typically defined by $M = H + D$, where H stands for high-powered money in the hands of the public (or "cash" for short) and D denotes bank deposits. Under normal conditions, the relative price of D in terms of H is unity. However, this may not hold if, for instance, there is a bank run. Thus, it is possible for individuals to make errors if there is a bank run. But as the bank-run literature illustrates (e.g., Diamond and Dybvig (1983)), a banking system may easily display multiple equilibriums, which means errors—indeed, even "large" errors—could be "rational" because rational individuals may not have the information that allows them to base their judgment on "objective" probabilities. Central banks usually ensure that the relative price of deposits in terms of cash is equal to 1 and, therefore, errors about the relative price of deposits are eliminated. However, the example is relevant because the financial sector has a variety of assets that are not protected by a LOLR, like many of the instruments developed by "shadow banks" prior to the recent crisis, including foreign-exchange denominated bank deposits.

In what follows, I will show the channels through which liquidity illusion can impact asset prices, the credit market and output.

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2 Another factor is Irving Fisher's (1933) Debt Deflation, which will be discussed later in this paper.

2.1 Liquidity and Asset Prices, or How Liquidity Can Create (the Illusion of) Real Wealth

I will illustrate the impact of liquidity on asset prices in terms of a simple model. Again, let us denote real monetary balances by m; I will assume that there is another asset, land, which is in fixed supply. Output, y, is produced by land, and the production function satisfies $y = \rho k$, where ρ is a positive constant. Real (in terms of output) liquidity is produced by m and k. Let real liquidity be denoted by z. I will assume that z satisfies the following central equation:

$$z = m + \theta q k, \tag{1}$$

where q is the relative price of land in terms of output, and θ is the liquidity parameter, $0 \leq \theta < 1$. Thus, capital is endowed with liquidity but will not dominate money, unless the return on capital is high enough (because $\theta < 1$). One can think of land liquidity as produced by bank deposits that are channeled to the purchase of land or by Collateralized Debt Obligations, CDOs, with land as collateral.[3] Let us take z as given and look for the combination of m and k that minimizes the cost of liquidity holding. The opportunity cost of holding liquidity, at steady state, where q=0 is given by the following expression:

$$(r + \pi - i_m)\, m + (rq - \rho)k, \tag{2}$$

where r, π, and i_m stand for real interest rate (i.e., output own-rate of interest), inflation and interest rate on money. Here I follow Calvo and Végh (1995) in identifying i_m with the policy interest rate set by the central bank. The optimal combination of non-negative m and k, given z, is obtained by minimizing cost (2) subject to equation (1), $m \geq 0$ and $k \geq 0$. To solve it in a straightforward manner, I will use constraint (1) in equation (2), yielding

$$(r + \pi - i_m)\,(z - \theta q k) + (rq - \rho)k. \tag{3}$$

Thus, the problem is now equivalent to minimizing expression (3) with respect to land k. Expression (3) is linear with respect to k. Hence, interior solutions require that the cost of liquidity holding be independent of k. A necessary and sufficient condition for this condition to hold is

$$-(r + \pi - i_m)\,\theta q + rq - \rho = 0. \tag{4}$$

Solving for the price of land q from equation (4), we get[4]

$$q = \frac{\rho}{r(1-\theta) + (i_m - \pi)\theta}. \tag{5}$$

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3 For a discussion on how an expression similar to (1) can be derived in a model with bank loans and deposits, see Calvo (2011b).

4 Notice that the interior equilibrium price of land q is independent of the inelastically supplied stock of land. This is an implication of the strong linearity assumptions of the model.

To help intuition, consider the special case in which $r = \rho$, and inflation and the interest rate on money are zero (i.e., $\pi = i_m = 0$).[5] Then,

$$q = \frac{1}{1-\theta}. \tag{6}$$

It follows that an increase in land's liquidity raises the price of land in terms of output. Moreover, by equations (1) and (6), it follows that

$$m = z - \frac{\theta}{1-\theta} k. \tag{7}$$

Therefore, an increase in land's liquidity displaces money, given z.[6]

An important insight of the model is that standard fundamentals (ρ in the present case) are not enough to rationalize asset prices. The latter may widely differ from what can be inferred from standard fundamentals, given that $q = 1$ if $\theta = 0$ (recall equation (6) and the assumption $r = \rho$). However, standard fundamentals still play a key role. For example, if land was totally unproductive, i.e., $\rho = 0$, then, by equation (5), $q = 0$. Thus, the present approach does not help to rationalize the existence of *pure* bubbles, unless the underlying assets are perfect substitutes for regular money, m.

Parameter θ will be endogenized below but it is inadvisable to rush to do it. Parameter θ should be thought of as the result of a complex transactions network, which may be highly stable for some periods of time but is subject to sudden revision and, in particular, collapse. Premature endogenizing may give the wrong impression that liquidity is another stable structural parameter, when the whole point of the liquidity approach is that liquidity is not a fundamental based on individual preferences or production functions. This view is portrayed in the seminal paper by Samuelson (1958). This line of research, in which some concept of "liquidity" is exogenous to the model, is an active area of research; see, for example, Farhi and Tirole (2011) and Martin and Ventura (2012).

As it stands, the model can also be employed to get some insight on monetary policy and asset prices. By equation (5), a drop in the policy interest rate, i_m, increases the price of land q, *conditional on land exhibiting some liquidity* (i.e., $\theta > 0$). This gives some support to the conjecture that the real estate bubble, in the U.S. at least, may be partly due to the Fed's low rates of interest following 9/11 (see Taylor (2009)). This result is new; it does not hold in standard monetary models, because in those models $\theta = 0$. Likewise, an asset price bubble could be controlled by raising the policy interest rate. One thus wonders, incidentally, if the present regime of exceedingly low interest rates is not provoking liquidity

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5 For a derivation of equation (5) in a general-equilibrium rational-expectations setup, see Calvo (2011b).

6 By equation (7), $m = 0$ whenever $\theta \geq z/(k+z)$. Notice that if nominal money stock M is given, an increase in the liquidity of land, i.e., an increase θ, in provokes a rise in the price level P. This effect would not necessarily hold under other sensible modeling of liquidity services in which the marginal substitution between money and land was not constant and depended, for example, on the land/money ratio.

bubbles in a variety of assets, e.g., gold, and real estate in emerging market economies (EMs), for example.

2.2 Liquidity Destruction. Shattered Dreams: Asset Price Meltdown and Credit Sudden Stop

As pointed out above, liquidity does not hold in isolation. Robinson Crusoe would have had little use of financial liquidity (unless he was an inveterate miser!). Moreover, another central characteristic of liquidity, as pointed out above, is that it can quickly evaporate. Diamond and Dybvig (1983) provides a nice example in which, without a Lender of Last Resort (LOLR), liquidity could be destroyed in a flash, even though it provides a social service (in their model, liquidity provides some form of insurance). A similar situation occurs in a slightly fleshed-out version of the above model in which land liquidity is a function of expectations. For example, if land is suddenly expected to be devoid of liquidity, then there will be no incentives for holding land for liquidity purposes, and $\theta = 0$. If $\theta > 0$ prior to this liquidity-expectations shock, the price of land will collapse, and analysts are likely to characterize the episode as a bust of the real estate bubble.[7] The consequences of this may be minor if the collapse was widely anticipated. Otherwise, if specifying state contingencies in financial contracts is costly, the price collapse is unlikely to be incorporated in state-contingent contracts. Under those circumstances, leveraged speculators may be subject to margin calls and forced to liquidate other assets in a short span of time, triggering fire sales and a generalized fall in asset prices (except in the unlikely case in which assets being sold are perfectly liquid). The fall in asset prices lowers collateral values and causes a sudden stop in bank credit flows. The latter is more likely, the closer are borrowers to their collateral constraints, which is arguably the case after a credit boom.[8] If prices and wages are flexible and debts are denominated in domestic currency, *real* debt rises (bringing about Irving Fisher's Debt Deflation, see Fisher (1933)) inducing deleverage in indebted sectors. Even setting aside Keynesian aggregate-demand effects due to different marginal propensities to spend between lender and borrowers, the sudden cut in credit flows may bring about a new round of *sharp changes* in relative prices, because the composition of debtors' and creditors' consumption and investment baskets are unlikely to be the same. These changes stem from an unanticipated liquidity crunch. Therefore, it is unlikely that individuals are well prepared to cope, or even understand the nature of the shock. The impact of a credit crunch differs across sectors and individuals. This environment is enormously more complex than a market economy under normal conditions in which the knowledge of a few price series and the reputations of a select number of business partners may suffice. Creditworthiness, in particular, is very hard to assess because the shock raises doubts about every agent in the system, with few exceptions. Opinions depend on individual experiences and,

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7 For a model with a similar flavor that focuses on capital inflow episodes, see Calvo (2011a).

8 For recent papers showing that credit booms could be harbingers of financial crisis, see Agosin and Huaita (2012), Schularick and Taylor (2009), and Reinhart and Rogoff (2011).

thus, may sharply differ across individuals. This militates against assets' liquidity because salability is hard to assess—exacerbating the collapse of asset prices. In this manner, a liquidity crunch could generate wholesale insolvency problems and Knightian uncertainty (see Frank Knight (1921)). Notice that none of these effects depend on wage/price inflexibility. They stem from the toxic link between liquidity and asset prices, a phenomenon largely ignored by mainstream macroeconomics, including the New Keynesian approach (which, by the way, should more appropriately be labeled *New Hicksian*, for Hicks (1937)).

But, the question arises, if the root of this nightmare is a liquidity shock, why not instruct the central bank to offset the shock by engaging in a massive infusion of central bank liquidity (i.e., a massive increase in money supply)? This is somewhat what the Fed and the ECB have been trying to do. However, as equation (5) shows, a once-and-for-all increase in nominal money supply has *no* effect on *relative* asset prices. Thus, averting CPI deflation has no effect on credit problems stemming from the fall of collateral values. It helps to stave off Debt Deflation, but it may be far from restoring financial health—which, by the way, helps to explain why the world economy is still in the doldrums despite the absence of CPI deflation. The situation might be better if, assuming that debt is denominated in domestic currency, the price level P increased sharply enough so as to keep the nominal price of land (= qP) virtually intact. The implementation of this, however, is fraught with serious problems. Take the case of the U.S. where average real estate prices fell by around 30 percent, and consider the case of many borrowers who borrowed close to 100 percent of their house's market value. To compensate these borrowers, the price level P would have to increase by 30 percent in a short span of time! Given the political circumstances, I much doubt that Bernanke or Trichet would have been able to hold on to their posts if they dared to travel even half-way that route. Besides, by equation (5), the once-and-for-all price-rise shock would not be strong enough to restore assets' relative prices and reinvigorate the rickety credit market. On the other hand, if political resistance can be overcome, high inflation Π could be more effective because, by equation (5), it would be capable of lifting the price of land q.[9] But, even this policy would be rendered ineffective if land's liquidity completely collapsed (i.e., $\theta = 0$).

In summary, a liquidity meltdown may seriously complicate the workings of the credit market and provoke major changes in relative prices that exacerbate credit-market problems. Averting price deflation may not prevent the generation of a vicious cycle.

2.3 A Brief Detour: Modeling Debt

Debt problems are not borne out by conventional closed-economy representative-individual models, because in that setup individuals are identical to each other

9 That is what theory implies. However, the present theory abstracts from realistic and important issues having to do with inflationary expectations, which may offset the benefits of higher inflation highlighted here.

and are neither net borrowers nor lenders in equilibrium.[10] However, high debt can be rationalized in terms of an open-economy model (opened to trade and capital flows) without having to discard the representative-individual assumption. Debt can be positive or negative in equilibrium, and takes the form of external debt. Suppose, for example, a world with a common currency (e.g., gold), $\pi = i_m = 0$, and that external creditors do not care about the liquidity services provided by land. There is perfect capital mobility but loans to domestic residents will take place if and only if they ensure a real rate of return equal to r, internationally given, and do not exceed a maximum loan-to-equity ratio (in order to ensure incentive-compatibility). Suppose $r = \rho$ and that, initially, land yields no liquidity services for domestic residents. Then, by previous analysis, land's price would be unity and it would offer the same services to foreign and domestic residents. I will assume that, initially, land is fully owned by foreign residents.[11] I will now consider the effect of a financial innovation that succeeds in increasing the liquidity of land for domestic residents only. This obviously makes land more attractive to domestic residents, and at an interior equilibrium (in which $m > 0$) domestic residents will be willing to buy all the foreign residents' land. I will assume that demand for liquidity, z, stays the same.[12] Thus, the price of land q is given by equation (6), implying that $q > 1$. Let m_0 and m_1 stand for the demand for real monetary balances before and after financial innovation, respectively. Therefore,

$$z = m_0 = m_1 + \theta qk = m_1 + \frac{\theta}{1-\theta}k, \tag{8}$$

implying that

$$m_0 - m_1 = \frac{\theta}{1-\theta}k < \frac{1}{1-\theta}k = qk. \tag{9}$$

Therefore, the demand for money falls (i.e., $m_1 < m_0$), but freed up resources (i.e.,) are not enough to buy the entire stock of land, qk. This is so because, by (9), the difference, i.e.,

$$qk - \left(m_0 - m_1\right) = qk - \frac{\theta}{1-\theta}k = k > 0. \tag{10}$$

The difference is borrowed from foreign residents at interest rate r. The loan-to-equity ratio is

$$\frac{k}{qk} = 1 - \theta < 1. \tag{11}$$

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10 To be more precise, in that context one can still account for debt obligations between the private and the public sectors. However, that is not an issue that appears to shed light on the link between liquidity and debt, and will be ignored in the present paper.

11 This assumption helps to streamline the argument presented below and could be replaced by other more realistic assumptions.

12 At an interior solution the marginal cost of liquidity is invariant to this type of financial innovation, which helps to rationalize a constant demand for liquidity z.

Thus, if $1 - \theta$ is smaller than the maximum loan-to-equity ratio, borrowing will take place, and it will be enough to buy all of foreign residents' land. This will be reflected in *gross* portfolio capital inflows equivalent to k in terms of output (the output equivalent of the external loan to purchase domestic land at price q) *plus* $m_0 - m_1$ (i.e., the decumulation of global currency holdings by domestic residents in order to complete the land purchase), coupled with FDI outflows equal to qk. By (10), gross inflows and outflows are equal implying, of course, that net capital flows are zero. The operation does no widen the current account deficit. Thus, an observer that ignores the possibility of a liquidity meltdown, would see no reason for concern.

Consider now a liquidity crunch pushing θ down to zero and hence, by expression (11), raising the loan-to-equity ratio. This may force borrowers to liquidate some of their land, in which case the only option would be to sell it to foreign residents. The price of land will fall to 1, implying a capital loss for domestic residents. However, this is likely to be the least of their problems. By assumption, land renders no liquidity services to foreign residents, thus the sudden liquidation of land may entail additional fire-sale type losses, which could be easily modeled in a richer framework. This example captures in a very simple way the disruption in capital markets that might ensue from a liquidity meltdown.

2.4 Liquidity Creation and Destruction: Dreams and Nightmares

Until now, the discussion has taken liquidity creation and destruction as exogenous processes. This is a good first approximation to understand the basic role of liquidity, but it does not give much insight relevant for understanding the kind of financial innovation and destruction associated with the subprime crisis. Unfortunately, liquidity endogeneity is a hard subject. Mainstream macroeconomics has ignored it, and the available literature addresses fundamental topics but it does not shed light on the issues highlighted above (see, for example, Jones (1976), Kiyotaki and Wright (1989)). The papers are useful for developing intuition about the factors that may play a role in determining an economy's choice of one or several means of payment, including some general welfare implications. But little more than that. Here I will pursue a much more modest approach in which I take the assets which are candidates for being endowed with liquidity as given, and examine how their liquidity reacts to variables like inflation and the central bank interest rate. Moreover, I will focus on the model developed above and study the determination of the liquidity parameter θ. Following Calvo (2011b) I will assume that individuals could endow their land holdings with liquidity at a cost. This they can do, for example, by offering insurance against low land productivity, or paying a fee to a well-respected firm (Sotheby?) to advertise the land, or making individual plots of land part of a pool administered by a well-known global bank. The latter arrangement would be akin to asset-backed securities which have played a prominent role in the subprime crisis. These are just examples in which individuals may have incentives to make their holdings better known to potential buyers by enhancing their liquidity.[13]

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13 The analysis will be confined to a competitive environment which is likely to be inconsistent with the example of land pooling by large corporations.

I will assume that the output cost of endowing a piece of land k with liquidity is an increasing function of the value of land qk, and the liquidity coefficient θ. More concretely, I will assume that the cost function is given by $\varphi(\theta)qk$ where function φ is defined on the nonnegative real line, it is twice-continuously differentiable and $\varphi(0)=0$, $\varphi'>0$ and $\varphi''>0$. The assumptions are intuitive and are partly made in order to ensure that second-order conditions can be taken for granted. Under these assumptions, the opportunity cost of holding liquidity would take the following expanded form (recall expression (3)):

$$\left(r+\pi-i_m\right)(z-\theta qk)+\left(rq-\rho\right)k+\varphi\left(\theta\right)qk. \tag{3'}$$

Hence, minimizing (2') with respect to we get the following first-order condition:

$$\varphi'\left(\theta\right)=r+\pi-i_m. \tag{12}$$

Correspondingly, assuming an interior solution, equation (5) becomes

$$q=\frac{\rho}{r\left(1-\theta\right)+\varphi\left(\theta\right)+(i_m-\pi)\theta}\ . \tag{5'}$$

The price of land is lower than in the exogenous-liquidity model, reflecting the cost of liquidity, but it can readily be shown, employing equation (12), that the effects on q of a change in r, i_m and π have the same signs as in the basic model in section 2. Thus, new results are entirely encapsulated in equation (12), which implies that monetary policy can have an effect on land's liquidity. This is a conjecture that goes back at least to Minsky (1957). He conjectured that tight monetary policy may be partially offset by the creation of quasi-monies. By equation (12), this holds true in the present model if tighter monetary policy increases the real interest rate r, a common assumption in conventional monetary theory. But the opposite holds if, given r, central bank tightening operates through a higher i_m. The intuition is that a higher i_m makes money more attractive relative to land and, thus, the payoff of making land more liquid declines.[14] Similarly, an increase in the rate of inflation (from which land is insulated at steady state) makes land more attractive, increasing the payoff of land liquidity. Thus, the model gives further support to the argument that the Fed's lax monetary stance after 2001 is responsible for the real estate bubble (once again, if "lax" is equivalent to low i_m). But the model also provides some backing to the view that the bubble stems from "savings glut" in Asia, which arguably pushed down real interest rates, r.

Liquidity meltdown has received much greater attention in the literature (although, again, mainstream macroeconomics is oblivious about it). For example, to rationalize a liquidity crunch through a collapse in the liquidity coefficient θ, one can appeal to the bank-run literature (e.g., Diamond and

14 An increase in i_m increases the demand for m and, in a closed economy model, pushes down the price level. However, if prices are sticky, this may give rise to higher real interest rate r. Therefore, the net effect on the liquidity coefficient is ambiguous unless one makes more explicit assumptions about the demand side.

Dybvig (1983), Allen and Gale (2005)). The meltdown of "shadow banks" had similar characteristics to an old-fashioned run on bank deposits. In the subprime crisis, the run was staged mostly by bond holders (even in the case of Northern Rock, see Shin (2010)), and the ensuing financial distress was linked to maturity mismatch between assets and liabilities. A full-fledged model would probably include the probability of liquidity crunch into the decision of liquidity creation—a feature that is ignored in the model discussed above—although I doubt that this feature will result in a significant modification of previous insights. However, the analytics are likely to get substantially more complicated. For instance, one would have to specify a mechanism for equilibrium selection (the bank-run model exhibits equilibrium multiplicity). An option is to adapt the model in Morris and Shin (1998). A simpler one is to assume that the probability of liquidity crunch is exogenous. If one has in mind the U.S. and advanced economies, the probability of severe liquidity crunch can realistically be modeled as very small. Thus, as a first approximation, one should not be far from target by assuming that the probability is zero, in which case the model of liquidity creation discussed above stands unchanged. The zero-probability case also serves to illustrate, if not dramatize, the financial disarray that follows a liquidity crunch, because under zero probability no financial contract will take that contingency into account, and bankruptcies will be the order of the day.

In sum, this segment shows that one can get some insights about liquidity creation by assuming that liquidity can be created at a cost. The insights suggest that policies followed after 9/11 may have contributed to enhancing the liquidity of some financial assets, even if one abstracts from regulatory changes. Finally, it appears that from a macro perspective the assumption that liquidity meltdown are exogenous low-probability events may not be misleading.

III. JOBLESS RECOVERY AND INVOLUNTARY UNEMPLOYMENT

A salient feature of recovery from financial crisis is that certain key relative prices like the real wage and the real exchange rate do not bounce back to their pre-crisis levels (see Calvo, Izquierdo, and Talvi (2006)). In the U.S., output has still not reached pre-crisis level but it is already evident that the labor market lags far behind with unemployment still hovering around 10 percent.[15] In this section I will explore two lines of explanation geared to disturbances and imperfection in the labor and credit market.

3.1 Collateral Constraints

A liquidity crunch may bring about sharp changes in relative prices and wealth destruction, lowering the output value of assets that can be employed to collateralize—and, thus, support—credit transactions. However, there are various ways in which the economy can start mending itself, even if it gets no external help or the government remains inactive.

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15 For some evidence about U.S. recovery, see Calvo and Loo-Kung (2010).

To illustrate this point, consider the case in which banks require borrowers to post collateral in order to ensure that they have incentives to repay (a typical principal-agent problem), and that there are three types of investment projects: (1) firing old workers to improve efficiency, (2) buying new computers, and (3) hiring new workers. Firing old workers is the easiest to fund. It requires little imagination. Basically, all you have to know is severance costs and foregone wages (the benefit), and make sure that output stays about the same—no new markets have to be opened or new ideas sold to potential customers. In contrast, projects (2) and (3), to the extent that they are aimed at increasing output or developing new product lines, require convincing the banker that there will be a healthy demand for the new stuff. This may be difficult when recovery is still iffy, as in present circumstances. Funding for hiring new workers is likely to be decisively more difficult than buying new computers—and the reason is that computers provide their *own* collateral, a situation that I will characterize by saying that they exhibit "intrinsic collateral." If the project fails, the bank can repossess the computers, a situation that, of course, does not apply to project (3). Project (3) could thus be said to be relatively more "extrinsic-collateral" intensive—where "extrinsic collateral" stands for collateral which is not imbedded in the investment project. Therefore, *ceteris paribus*, in a collateral-scarce environment, project (2) is likely to dominate project (3), which suggests that, as the economy comes out from liquidity/credit crunch, labor-intensive projects may be discriminated in favor of capital-intensive projects that are more likely to be less dependent on extrinsic collateral.[16] Therefore, until the credit market does not recover its pre-crisis conditions, a salient characteristic of Phoenix Miracles, real wages and employment will lag behind output and, if there is real-wage downward inflexibility (a feature that will be displayed by the next model), unemployment will tend to be high.

3.2 Involuntary Unemployment (a Non-Keynesian Perspective)

Deep financial crisis is a brutal blow to the core of the economic system. In contrast to a regular supply shock (standard in mainstream macro theory), a liquidity/credit crunch destroys channels of information. Under these conditions, production efficiency takes the back seat, and output is dictated by financial constraints. A firm could be highly productive and yet unable to have access to working capital, for example. The firm could have an impeccable credit record but this is not enough to establish creditworthiness during financial crisis. The bank has to make sure that the firm's clients—to whom the firm extends trade credit, for example—will repay their debt obligations. Absent that, the firm in question may not be able to comply with its own debt obligations.

A cut in working capital credit lowers the (effective) demand for labor, independently of labor's marginal productivity. If labor supervision is not an

16 For recent evidence in this respect, see Madigan (2011), although collateral considerations are not mentioned in the journal's article.

issue, the new equilibrium will lie on the labor supply curve. Thus, the fall in the demand for labor dictated by the credit crunch would likely bring about lower real wages and employment; but not unemployment (i.e., excess supply of workers willing to work at the current wage), unless nominal wages are downward inflexible—a problem that could be easily be dealt with by preventing price deflation and will, thus, be ignored in the ensuing discussion. The following discussion will focus on *structural* problems that cannot be remedied by standard monetary or aggregate-demand fiscal policies.

If labor supervision is an issue, the fall in real wages may make supervision matters harder to handle. Consider the case in which individuals face the option of working in firms owned by others (which I will just refer to as true-firms) or become self-employed, the latter being technologically inferior to the former. Thus, without credit constraints and labor supervision problems, labor would be fully allocated to true-firms. For future reference, I will denote the associated equilibrium real wage by w^*. Existence of supervision problems may change things in a dramatic way. Suppose that workers aim at maximizing income and that, hence, if unsupervised they will sneak out of true-firms and engage in self-employment activities which, to simplify the exposition, I assume require no capital or credit. Clearly, without labor supervision true-firms could not survive. I will now take a closer look at shirking. I will assume that if a shirker is not caught he gets his wage plus self-employment income. Otherwise, he only gets self-employment income. Therefore, given the probability of being caught, shirking incentives are likely to rise as the gap between wages and self-employment income goes to zero. In the limit case in which the gap between true-firms' wages and self-employment income is nil, a true-firm will have to supervise everybody all the time because workers suffer no cost if caught shirking.[17] Therefore, it is plausible to assume that below a critical point, effective labor costs may *rise*, not decline, with lower wages. Let us denote the critical real wage by $\underline{w}$. Clearly, if the credit-crunch wage $w^* < \underline{w}$, true-firms' equilibrium wages will be higher than w^*, even though workers will be banging at their doors ready to work for less—and, thus, involuntary unemployment arises.[18]

In this scenario, the equilibrium rate of unemployment depends on true-firms' "wage fund," i.e., funds allotted for the payroll, including working capital credit and own funds—and the critical wage $\underline{w}$. The wage fund is not a constant over time because its effectiveness could be gradually augmented by undistributed earnings and/or by a decline in $\underline{w}$. Firms have incentives to increase the wage fund because at the after-shock equilibrium the marginal productivity of labor exceeds $\underline{w}$. Thus, absent credit expansion, employment may rise over time by the accumulation of true-firms' own funds (although this does not guarantee that unemployment will fall, since

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17 This is bad enough but things are likely to be worse: who supervises the supervisors?

18 There are several models bearing this kind of unemployment, but they focused on less-developed countries in which formal-sector wages are "low." See, for instance, Harris and Todaro (1970), Calvo (1979), and Shapiro and Stiglitz (1984).

employment may be outstripped by labor force). The dynamics of $\underline{w}$ depends on what happens in the self-employment sector and on workers' expectations. After the initial credit shock it is likely that workers' discipline would be quickly lost if wages fall below pre-crisis levels, especially if workers have backward-looking expectations. However, $\underline{w}$ is likely to fall over time as unemployment arises and shows no signs to subside. The fall in $\underline{w}$ is another factor that contributes to attenuating unemployment, but in this case real wages will drop and workers' total income may actually contract, deteriorating income distribution. All in all, the process is likely to occur at a snail's pace, a pace much slower than if the economy was facing a sheer supply shock without credit market complications—validating the observation that recovery from financial crisis is more painful and time consuming than if the financial sector was not part of the problem.

3.3 Some Key Implications

• The discussion has identified some central factors that prevent quick recovery from financial crisis, a phenomenon that has been amply documented by Reinhart and Rogoff (2010) and others.
• Unemployment arises even absent nominal rigidities, which are central to New Hicksian models. Therefore, beyond a certain point, lax monetary policy may become ineffective in triggering employment and growth—and result in stagflation.[19]
• In contrast, credit policy may be effective, if it helps to increase the wage fund, for example. This could be accomplished by directed credit and/or *debt haircuts* that allay deleveraging from highly indebted sectors. These are heterodox policies that will face strong resistance from established orthodoxy. However, their plausibility follows from the fact that serious obstruction in the credit channel prevents the private sector from doing its job.

IV. CONCLUSIONS

A major implication of this discussion is that liquidity creation and destruction can have strong effects on some key relative prices and wreak havoc in the credit market, particularly after an episode of sudden and highly unexpected liquidity crunch. This may sound *déjà vu* for some readers because liquidity-crunch episodes are not unprecedented and are known to cause bankruptcies if there is no LOLR bailing out credit-stressed sectors. However, if momentary dearth of liquidity was all that there was to it, liquidity crunches could be easily dealt with by a timely LOLR who pumped in liquidity in the affected sectors. But, as section 2 shows, there may be long-lasting effects that cannot be easily undone by open-market operations of the regular sort. The financial sector does not generate liquidity on the back of U.S. wealth, say, but on the back of a much narrower set of assets like asset-backed securities. The example discussed in section 2 shows that this type of liquidity-creation process increases the relative

19 Phelps (1994) applies this view for non-crisis situations.

price of the underlying assets. This is indeed highly intuitive but, despite its appeal and simplicity, the insight runs against the mainstream's cherished view that "money is neutral," and that monetary policy is ineffective for changing real variables like relative prices and unemployment in the long run (illustrated by the "vertical Phillips curve" conjecture). Granted, the vertical-Phillips curve view refers to money issued by the sovereign, and not private money of the sort discussed in section 2. But it seems to me quite clear that as long as private money becomes a close substitute to sovereign money, economists are prone to jump to the conclusion that private money can be bundled together with sovereign money and display the same neutrality properties (isn't it common practice to define "money" as an aggregate that includes bank deposits issued by private banks?). Another indication that the neutrality proposition ranks high in economists' minds is that the overwhelming majority of financial commentators refer to the recent meltdown of real estate prices as the bursting of a speculative bubble, stemming from irrational expectations, or prompted by SOEs like Fannie Mae, or stealthy financial moguls—but no reference is given to the liquidity effects highlighted in section 1.[20]

The paper focused on issues relevant for the U.S. in the context of the subprime crisis. However, the insights of this note are applicable to a variety of circumstances. For example, a capital-inflow episode in EMs. Again, the model of section 2 can be employed to conjecture that a surge of capital inflows to a given economy can increase the liquidity of some of that economy's assets. In fact, if the economy is small enough, enhanced liquidity could provoke a real appreciation of the domestic currency (i.e., a fall in the *real exchange rate*, defined as the relative price of tradables with respect to non-tradables). This is a typical phenomenon during these episodes, which gets reverted by a Sudden Stop, usually causing severe problems in the domestic credit market. Ignoring the liquidity effect has led policymakers to attribute currency appreciation to their own good policies (of course), catching them mostly underprepared when hit by Sudden Stop (see Calvo (2007 and 2011a)).

Liquidity is a very slippery concept which, unfortunately, economists have eschewed or over-simplified. Concepts like money and liquidity are much harder to model than a regular consumption good, for example. Their market value depends on a transactions technology that is hard to specify and may undergo large mutations during crisis episodes. But this is no basis for ignoring the issue, because it could lead to wrong and costly policy prescriptions. Liquidity is a *fundamental*, and has to be treated like that. Moreover, it changes relative prices and during its inception is likely to foster credit flows. Therefore, although difficult to pinpoint and define in practice, liquidity fingerprints have some regularity that may help to identify the presence of liquidity cycles. Unfortunately, there are other shocks that mimic the effects of liquidity shocks.

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20 Taylor (2009) stands, however, closer to the view offered here, albeit in an indirect way; for he claims that low Fed interest rates after 9/11 are behind the real estate price hike, a statement that is supported by the model in section 2 but not by mainstream theory.

For example, technical innovations or terms-of-trade shocks. Telling them apart is momentarily more an "art" than a "science." There are many instances, however, in which there is no clear evidence of competing explanations, in which case liquidity should be the primary suspect.

Would it be possible to prevent liquidity cycles? One strategy would be to shackle the financial sector by some Basel III agreement that shrinks the sector to a mere bureau of exchange. This may prevent serious blow-outs but credit may vanish unless, going back to the 1950s, the financial sector is mostly run by government. On the other hand, if draconian financial regulation fails, new and even more unstable financial institutions may arise. Therefore, the financial regulatory road has to be trod with a high degree of caution. This does not imply total inaction on the part of government.[21] Given the liquidity fingerprints mentioned above, the central bank would be well-advised to imposing counter-cyclical controls on credit flows or capital inflows, and accumulating international reserves during capital inflow episodes. This will not totally insulate the economy from a liquidity crunch, particularly when the latter stems from external sources, but it may help to attenuate its effects. The liquidity aspects discussed in this chapter should make macroeconomists more aware that they navigate waters considerably more risky than they used to think, and that the necessary tools to prevent and manage crises may involve operations resembling those of a Lender of Last Resort. These operations should therefore be incorporated in central bank monitoring. An effective LOLR should have in its ranks individuals with first-hand knowledge of the credit market and credit-market instruments, and should be able to conduct regular stress tests and fire drills to prevent and deal with extreme situations. The latter, in particular, will likely require tight coordination with other government departments, like the finance ministry and the executive branch—not something that can wait for crisis to happen.

In closing, it is worth pointing out that the analysis of section 2 regarding jobless recovery and unemployment stems from credit market disturbances, which may or may not be associated with a liquidity crunch. However, absent a liquidity shock it is hard to rationalize credit crunch, i.e., a sudden and large cut in credit flows. If the market senses that there is overinvestment in the real estate sector, for example, investment will start to fall and the economy will decelerate. Sharp recession, like the one triggered by the Lehman episode, is unlikely to happen. For that to occur, a clear signal will have to come from somewhere, which leads investors and financial intermediaries to stop demanding and offering loans in a coordinated way. Some sort of divine revelation. Keynes identified the phenomenon in a more materialistic fashion as 'animal spirits.' If this holds true, 'animal spirits' should be reflected in a wide variety of human endeavors. The appeal of the liquidity factor, in contrast, is that *its very nature* makes it highly labile, and its destruction can easily be verified—while arguments that appeal to 'animal spirits' without liquidity shocks often refer to sudden contraction of

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21 See Borio (2011) for a similar view and a fuller discussion of these issues.

consumption or investment that are triggered by a swift and massive change in expectations about the real economy. However, 'animal spirits' in the form of *herding*, for example, could follow a large shock on relative prices caused by liquidity crunch. Since a liquidity crunch easily escapes the attention and analytical abilities of most economic agents, the latter are bound to attribute the corresponding initial drop in asset prices to the existence of a new "downward trend." This "rational" behavior can contribute to magnifying the effects of the initial liquidity shock, and play a major role in major price-bubble episodes.

Postscript, June 2015

This paper was written about four years ago. Since then, liquidity issues have acquired greater significance. A slew of highly valuable material addressing these issues has been circulated. Despite having to share the stage with many worthy competitors, though, I feel that the original paper is still relevant and has the advantage of presenting some key issues in a very simple form. However, I also think that it is worth linking up the paper, albeit in a brief and incomplete manner, with some central issues and a couple of ideas—one of which mine—that have surfaced in recent times. This is the main objective of this postscript.

Liquidity concepts familiar to financial experts are now making their entrance in the macro field. A prominent example is "safe assets." Safe assets ensure command on output, subject to minimal uncertainty. Safe assets are critical for oiling the international payments system (see Gorton and Metrick (2012)). U.S. Treasury bills and German bunds are good examples. Empirical estimates show that safe assets suffered a major blow during the Lehman crisis from which they have not fully recovered (see Fernández and others, 2015). Safe assets' shortage can have severe effects on output and impede recovery unless unconventional policy is implemented. If left untreated, shortage of safe assets could give rise to Secular Stagnation (see Caballero and Farhi, 2015). The model in my paper can display some features in common with the safe assets literature, since the phenomenon is akin to a fall in coefficient θ.[22] It can easily be shown, for instance, that a fall in θ causes unemployment under price stickiness or, alternatively, under policies that prevent price level deflation (as the ones currently implemented in developed market economies). I suspect, however, that this model will be criticized for its weak microfoundations, which I do not deny. But this type of objection is pointless because *all macro models have weak microfoundations*. In fact, my main criticism against many of the new crop of papers is that they contain *unnecessarily complex microfoundations*, which oftentimes have weak empirical support to boot. Their microfoundations are often prompted by "elegance" or "tractability," i.e., making the model amenable to computing techniques, given current computational capabilities. Moreover, we seem to be far from agreeing on a common paradigm. Each paper chooses its own microfoundations, a striking difference with Physics that strives for a common framework or, more modestly, the Real Business Cycle literature

22 *For some related ideas and more formal discussion of the present paper's model, see Calvo (2012).*

of the 20th century that was built on the conventional general equilibrium apparatus. This situation makes the new crop of papers unreliable sources for policy advice. It actually may be preferable to derive intuition from simple models like the one discussed in this paper. However, I would like to make it very clear that these comments are not intended to invalidate the contribution of the new papers but... *caveat emptor*: this stuff has to be handled with care, especially by policymakers!

I will now address an issue ignored by the literature, including the present paper. A common assumption is the existence of an object, usually called "money," which is also assumed to be the epitome of liquidity (in terms of the present paper, money's liquidity coefficient $\theta=1$, and there is virtually no risk of θ falling). Typically, money is identified with *fiat money* or some of its derivatives (M1, M2, etc.) having no intrinsic value. Models focusing on advanced markets further assume that money is the ultimate safe asset towards which investors converge in the midst of financial crisis, causing what Keynes labeled Liquidity Trap. This curious phenomenon does not apply to all currencies. Actually, empirical evidence shows that it applies to a few currencies like the U.S. dollar, the euro, and the yen. What makes a currency as "safe" as those just mentioned (hereon, "safe money")? This is a fundamental question for which I don't think we have a very satisfactory answer, particularly in macroeconomics.

This is not the place to discuss this issue in great detail. However, to start closing the circle I would like to refer to Calvo (2012) where some progress is made in that direction. I develop an idea that can be found in a paragraph of Keynes's *General Theory*, which sets the foundations for what I call "The Price Theory of Money" (PTM). Here is the paragraph:

"The fact that contracts are fixed, and wages are usually somewhat stable in terms of money, *unquestionably* plays a large part in attracting to money so high a liquidity-premium" (Keynes 1961, Chapter 17, italics are mine).

By liquidity premium, Keynes was referring to the difference between output that a unit of money can fetch in the market and its intrinsic output value (which Keynes implicitly assumes to be nil). Obviously, Keynes must have been intrigued by the Liquidity Trap phenomenon, and was trying to find a rationale for the fact that money can fetch valuable commodities, despite having no intrinsic value. As discussed in Calvo (2012), the idea was novel at the time and is still novel today. The fundamental insight is that the output backing of monies (even non-safe monies) derives from the fact that these objects are utilized as units of account and, more importantly, that the private sector is willing to set prices and wages in advance for a considerable length of time. Safe monies, in addition, have that sort of backing in a large economic area. The output value of money, thus, would depend on the rate of (expected) inflation (the standard insight from conventional monetary models) but, in addition, it would also depend on the existence of a large set of agents that are prepared to post their prices and wages in advance or to manipulate output in order to stabilize prices in terms of that unit of account (like the OPEC does for oil's

U.S. dollar price). Safe monies are further enhanced by being a unit of account for international financial transactions.

The PTM helps to understand why fiat money was able to substitute for the gold standard, for example, without causing the monetary chaos that some economists feared, especially after the demise of Bretton Woods. On the other hand, the PTM helps to explain why the U.S. dollar is king and many emerging market currencies are weak second-fiddlers, and thus understand why these weak currencies are often pegged to safe currencies (a phenomenon labeled Fear of Floating, see Calvo and Reinhart, 2002). Moreover, the PTM puts some damper on floating exchange rates for non-safe monies.

None of this invalidates the models in the current crop of papers, but opens up a door towards richer and more relevant scenarios where, among other things, multiple monies are taken into account. In this respect, I sense that we need a much better understanding of a world with at least two equally strong safe monies. The U.S. dollar was king since the breakdown of Bretton Woods. Now there is a chance that the euro and even the renminbi surge as worthy contenders. How will the world economy manage that situation if these currencies play the game of floating exchange rates? This is an open question of enormous importance.

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WHY DO COUNTRIES HAVE FISCAL RULES?*

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I. INTRODUCTION

Professor Vittorio Corbo, in whose honor this conference is organized, has an outstanding academic and professional career that spans teaching, research, policy making, and advice provided to the private sector, international institutions, and governments. In the latter capacity of government advisor, he served recently as Chairman of the Advisory Committee on Fiscal Policy to Finance Minister Felipe Larraín, coordinating preparation of the Committee's proposals for strengthening Chile's fiscal institutions and decade-old fiscal policy rule. The final document delivered by the Committee to Minister Larraín offers relevant and well-grounded recommendations on fiscal policy reform in Chile, which undoubtedly will be useful to other reforming countries, too (Advisory Committee on Fiscal Policy in Chile, 2011). The latter document—like many others written or led by Vittorio Corbo—is a tribute to his skills in guiding deep and productive debate among economists that hold different views, toward the goal of attaining consensus on research and policy advice.

Chile, like many other countries, is certainly not alone among countries that have adopted fiscal rules. While four countries had fiscal rules in place in 1982, many more countries have adopted rules since the 1990s, from a universe of 10 countries in 1990 to 30 in 2001 and 51 in 2009 (figure 1). Another group of 46 countries had supra-national rules in place in 2009—most of them are EU members. Countries with fiscal rules had on average 2.5 active fiscal rules in 2009.

Reforms of fiscal institutions and fiscal rules are motivated by objectives similar to those that inspired the changes in central banking. In the case of fiscal rules, the explicit objectives that motivate their adoption comprise strengthening fiscal solvency and sustainability (i.e., attaining sustainable levels of government deficits and debt), contributing to macroeconomic (or cyclical) stabilization (i.e., reducing fiscal policy pro-cyclicality or raising policy counter-cyclicality), and making fiscal policy design and execution more resilient to government

* *This paper is motivated by our academic and personal admiration of Vittorio Corbo, under whose leadership we worked in the Macroeconomic Adjustment and Growth Division in the World Bank's Research Department, where we started our research collaboration.*
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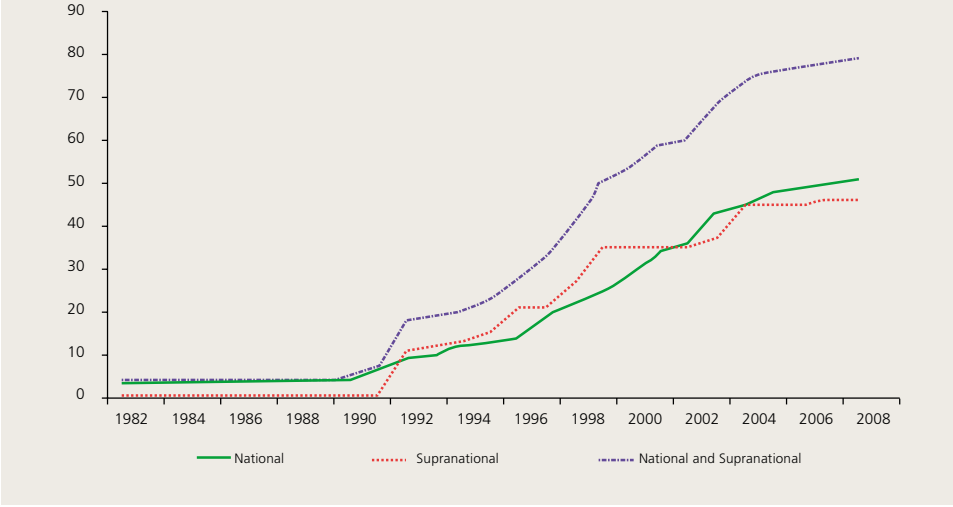
corruption and private-sector lobbies (i.e., strengthening the political economy of fiscal policy decisions and budget management).

The latter objectives are shared by most fiscal policy makers worldwide. Hence why do countries adopt fiscal rules? This question boils down to identifying the conditions under which some countries do adopt fiscal rules and maintain them over time, while others do not. In particular, which political and institutional conditions are behind the decision of policy makers to tie their own hands? Are fiscal rules more likely to be associated to particular monetary and exchange-rate regimes, or to deeper financial market development and openness? Is it more likely that countries have fiscal rules in place when they exhibit stronger fiscal policy performance—or is it the opposite? Are fiscal rules more likely to be adopted by richer countries? These are the empirical questions addressed by this paper.

Yet fiscal rules are only one element of fiscal reform. Currently many countries—industrial and emerging economies alike—are designing and implementing major reforms of their institutional framework for fiscal policy. These reforms are motivated by different reasons. First, they reflect a growing global consensus among academics and policy makers about the economic benefits of procedures and rules that shape and limit planning and execution of fiscal policy. Second, they respond to the political benefits of more transparency and accountability in the exercise of fiscal policy in a democracy. Third, they respond to the failure of previous fiscal institutions and rules in many industrial countries, as is the case of the systematic violation of the fiscal rules of the Stability and Growth Pact by many member countries of the Euro Zone.

Figure 1

Number of countries with fiscal rules



Source: International Monetary Fund (2009).

A modern institutional framework for the conduct of fiscal policy and financial management should aim at addressing the principal-agent problems that arise between voters and political authorities due to government impatience, lack of representation of future generations, electoral competition, sensitivity to special-interest lobbies, corruption, and use of asymmetric and biased information (von Hagen 2005, Wren-Lewis, 2010). To overcome these distortions and negative externalities, the academic literature and international experience suggests adopting an institutional framework for fiscal policy based on the following components (Ter-Minassian 2010, IMF 2009, Schmidt-Hebbel 2012): a fiscal responsibility law, modern financial management, a planning horizon that exceeds one year, rules for government asset and liability management, requirements on accountability and public information on the government's financial management, effective external control and auditing, and establishment of a fiscal council and/or fiscal committees—and a fiscal rule for the budget.

Reforms of fiscal institutions and adoption of fiscal rules came with a time lag following the revolution in monetary policy institutions that took place in the 1980s and 1990s, with the adoption of independent and accountable central banks conducting rule-based monetary policy under conditions of increased transparency and accountability. The reform of central banks and their monetary policy frameworks was politically motivated by the 1970s Great Inflation and intellectually grounded in the rational expectations revolution in macroeconomics, reflected in the theoretical work in support of independent central banking and the dominance of rules over discretion (Cukierman 1992, Kydland and Prescott 1977, Barro and Gordon 1983). This radical change in central banking was pursued for objectives to raise policy effectiveness, increase economic efficiency, and strengthen democratic accountability.

Fiscal rules differ widely across countries in how they are defined. Fiscal rules include rules that set targets, ceilings or floors for the government budget balance (on overall or primary balance; on actual cyclically-adjusted balance, or multi-year balance "over the business cycle"), targets or ceilings for government debt levels, targets or ceilings for government expenditure levels (on aggregate, primary or current spending), and targets, ceilings or floors for government revenue. Target levels are set in absolute terms, as growth rates or as ratios to GDP.

Different types of rules are related to different fiscal policy objectives. One category are deficit and debt ceilings set predominantly to strengthen fiscal sustainability. A paramount example of the latter rules is the Stability and Growth Pact ceilings on government deficits (3% of GDP) and debt levels (60% of GDP) set in the 1990s for prospective euro zone member countries. Another category is comprised by fiscal rules that aim at strengthening both fiscal sustainability and counter-cyclical fiscal stabilization (or at least avoiding pro-cyclical policy bias). Ten countries had such rules in place in 2009 (IMF 2009), including Chile, which sets a yearly cyclically-adjusted balance target. Among the 10 countries, Germany, the UK, and Sweden have a fiscal rule in place that defines a numerical target for the average budget balance throughout the economic cycle.

There is a growing literature on fiscal rules, comprising descriptive and empirical papers on country and cross-country experiences, their design and institutional issues, and the fiscal, macroeconomic, growth, and welfare effects of different fiscal rules (a few examples include Debrun and Kumar 2007; IMF 2009; Ter-Minassian 2010; Anderson and Minarik 2006; Deroose, Moulin and Wierts 2006; and Maliszewski 2009).

To our best knowledge there are only two previous empirical studies that identify institutional and economic variables that explain why countries have fiscal rules in place. Calderón and Schmidt-Hebbel (2008a) estimate a model for the likelihood of having a fiscal rule in place on an unbalanced panel dataset constructed by the authors (extending the database compiled by Kopits and Symanski 1998 and others) on fiscal rules for 75 countries (of which 24 have fiscal rules) and spanning 1975-2005. Their results (based on pooled, fixed-effect, and random effect logit estimation; and pooled and fixed-effect probit estimations) show that a larger budget balance, lower population dependency ratio, lower expenditure pro-cyclicality, and more government stability raise the likelihood of having a fiscal rule in place.

In an appendix, IMF (2009) presents some panel data results for the likelihood of adopting a fiscal rule and for having a *de jure* fiscal regime in place, using a panel dataset constructed by the IMF for 68 countries (of which two thirds have fiscal rules) and spanning 1985-2008. Results show that the likelihood of adopting a fiscal rule (based on an exponential hazard model that identifies the probability of switching to a rule in any given country and year) is raised by a higher primary budget balance and a lower public debt ratio, and is also affected by various macroeconomic performance variables. Additional results show that the likelihood of having a fiscal rule in place (based on a conditional fixed-effects logit model that identifies the probability of having a fiscal rule in any given country and year) respond to the same variables that help explaining adoption of a rule.

While its focus is also on explaining the likelihood of having a fiscal rule in place, this paper extends very significantly the two previous studies. Its specification form is much broader, focusing on five categories of potential determinants of the choice of *de jure* national fiscal rules that address the particular questions raised by us above. The sample size is larger, comprising an annual-data panel sample of 94 countries (of which 35 have adopted fiscal rules) and spanning the 1975-2008 period. Empirical estimation is performed using a battery of estimation models, chosen after a detailed discussion of econometric issues relevant to this choice. Finally, the base-line results are subject to several robustness checks, presenting alternative results for different time samples, country samples, and categories of fiscal rules (national and supra-national rules).

This paper is structured in the following way. Section 2 presents the comprehensive set of potential determinants of the decision to adopt fiscal rules, providing the broad theoretical arguments for the relevance of five categories of such correlates. Section 3 describes data and descriptive statistics, including providing detailed descriptions of the variables and empirical proxies used to

account for the theoretical determinants of the previous sections. Section 4 briefly reviews the state of non-linear panel data econometrics for discrete dependent variable in order to motivate the model selection. Section 5 analyzes the estimation results. Section 6 concludes.

II. VARIABLE SELECTION AND MODEL SPECIFICATION

The availability of data on fiscal rules is limited. The pioneering work of Kopits and Symansky (1998) has been updated and extended recently by the IMF (2009) to include the 89 countries (21 advanced, 33 emerging, and 26 low-income economies) with national and/or supra-national *de jure* fiscal rules in place in 2008, as depicted in figure 1 Using this information, countries have been classified for this paper using a binary variable that takes a value of one if the country has in place any form of national fiscal rule and zero otherwise. The measure is arguably simplistic and it certainly does not reflect the variety of fiscal rules[1] or the degree of enforcement of rules.[2] However, coding fiscal rules is adequate to specify a behavioral model for a limited dependent variable defined as a binary random variable explained by a vector of potential determinants, making use of discrete-choice panel-data estimation methods.

There is no narrow theoretical framework that explains the choice of macroeconomic policy regimes. Hence most empirical studies of the determinants of macroeconomic regime choice is based on a narrative about objectives pursued by policy makers, (pre-) conditions that facilitate adoption of a particular regime, complementarity with regimes in other policy areas (e.g., inflation targeting and exchange rate floats) or structural features that require or facilitate adoption of a particular regime. This is the case of empirical studies of determinants of exchange-rate regimes (Levy-Yeyati and others 2010; Calderón and Schmidt-Hebbel 2008c), monetary policy regimes (Calderón and Schmidt-Hebbel 2008c, and fiscal regimes based on fiscal rules (Calderón and Schmidt-Hebbel 2008a, IMF 2009).

This paper follows the latter literature, extending significantly the two previous studies on fiscal rules. We identify five categories of potential determinants of choosing fiscal rules: political and institutional variables, fiscal policy conditions, monetary and exchange-rate regimes, financial market development measures, and the overall development level. For these categories we select the most representative variables available for each category. We match the sample of

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1 As discussed in the introduction, there is a large variety or fiscal rules. We limit our empirical analysis to national (and supra-national) rules of any type.

2 Most fiscal rules do not specify escape clauses. Even those governments with ex ante defined escape clauses attached to their rules face sometimes situations where escape clauses do not apply but rules should be suspended—say, facing the deep 2008-2009 recession. However, with or without escape clauses, many governments have violated their fiscal rules and some of them—including several euro zone members—have incurred in recurrent, systematic violation of their national and supra-national fiscal rules. Hence enforcement of de jure rules varies significantly across countries and over time. However, in the absence of data on enforcement of de jure rules (i.e., data on de facto rules), we limit our statistical analysis to de jure fiscal rules.

countries with fiscal rules with a larger control group of economies without fiscal rules.

2.1 Political and Institutional Variables

We identify four potential determinants of fiscal rules among political and institutional variables, and discuss their expected signs next.

Fiscal rules are very likely to be an outcome of particular political regimes and institutions. Fiscal rules—by constraining fiscal policy makers in the design and execution of the budget, in a way that is relatively transparent and subject to open monitoring—contribute to transparency, democratic accountability, less discretion, and less corruption. Therefore our first political determinant is a standard measure of democracy.

At the constitutional level, the distinction between federal and unitary government is likely to make a difference for the adoption of fiscal rules. In federal countries fiscal sovereignty of federal governments is weaker than that enjoyed by central governments in unitary countries. The large literature on fiscal federalism attests to the important differences in the conduct and outcome of fiscal policy between federal and unitary countries (Feld and Schnellenbach, 2010). We expect federal governments to be more likely to adopt fiscal rules than unitary governments because they strengthen their bargaining position with respect to the federated states or provinces.[3] Hence we include a binary dummy variable for federal governments.

There is evidence suggesting that rules reflect an implicit contract between governments and voters, that is, they signal a government commitment to maintain mutually agreed standards of fiscal discipline (Debrun and Kumar, 2007). Therefore, we include a measure of political risk and checks and balances, the Political Constraint Index.

Political instability of governments make it difficult or pre-commit to rules. Hence fiscal rules are more likely to be adopted and continued over time under conditions of government stability.[4] Hence we include a government stability measure as potential regressor.

2.2 Fiscal Policy Conditions

We identify three variables related to fiscal policy strength and conduct that may exert an influence on choosing a fiscal rule. First, we include the population dependency ratio, i.e., the ratio of under-15 and above-64 population to those

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3 Federal states complement adoption of fiscal rules at the federal (or national) level with adoption of sub-national rules at state or provincial levels (IMF 2009).

4 This argument is analogous to the inclusion of government stability measures as determinants of counter-cyclical fiscal and monetary policies in international panel data studies (e.g., Calderón and Schmidt-Hebbel 2008d, Calderón and others 2010).

in the 15-64 year range. As the ratio rises, the demands for higher government spending on social programs in support of the young and the elderly (for child-care, education, pensions, and health) rise. This makes it more difficult for government to commit to a fiscal rule, reducing the likelihood of putting them in place.

Next we include the (lagged) government budget balance as a measure of overall fiscal policy strength. We expect that a higher budget balance raises the likelihood of adopting a rule-based fiscal regime, as it is easier to adopt a disciplining device and stick to it when fiscal accounts are on a more sustainable footing (Debrun and Kumar 2007). Intrinsically well-behaved governments adopt strict rules and institutions to reveal the nature of their unobservable preferences. However, in many papers on fiscal institutions and policy outcomes the focus is on the reverse causality (from institutions to outcomes): because institutions are effective commitment devices, the fiscal outcomes are observed. It thus remains an empirical issue to determine which causality prevails—an issue outside the scope of this paper. In any case, we include the budget balance as a possible determinant of fiscal rule choice, noting its potential endogeneity

Several explanations for the existence of pro-cyclicality in government expenditures are provided in the analytical and empirical literature. First, restricted government access to credit markets, particularly during recessions, preclude borrowing to weather temporary shocks or recessions (Gavin and Perotti 1997, Agénor and Aizenman 2000, Kaminsky and others 2004). Second, citizens in countries with corrupt governments demand less taxes and more government benefits in good times for fear that these rents will be appropriated by government officials (Alesina and Tabellini, 2005). Third, voracity effects arise from interest groups influencing government expenditure to raise their consumption more than output in response to favorable income shocks (Talvi and Végh, 2004). The recent empirical literature shows that weaknesses in political institutions and financial underdevelopment are the main determinants of fiscal pro-cyclicality in the world (Calderón and Schmidt-Hebel 2008c, Ilzetzki and Végh 2008).

We expect that governments prone to pro-cyclical government expenditure behavior are less willing to subject themselves to the discipline of a fiscal rule. Therefore we include a measure of fiscal pro-cyclicality.

2.3 Monetary and Exchange-Rate Regimes

Inflation targeting requires central banks to commit to a pre-announced, explicit target for inflation as well as developing a highly transparent set of rules for operating monetary instruments and providing information to the public. Moreover, there is significant theoretical and policy consensus that a pre-condition for the success of inflation targeting is the absence of fiscal dominance. In turn, fiscal dominance—the need to rely on central bank resources (ultimately seigniorage)—is more unlikely when a government commits to a fiscal rule.

Minea and Villieu (2009) develop a theoretical model whereby inflation targeting provides an incentive for governments to improve institutional quality in order to enhance tax revenue performance.[5] Testing of this model by Lucotte (2010), using propensity score matching, indicates that in thirteen emerging countries inflation targeting has a significant positive effect on public revenue collection. Hence we include a discrete variable for the countries where monetary policy is based on an inflation targeting regime. We expect that inflation targeting regime raises the likelihood of having a fiscal rule in place.

While there is literature that links the choice of exchange rates to fiscal performance, it focuses on the impact of government deficits and public debt levels on the success of fixed, intermediate, and floating exchange rates. The conventional view (e.g., Giavazzi and Pagano (1988) and Frenkel and others (1991), among others) is that pegs provide more fiscal discipline than floats. If governments adopt a lax fiscal policy under a fixed exchange rate, this would lead to a speculative attack on reserves and consequently to currency devaluation. Because the eventual collapse of the peg would imply a large political cost for the policy maker, fixed regimes impose discipline on fiscal authorities.

However, political economy arguments provide the opposite rationale. Tornell and Velasco (2000) stress that under reasonable conditions (linked to uncertainty of government about their re-election and lack of access to capital markets), more fiscal discipline is attained under floats, where fiscal mismanagement leads to devaluation and inflation in the short term. Under pegs, unsustainable fiscal policy leads to higher debt and lower reserves in the short term, postponing the costs of devaluation and inflation to the future

Hence we include as a second policy regime measure a binary variable for a fixed exchange-rate regime. Considering the arguments of the preceding literature, its effect on the likelihood of having a fiscal rule in place is ambiguous.

2.4 Financial-Market Development Variables

Financial-market development could have a positive influence on the likelihood of having fiscal rules in place through two channels. First, both domestic financial development and stronger integration into world capital markets raise government access to domestic and external debt financing and subjects governments to closer scrutiny of fiscal sustainability by financial market analysts and rating agencies. This strengthens the case for adopting fiscal rules that commit governments to a course of fiscal prudence and solvency. Second, if domestic financial markets are deeper and integration into world capital markets is full and comprehensive, governments will be more likely to

5 The result requires monetary policy to be set in advance of fiscal effort to collect taxes. In our case, this requirement is empirically valid: no country in the sample initiated national fiscal rules prior to setting up inflation targeting.

access domestic or external funding during cyclical downturns. This reinforces government adoption of fiscal rules that minimize fiscal pro-cyclicality or strengthen fiscal counter-cyclicality.

Therefore we include one variable that reflects domestic financial development and another variable that measures international financial integration or openness as potential determinants of having fiscal rules in place.

2.5 Overall Development Level

Finally, we control for the overall level of development, for which we use per-capita GDP in real terms (US$ of 2000). Much of the literature has focused on the reverse causality, i.e., on the impact of fiscal rules on economic growth (Castro 2011). Here we focus on the reverse causality from the level of development to the likelihood of having a fiscal rule in place. This hypothesis embodies the stylized fact that governments in richer economies have more human and financial resources available to undertake the complex task of implementing, monitoring, and evaluating operation of a fiscal rule.

III. DATA AND DESCRIPTIVE STATISTICS

Next we describe the empirical measures chosen for our dependent variable and the ten variables selected as potential determinants. We also present summary information about the variables, their distributions and correlations in graphical and tabular form. Appendix table A.1 provides more detail on data definitions and sources, while appendix table A.2 contains a country list showing adoption of fiscal rules, inflation targeting and federal system.

Our dependent variable is the binary measure for a *de jure* fiscal rule that includes 89 countries and covers the period from 1975 to 2008, compiled by IMF (2009). We code national rules and supra-national rules separately. Most of our empirical analysis is conducted for national rules only, but we use national and supra-national rules for conducting sensitivity analysis.

Our first political and institutional variable is a measure of democracy: the democracy and Polity 2 indices of the Polity IV project. Then we include a binary dummy variable for federal governments (1 for federal governments, 0 otherwise). In this paper we use a *de jure* definition of a country as federal or unitary. In most cases the *de jure* classification matches the *de facto* fiscal structure; in a few cases, like Spain, the country is *de jure* unitary, but one could argue that its fiscal structure is so decentralized that it resembles *de facto* a federal structure.

As measure of political checks and balances, we use the Political Constraint Index (POLCON-V), developed originally by Henisz (2000) and later refined and extended by Henisz and Zelner (2010). It is a quantitative measure of the institutional constraints faced by authorities, reflecting the extent to which a political actor or the replacement for any one actor (e.g., the executive or a chamber of the legislature) is constrained in his choice of future policies.

An alternative to the latter is the index developed by the World Bank in its database of Political Indicators (CHECKS2a), which counts the number of veto players in a political system, adjusting for whether these veto players are independent of each other, as determined by the level of electoral competitiveness in a system, their respective party affiliations, and electoral rules (Beck and others, 2001). Checks rank countries from 1 (low) to 6 (high). While the CHECKS2a index takes into account the complex relations between veto points, party preferences, and preference heterogeneity, it also assumes a linear relationship between the number of adjusted veto points and the degree of constraints on policy change. Similarly, the number of adjusted veto points increases linearly in parliamentary systems with each addition of a party to the ruling coalition without regard to the relative size of the parties in the coalition. The Political Constraint Index (POLCON-V) overcomes these limitations. The pair wise correlation between both measures of political checks and balances is 68%.

As a measure of government stability we use the corresponding International Country Risk Guide (ICRG) Index.

Now let us turn to fiscal condition variables. We use the standard population dependency ratio determined by a country's population structure (share of the population between 15 and 64 years old). For the budget balance we use the general government balance on a cash basis. Our third fiscal variable is a measure of government pro-cyclicality. Here most of the literature on cyclical behavior of fiscal policy has focused on cross-section models, for which time correlations in preceding periods can be used for measuring the degree of government spending pro-cyclicality. For our panel-data model, we need a time-varying instrument. We compute a rolling-window correlation between detrended data on government consumption and GDP. Data were detrended using the Hodrick-Prescott filter with the optimal smoothing parameter suggested by Ravn and Uhlig (2002). The pro-cyclicality measure is computed subsequently as a rolling correlation of three, five, and ten periods.

For monetary and exchange-rate regimes, we use a binary variable for countries under an inflationtargeting and another binary variables under a fixed exchange-rate regime. On classification of countries according to their adherence to inflation targeting, there is no difference between *de facto* and *de jure* regimes, and little disagreement among different sources on the dating of the start of inflation targeting. This is in contrast with classification of exchange-rate regimes, which are either *de facto* or *de jure*. Following the recent literature, we use the *de facto classification*. Our binary variable is for fixed exchange-rate regimes (encompassing monetary union, dollarization, and currency boards) with a value of one, and other regimes (intermediate and floating exchange rates) with a value of zero. Because our interest is mainly on institutions, we consider as fixed exchange-rate systems only dollarization, currency boards, and monetary unions. To account for (unlikely) mutual causation between these extreme and largely institutional fixed exchange-rate regimes and fiscal rules, we use lagged values in the regressions.

Our first financial-market development variable is domestic financial development, for which we use a standard measure: the outstanding stock of domestic bank credit to the private sector as a ratio to GDP.

The second dimension is international financial integration or openness, for which we use the measure developed by Chinn and Ito (2008). Choosing between ex-post measures of financial integration (such as foreign asset ratios to GDP) and ex-ante policy measures, we prefer the latter for reasons of consistency with other policy measures included among regressors.

Finally, we follow the standard measure of overall development, which is real per-capita GDP at market prices (expressed in US$ of 2000).

Potential endogeneity of our independent variables to having a fiscal rule in place should not be a significant concern because countries either adopt once and then for the full remaining sample period or do not adopt at all a fiscal rule. However, in order to address in some way possible residual endogeneity, we use lagged values for several variables that may be affected by the contemporaneous choice of a fiscal rule, namely capital account openness, government balance ratio to GDP, fixed exchange-rate regime, dependency ratios and GDP per capita.

We summarize country information for our sample of three key variables: starting sates of national and supra-national fiscal rules, classification of countries by constitutional federal governments, and starting dates of inflation targeting. While fiscal rules were started in the 1970s (as reflected by figure 1), inflation-targeting regimes started around 1990.

Table 1 reports descriptive statistics for the dependent and all independent variables for the sample period 1975-2008. While the number of available observations for all variables is around 3,000, there are missing data for some countries and years (in particular in the 1970s) so that the effective sample used in the econometric analysis is around 2,200 observations. It can be seen that around 16% of the sample corresponds to observations of countries employing fiscal rules. Likewise, in around 9% of the years, countries had conducted monetary policy using inflation-targeting schemes while in another 24% of the cases, countries had relinquished monetary policy by having fixed exchange-rate regimes. The coefficient of variation of each variable indicates that heterogeneity is notorious among several control variables, including those representing political aspects (democracy, federalism) and fiscal policies (government budget balances and pro-cyclicality of government expenditures).

Table 1

Descriptive statistics

	Observations	Mean	Standard deviation	Coefficient of variation	Range
Fiscal rule	3,026	0.158	0.365	2.306	[0,1]
Checks and balances	2,855	0.451	0.328	0.727	[0,0.9]
Democracy	2,871	2.690	7.382	2.744	[-10,10]
Federalism	3,026	0.169	0.374	2.221	[0,1]
Government stability	2,798	7.344	2.125	0.289	[1,11]
Dependency ratio	2,937	-0.413	0.277	-0.671	[-1.08, 0.12]
Government budget	2,434	-0.058	0.412	-7.089	[-13.4,0.23]
Pro-cyclicality gov. Expend.	2,840	0.168	0.554	3.293	[-0.99,0.99]
Fixed-exchange rate	2,781	0.242	0.428	1.772	[0,1]
Inflation target	3,026	0.090	0.286	3.189	[0,1]
Capital account openness	2,823	0.272	1.586	5.836	[-1.84, 2.48]
Financial development	2,810	3.562	0.877	0.246	[-0.38, 5.55]
GDP per capita	2,807	7.897	1.543	0.195	[4.81, 10.65]

Source: Authors' calculation.

Table 2 presents a matrix with simple correlations between all variables. In general, variables tend to display very low correlation, in particular when comparing political and economic fundamentals. Among political variables, there is only a relatively high correlation between democracy and political checks and balances—which to some extent is expected—but neither variable is highly associated with having federal or stable governments. Among economic variables, there is very little correlation between fiscal variables (dependency ratio, fiscal balances and the pro-cyclicality of government expenditures) and a positive—yet unsurprising— correlation between the degree of development (measure by GDP per capita) and the two variables representing financial development and integration to international capital markets. Across these groups of variables, there is minor evidence that higher development levels are positively correlated with higher degrees of checks and balances.

Table 2

Correlations, 1975-2008

Variable	Checks and balances	Democracy	Federalism	Gov. stability	Dependency ratio	Gov. budget	Pro-cyclicality gov. expend.	Fixed exchange	Inflation target	Capital acc. openness	Financial develop.	GDP per capita
Checks and balances	1.000											
Democracy	0.605	1.000										
Federalism	0.231	0.175	1.000									
Government stability	0.386	0.204	0.076	1.000								
Dependency ratio	0.630	-0.470	-0.154	-0.400	1.000							
Government balance	-0.014	-0.030	0.022	0.048	0.047	1.000						
Pro-cyclicality gov. expend.	-0.136	-0.059	-0.021	-0.136	0.172	0.021	1.000					
Fixed-exchange	0.258	0.183	0.066	0.142	-0.328	-0.129	-0.078	1.000				
Inflation target	-0.186	-0.173	-0.070	0.005	0.179	0.027	-0.015	-0.175	1.000			
Capital acc. openness	0.435	0.304	0.104	0.319	-0.530	-0.024	-0.171	0.216	0.035	1.000		
Financial development	0.472	0.193	0.199	0.287	-0.654	0.019	-0.144	0.261	-0.026	0.480	1.000	
GDP per capita	0.620	0.439	0.220	0.341	-0.790	0.003	-0.143	0.274	-0.133	0.555	0.712	1.000

Source: Authors' calculation.

IV. ESTIMATORS AND ECONOMETRIC ISSUES

The econometric literature on panel data models has progressed substantially in the last half-century. The properties of the parametric estimators in linear models are well understood, at least for the popular cases of the fixed-effects, random-effects and mixed (or two-way) estimators. Their performance under different conditions (sample size, endogeneity, misspecification, error-correlation, sampling, etc.) has been widely explored from both analytical and empirical viewpoints (Wooldridge, 1995).

The conventional practice indicates that in static linear models, fixed-effects estimators are preferred to random-effects estimators when the effects are correlated with other regressors. However, the random-effects estimator is more parsimonious, requiring only one additional parameter to be estimated (namely, the variance of the distribution of random effects), and hence it is preferred in the absence of correlation between effects and control variables.[6]

6 Time dependency in disturbances can only be modeled using the random-effects estimator; fixed effects estimators are biased (Nickell, 1981). Fully dynamic models taking into account complex dynamic patterns require estimation using instrumental variables procedures to account for the endogeneity of pre-determined variables.

The properties of estimators in non-linear panel data models, in particular for discrete variables, are less developed and therefore substantial issues remain unsolved (Greene, 2009). The current consensus view about the choice of fixed versus random effects in linear models does not carry through to non-linear models. In the general case of the fixed-effects estimator for discrete data models, the incidental parameter problem (Neyman and Scott, 1948) leads to estimator bias when the time dimension T is fixed, even when the cross-section dimension tends to infinity ($N \to \infty$). In simple terms, the estimator for the included control variables depends on the estimator of the fixed effects and the latter is only consistent when $T \to \infty$.[7] Consider the general fixed-effects model:

$$f\left(y_{it} \mid x_{it}, x_{it}, \ldots, x_{it}\right) = g\left(y_{it}, \beta x_{it} + \alpha_i, \theta\right), \tag{1}$$

where y is the variable of interest, x are exogenous control variables, α is the individual effect, β is the vector of slope coefficients, and θ is an ancillary parameter (e.g., scale parameter or dispersion of disturbances). The log likelihood function for a sample of size (N,T) is:

$$\log L = \Sigma_{i=1}^{N} \Sigma_{i=1}^{T} \log g\left(y_{it}, \beta x_{it} + \alpha_i, \theta\right). \tag{2}$$

Maximization of equation (2) to obtain the maximum likelihood (*ML*) estimators is complicated by the fact that the first-order conditions conform to a set of non-linear equations and therefore estimates are obtained by numerical approximation.

The incidental parameter problem arises from the fact that, in general, the estimator of the parameters of interest (say, $\hat{\beta}_{it}$) will depend on the estimator of the individual effects ($\hat{\alpha}_i$). Assume that β and θ were known. Then the estimator of α_i would use the T_i observations for each individual. Only when T converges to ∞, the estimator of $\hat{\alpha}_i$ converges to the population parameter and it allows the estimators $\hat{\beta}_{it}$ to also converge. However, for fixed T, the latter will be generally biased. The size of the bias diminishes relatively rapidly in T, so that Heckman (1981) suggests that biases are negligible for N=100 and T=8.

However, for the particular case when y is a binary variable and the cumulative distribution function of $g(\bullet)$ in equation (1) is the logistic distribution, the incidental parameter can be avoided altogether if one focuses on the conditional logit estimator. As noted in Greene (2001), in any group where the sample of the dependent variable is comprised by either all 1s or all 0s, there is no *ML* estimator for α_i—the likelihood equation for *log Li* has no solution if there is no within-group variation in y_{it}. However, conditional upon observing such variation, the *ML* estimator can be obtained: by focusing on the distance

7 Linear models avoid this problem by virtue of the Frisch-Waugh theorem (which separates estimation of the parameters of interest from estimation of the fixed effects) and recover the individual effects using the individual mean, which is a sufficient statistic for the effect.

between control variables before and after such variation, the fixed effects cancel out as they do in the linear model. Note, however, that this procedure eliminates a potentially large number of observations. The conditional estimator is consistent, so it bypasses the incidental parameter problem. However, it does have a major shortcoming (Greene 2009). By avoiding the estimation of the fixed effects it precludes computation of the partial effects or estimates of the probabilities for the outcomes. After all, there is no way to tell if an individual has any value of α_i if he does not change his behavior. Therefore this approach limits the analyst to infer only about β.[8]

The fixed-effects probit model, on the other hand, has not been widely used because *ML* estimators are biased and difficult to implement computationally. As noted by Maddala (1987), the conditional *ML* method does not produce computational simplifications as in the logit model because the fixed effects do not cancel out. This implies that all *N* fixed effects must be estimated as part of the estimation procedure. This also implies that, since the estimates of the fixed effects are inconsistent for small *T*, the fixed-effects probit model yields inconsistent estimates for β as well. Greene (2001) disputes the computation intractability of the probit fixed-effect model but he acknowledges the inconsistency of the estimator.[9]

Thus, in applying the fixed-effects estimator to panel-data models with discrete dependent variables, the conditional logit model seems to be the preferred choice. Nevertheless, one should bear in mind that the conditional logit estimator requires strict exogeneity of the regressors and stationarity over time (it cannot, at least in principle, accommodate heteroskedasticity over time in the latent model).[10] As these conditions are frequently violated in economic data, the random-effects estimator is an attractive alternative. For panel data, the probit model is computationally tractable while the logit model is not.[11]

For the random-effects estimator, equation (1) is modified to acknowledge the fact that individual effects (μ_i) come from realizations of a density function *f* (μ_i). The complete model is then:

$$\begin{aligned} &f\left(y_{it},\mu_i \mid x_{it},x_{it},\ldots,x_{it}\right) = g\left(y_{it},\beta x_{it},\mu_i,\theta\right). \\ &f\left(\mu_i\right) = h(\mu_i \mid \theta). \end{aligned} \tag{3}$$

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8 There is an extensive literature on semi-parametric and GMM approaches for some panel data models with latent heterogeneity (Honoré, 2002). Among the practical limitations of these estimators is that although they provide estimators of the primary slope parameters, they usually do not provide estimators for the full set of model parameters and thus preclude computation of marginal effects, probabilities or predictions for the dependent variable.

9 The estimator is biased upward, but the bias declines relatively fast. For a sample of 20 observations and in the case of a single scalar regressor, the fixed-effects probit estimator is biased upward by around 4% ($\Pi/80$).

10 The conditional ML estimator for the logit model is inconsistent if the conditional independence assumption fails (Kwak and Wooldridge, 2009).

11 According to Wooldridge (2009) some headway has been made in obtaining bias-corrected versions of fixed-effects estimators for non-linear models but these new methods have several practical shortcomings.

One can safely assume that in static models, conditional on μ_i, the T_i observations in each group are independent. This allows us to write the joint distribution of the y_{it} observations and the μ_i individual effects as:

$$f\left(y_{it},\mu_i \mid x_{it},x_{it},\ldots,x_{it},\beta,\theta\right) = f\left(y_{it} \mid x_{it},x_{it},\ldots,x_{it},\mu_i,\beta,\theta\right) f\left(\mu_i\right) \\ = \prod_1^{Ti} g\left(y_{it},\beta x_{it},\mu_i,\theta\right) h(\mu_i \mid \theta). \tag{4}$$

In order to form the likelihood function for the observed data, μ_i must be integrated out. The assumption that the individual effects follow a normal distribution—the essence of the probit model— allows for the tractability that is missing in the logit case. The log likelihood function becomes:

$$\log L = \sum_{i=1}^{N} \log \left[\int_{\mu} \prod_1^{Ti} g\left(y_{it},\beta x_{it},\mu_i,\theta\right) h\left(\mu_i \mid \theta\right) d\mu_i \right]. \tag{5}$$

Several methods are available to maximize the probit likelihood function (Hermite quadrature, exact integration, and simulated maximum likelihood). These methods are useful but they are also computationally cumbersome. Quadrature operates effectively when the dimension of the integral is small—as in our case—but not with higher dimensions.

In general, the probit model imposes the restriction that the correlation between successive error terms for the same individual is a constant (defined in the literature as the "equicorrelation" model). The only limitation of probit models is that they require normal distributions for all unobserved components, a feature that may characterize most unobserved, random components but that is notoriously absent in cases where variables are truncated (e.g., incomes or prices must be positive).

In summary, the econometric literature on limited dependent variable in non-linear panel data models has not yet reached the point where researchers can confidently identify the strengths and weaknesses of the different estimators. In general, random-effects probit models and conditional fixed-effects logit models tend to be preferred to other estimators when, as in our case, both N and T are relatively large.

The analysis undertaken below is econometrically rigorous. However, it is subject to limitations. In particular, because economic theory cannot guide the econometric specification, there is a possibility that omitted variables may exert a joint influence on the decision to implement fiscal rules and build institutions, suggesting a causal linkage while institutions would just be proxies for those omitted determinants of fiscal rules.

The general specification of our regression model for the likelihood of having a fiscal rule in place is as follows:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it}, \tag{6}$$

where y_{it} is a vector of discrete-choice country-year observations for a fiscal rule (a dummy that takes a value of 1 for having a fiscal regime in place, 0 otherwise), x_{it} is the matrix of country-year observations for the 12 explanatory variables that were introduced in the previous section, α is a vector of individual country effects that reflect unobservable country heterogeneity, β is a vector of slope coefficients that are common to all countries, and ε is a vector of error terms.

We estimate equation (6) making use of pooled-data probit and logit, random-effects probit, and conditional fixed-effects probit estimators.

V. ECONOMETRIC RESULTS

Following the conceptual framework regarding the choice of a fiscal regime (the likelihood of having a fiscal regime in place) and the detailed discussion of the corresponding econometric issues, now we turn to our estimation results of pooled logit and probit as well as random-effects probit and fixed-effect logit models. As discussed above we confine ourselves to the random-effects probit model because its fixed-effects counterpart produces a biased estimator, even asymptotically. On the other hand, the estimates of the random-effects logit model are difficult to interpret because the estimated coefficients are characterized by a mixed of distributions, normal (for the error) and logistic (for the fundamentals).

The results of the pooled-data regressions are reported in table 3. The results lend strong support to the conceptual framework discussed above. However, we do not pursue further discussion of the pooled regression results because they do not account for country heterogeneity, which we find to be present in our sample. According to likelihood-ratio tests reported in tables 5 to 10, the data strongly reject the null hypothesis of country homogeneity in all cases.

Hence we focus on random-effects probit and conditional fixed-effects logit models, starting with full sample regressions of table 4. Our unbalanced panel comprises the full 1975-2008 sample period and up to 89 countries, as long as data is available. Of course, sample size differs considerably across the two models (at most 941 country-year observations for fixed-effect estimations, compared to more than 2,250 for random-effect estimations). The treatment group (comprised by up to 37 countries) is the same under fixed and random effects—it includes all country-year observations of countries with a fiscal regime since their starting dates. In fixed-effects conditional logit models, the full sample is reduced to 34 countries because three countries have had fiscal rules through the entire period and the conditional estimator only uses information from countries that switched regimes. In contrast, in random-effects models the treatment group includes the 37 countries with fiscal rules and the 52 non-fiscal regime countries. We should, therefore, be mindful of the large differences in overall sample size when contrasting the results of the two models.

The results in table 4 provide strong evidence in support of our priors. Moreover, the evidence is generally robust across fixed-effects and random-effects estimations, notwithstanding their large sample differences. However, the

results of the conditional fixed-effects logit model are less robust for the capital account openness and the fixed exchange-rate regime, since this model accounts only for the country years close to the regime change (such as the switch from fixed to flexible exchange-rate regimes or from closed to open capital accounts). Moreover, due to the smaller sample size under fixed effects, multicollinearity appears to be affecting some variables, such as financial development, pro-cyclicality of government expenditure, and GDP per capita.

Now we turn to discuss the results by category of variables. Institutional and political variables (democracy, federalism, checks and balances, and government stability) are robustly significant for most regressions under the two models.[12] As expected, having fiscal rules is likely to be associated with democratic regimes, federal governments, strong political checks and balances, and stable governments. While democracy is an important determinant of fiscal rules, checks and balances tend to have an independent and even stronger effect. This is important because democracy, which mainly measures the competitiveness of the political process, may not necessarily promote strong checks and balances (figure 2). In particular, the high democracy-low checks and balances quadrant of the figure contains a few Latin American countries that have experienced democracy for some time now, yet failed to develop strong system of political checks and balances.

Second, among all categories of determinants, fiscal conditions are the most obvious correlates of fiscal rules. In fact, they are found to be empirically significant in the decision of having fiscal rules in place. Countries with high shares of young and old people are less likely to opt for a fiscal rule, reflecting the large (and typically rising) government liabilities due to government spending programs on the young and the old. Countries running fiscal surpluses are more likely to adopt fiscal rules. Both effects tend to be highly significant and robust to the choice of the estimating model. However, our first fiscal policy condition, government spending pro-cyclicality, was found to be uniformly non-significant under the random-effects model and in regression 3 of the fixed-effects model (which excludes GDP per capita to alleviate multicollinearity). Although the theoretical case for inclusion of spending pro-cyclicality appears to be compelling, it does not seem to have a significant influence on fiscal rules.

In the category of monetary and exchange-rate regimes, we find that inflation-targeting countries are more likely to adopt fiscal rules—a result that is found to be robust under both models. Fixed exchange-rate regimes are also found to be positively associated with fiscal rules under the random-effects model, and in regression 6 of the conditional fixed-effect model. These findings lend support to the view that inflation-targeting countries, and to a lesser extent those with a fixed exchange-rate regime, have stronger incentive to adopt fiscal rules.

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12 However, the time-invariant federal dummy is dropped from the fixed-effects model. Also in the random-effects model government stability turns to be significant only when removing the financial development variable.

Our results are mixed for the two variables reflecting financial-market development. Domestic financial development was generally not found to be significant. However, open capital accounts are positively associated with fiscal rules under the random-effects probit model and in regression 6 of the conditional fixed-effects logit regression.

Finally, per-capita GDP, the proxy of economic development, is also positively and robustly associated with fiscal rules under both models. This result suggests that, controlling for all other determinants that were discussed above, the richer countries are more likely to adopt and stick to fiscal rules, possibly because they have in place the institutional and human-resource capabilities that are required for abiding successfully to fiscal rules.

We conclude that our priors about potential determinants are largely confirmed by the main results reported in table 4. Our preferred results are those reported by regression 3. There we find four political and institutional variables, two fiscal-policy conditions, two monetary and exchange-rate regime variables, one financial-market development variable, and overall development are significantly robust determinants of the choice of fiscal rules. Only two variables are not robustly significant determinants of fiscal rules: government spending pro-cyclicality and domestic-financial development.

Figure 2

Scatter of political variables, average 1975-2009

Sources: Henisz and Zelner (2010); Integrated Network for Societal Conflict Research.

Table 3

Base-case results for national fiscal rules: Pooled-data probit and logit models, 1975-2008

	(1)	(2)	(3)	(4)	(5)	(6)
		Logit models			Probit models	
Checks and balances	1.87***	1.96***	2.07***	1.06***	1.14***	1.20***
	(0.40)	(0.39)	(0.37)	(0.22)	(0.22)	(0.21)
Democracy	0.03**	0.03**	0.03**	0.02**	0.02**	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Federalism	0.66***	0.62***	0.60***	0.43***	0.41***	0.40***
	(0.16)	(0.16)	(0.16)	(0.09)	(0.09)	(0.09)
Government stability	0.11***	0.10***	0.10***	0.06***	0.06***	0.07***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)
Dependency ratio	-3.00***	-2.80***	-2.67***	-1.63***	-1.52***	-1.42***
	(0.46)	(0.44)	(0.38)	(0.25)	(0.24)	(0.21)
Government budget	0.57**	0.56**	0.55**	0.34***	0.34***	0.33***
	(0.24)	(0.24)	(0.24)	(0.14)	(0.14)	(0.14)
Pro-cyclicality gov. expenditures	0.43***	0.37***	0.38***	0.23***	0.21***	0.21***
	(0.12)	(0.12)	(0.12)	(0.07)	(0.07)	(0.07)
Fixed-exchange rate	0.23	0.16	0.14	0.13	0.09	0.06
	(0.17)	(0.17)	(0.17)	(0.10)	(0.09)	(0.10)
Inflation target	1.60***	1.60***	1.60***	0.96***	0.96***	0.96***
	(0.18)	(0.17)	(0.18)	(0.10)	(0.10)	(0.10)
Capital account openness	0.75***	0.74***	0.73***	0.41***	0.41***	0.40***
	(0.06)	(0.06)	(0.06)	(0.03)	(0.03)	(0.03)
Financial development	-0.16			-0.11		
	(0.12)			(0.07)		
GDP per capita	-0.01	-0.06		-0.01	-0.04	
	(0.09)	(0.09)		(0.05)	(0.03)	
Constant	-3.50***	-3.50***	-3.85***	-1.95***	-1.97***	-2.18***
	(0.62)	(0.59)	(0.33)	(0.32)	(0.32)	(0.18)
Observations	2,190	2,213	2,215	2,190	2,213	2,215
Countries	89	89	89	89	89	89
Without fiscal regime	52	52	52	52	52	52
With fiscal regime	37	37	37	37	37	37
LR statistic	610.95	618.35	617.77	618.75	625.97	625.28
Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-718.95	-735.02	-735.71	-715.05	-731.21	-731.95

Source: Authors' estimations.

Table 4

Main results for national fiscal rules: Random-effects probit and conditional fixed-effects logit models, 1975-2008

	(1)	(2)	(3)	(4)	(5)	(6)
	Random-effects probit			Conditional fixed-effects logit models		
Checks and balances	4.04***	4.07***	3.29***	10.24**	8.88**	7.84**
	(0.81)	(1.10)	(0.91)	(5.89)	(4.10)	(4.02)
Democracy	0.24***	0.14**	0.24***	0.94***	0.78***	0.75***
	(0.05)	(0.06)	(0.06)	(0.34)	(0.30)	(0.30)
Federalism	5.09***	1.98**	3.41***	-	-	-
	(0.61)	(1.11)	(0.67)			
Government stability	0.15***	0.16***	0.19***	-0.04	0.08	0.05
	(0.06)	(0.06)	(0.05)	(0.20)	(0.18)	(0.18)
Dependency ratio	-19.55***	-26.49***	-19.15***	-151.76***	-138.31***	-133.9***
	(1.55)	(2.71)	(2.15)	(32.32)	(28.06)	(26.22)
Government budget	3.84***	3.02	3.60**	-0.14	-0.09	-0.10
	(0.84)	(2.62)	(1.11)	(1.57)	(1.38)	(1.33)
Pro-cyclicality gov. expenditures	0.10	0.14	-	-1.43***	-0.94*	-
	(0.16)	(0.16)		(0.68)	(0.57)	
Fixed-exchange rate	2.15***	1.85***	2.09***	-0.46	0.44	0.71
	(0.35)	(0.41)	(0.35)	(1.30)	(1.23)	(1.30)
Inflation target	1.87***	1.90***	1.82***	5.33***	3.95***	3.94***
	(0.31)	(0.35)	(0.29)	(1.35)	(1.06)	(1.04)
Capital account openness	0.59***	0.46***	0.56***	0.44	0.88	0.94*
	(0.14)	(0.17)	(0.14)	(0.66)	(0.58)	(0.53)
Financial development	0.03	-	-	-5.50***	-	-
	(0.26)			(1.67)		
GDP per capita	2.96***	7.02***	2.54***	66.92***	48.28***	45.25***
	(0.40)	(0.36)	(0.37)	(11.43)	(8.35)	(7.66)
Constant	-39.66***	-85.19***	-38.62***	-	-	-
	(2.47)	(2.46)	(1.97)			
Observations	2,190	2,213	2,252	932	941	941
Countries	89	89	89	89	89	89
Without fiscal regime	52	52	52	55	55	55
With fiscal regime	37	37	37	34	34	34
LR statistic	863.91	944.40	907.28	839.52	844.45	843.69
Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-283.09	-259.00	-293.47	-38.41	-45.75	-47.29

Source: Authors' estimations.

5.1 Robustness Checks

Next we undertake three robustness checks, including against shorter time period; smaller sample comprised of advanced countries only; and an alternative concept of fiscal rule that combines both national and supranational rules. We find that our results are not affected under the shorter period, where the estimated individual effects remain remarkably similar—in terms of sign, order of magnitudes and degree of significance (table 5). However, for the other two robustness checks some variables turned insignificant, which in our view, reveal some interesting insights (tables 6 and 7).

For the advanced country regressions, the estimation of the pooled[13] logit and probit regressions reveal two interesting results (table 6). First, democracy, checks and balances and government stability were no longer significant. Second, government budget balance and dependency ratio were also uniformly insignificant. These results suggest that, within this group, there are little variations in these variables; hence they cannot be a factor in explaining the adoption decision. However, variables, such as inflation target, federalism and GDP per capita, that tend to exhibit sufficient variations across the advanced group of countries, retain their significance as determinants of the fiscal rules decision.

Finally, for the alternative concept of fiscal rules that combines both national and supranational ones (table 7), all previously significant variables (under the national fiscal rules concept of table 4) remain so, except for two variables: checks and balances and the government budget balance. Again, we would argue, this in our view is an interesting finding. It seems that the broadening of the fiscal rules concept to include a supranational component has diluted the link between these two variables and the decision process. While under monetary unions fiscal rules act like a mechanical eligibility criteria for member countries; neither checks and balances nor were budget balances rigorously enforced. Evidence abounds from recent experiences of the EU, CFA, and Mercosur.

13 We used pooled regressions because country heterogeneity is not likely to be important for this sample and sample size would reduce too much (only 22 countries).

Table 5

Alternative results for national fiscal rules and smaller time sample: Random-effects probit and conditional fixed-effects logit models, 1990-2008

	(1)	(2)	(3)	(4)	(5)	(6)
	Random-effects probit			Conditional fixed-effects logit models		
Checks and balances	5.13***	5.28***	4.22***	8.84**	8.25**	10.04***
	(1.18)	(1.40)	(1.05)	(4.76)	(4.11)	(3.54)
Democracy	0.29***	0.35***	0.30***	0.92***	0.77***	0.98***
	(0.06)	(0.12)	(0.05)	(0.32)	(0.30)	(0.32)
Federalism	2.78***	3.22***	3.43***	-	-	-
	(1.03)	(0.95)	(0.90)			
Government stability	0.27***	0.28***	0.24***	0.05	0.13	0.61***
	(0.06)	(0.07)	(0.06)	(0.20)	(0.19)	(0.15)
Dependency ratio	-18.87***	-21.96***	-19.95***	-133.1***	-140.9***	-78.9***
	(2.37)	(2.56)	(2.47)	(28.73)	(28.92)	(11.54)
Government budget	2.47*	2.80*	3.07*	-0.16	-0.07	8.17***
	(1.45)	(1.71)	(1.63)	(1.37)	(1.35)	(7.86)
Pro-cyclicality gov. expenditures	-0.05	-0.09	-	-1.40**	-1.00*	0.04
	(0.18)	(0.19)		(0.65)	(0.59)	(0.37)
Fixed-exchange rate	2.33***	2.44***	2.33***	0.06	0.15	5.19***
	(0.40)	(0.42)	(0.39)	(1.36)	(1.19)	(0.93)
Inflation target	1.47***	1.59***	1.56***	3.54***	3.14***	2.93***
	(0.38)	(0.39)	(0.38)	(1.37)	(1.19)	(0.83)
Capital account openness	0.39***	0.38**	0.37**	0.25	0.79	1.00***
	(0.16)	(0.17)	(0.16)	(0.64)	(0.58)	(0.42)
Financial development	0.52	-	-	-4.97***	-	-
	(0.37)			(2.10)		
GDP per capita	0.25	0.98**	0.88***	57.91***	46.90***	-
	(0.55)	(0.41)	(0.45)	(11.58)	(8.75)	
Constant	-19.98***	-27.81***	-24.97***	-	-	-
	(2.62)	(2.21)	(2.49)			
Observations	1,380	1,392	1,409	564	570	570
Countries	89	89	89	89	89	89
Without fiscal regime	55	55	55	55	55	55
With fiscal regime	34	34	34	34	34	34
LR statistic	599.20	613.19	609.62	466.85	468.59	386.41
Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-261.32	-260.24	-272.69	-39.19	-42.99	-84.09

Source: Authors' estimations.

Table 6

Alternative results for national fiscal rules in advanced economies: Pooled-data probit and logit models, 1975-2008

	(1)	(2)	(3)	(4)	(5)	(6)
	Conditional-logit models			Random-effects probit models		
Checks and balances	-76.42 (144.79)	54.06 (72.32)	-32.99 (23.68)	6.20 (12.89)	3.99 (7.00)	6.20 (12.89)
Democracy	12.73 (34,388)	11.41 (16,025)	14.25 (3,512)	0.13 (0.20)	0.19 (0.33)	0.129 (0.20)
Federalism	-	-	-	-4.72** (2.05)	-4.50*** (1.66)	-4.72** (2.05)
Government stability	-0.65 (0.50)	-0.31 (0.37)	0.44 (0.18)	0.10 (0.14)	0.14 (0.13)	0.10 (0.14)
Dependency ratio	-133.94 (98.57)	-67.85 (69.33)	-25.86 (13.02)	-12.00 (11.64)	-12.89 (11.60)	-12.00 (11.64)
Government budget	-47.52 (37.50)	-50.05 (32.54)	17.49 (11.36)	1.42 (6.87)	0.77 (7.00)	1.42 (6.87)
Pro-cyclicality gov. expenditures	-3.69* (1.90)	-3.87** (1.78)	0.55 (0.46)	-0.02 (0.33)	-0.05 (0.33)	-0.02 (0.33)
Fixed-exchange rate	12.92 (6,871)	10.80 (1,809)	21.83 (1,132)	2.30** (1.17)	2.84** (1.17)	2.30** (1.17)
Inflation target	5.18* (2.66)	4.18* (1.93)	4.93*** (1.09)	1.98** (0.79)	2.30** (0.65)	1.98** (0.79)
Capital account openness	0.60 (3.32)	0.05 (2.47)	2.43*** (0.70)	1.57*** (0.60)	1.27** (0.61)	1.57*** (0.60)
Financial development	-3.58 (8.13)	-	-	1.34 (1.15)	-	-
GDP per capita	140.37*** (46.80)	135.75*** (41.20)	-	14.59*** (1.48)	14.96*** (1.19)	-
Constant	-	-	-	-170.72*** (14.58)	-167.84*** (12.83)	-170.72*** (14.58)
Observations	415	422	422	632	640	2,215
Countries	22	22	22	22	22	22
Without fiscal regime	8	8	8	8	8	8
With fiscal regime	14	14	14	14	14	14
LR statistic	422.76	438.60	345.51	240.79	248.79	753.43
Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-12.32	-13.48	-60.04	-86.94	-89.74	-889.56

Source: Authors' estimations.

Table 7

Alternative results for national and supra-national fiscal rules: Random-effects probit and conditional fixed-effects logit models, 1975-2008

	(1)	(2)	(3)	(4)	(5)	(6)
	Random-effects probit			Conditional fixed-effects logit models		
Checks and balances	0.70 (0.74)	0.51 (0.75)	0.49 (0.72)	1.85 (2.08)	-2.66 (1.95)	0.04 (1.69)
Democracy	0.20*** (0.04)	0.20*** (0.04)	0.20*** (0.04)	0.47*** (0.13)	0.44*** (0.12)	0.53*** (0.13)
Federalism	-4.37*** (1.06)	-4.30*** (1.41)	0.92 (0.91)	-	-	-
Government stability	0.22*** (0.05)	0.23*** (0.05)	0.22*** (0.05)	0.24** (0.11)	0.30*** (0.11)	0.51*** (0.10)
Dependency ratio	-21.03*** (2.08)	-21.17*** (1.64)	-21.69*** (3.25)	-66.25*** (9.66)	-71.3*** (9.61)	-59.7*** (6.22)
Government budget	0.57 (0.43)	0.55 (0.42)	0.54 (0.42)	0.02 (1.43)	-0.03 (1.24)	0.80 (0.85)
Pro-cyclicality gov. expenditures	-0.11 (0.14)	-0.10 (0.14)	-	-0.33 (0.31)	-0.31 (0.31)	0.08 (0.25)
Fixed-exchange rate	2.00*** (0.39)	1.92*** (0.38)	1.94*** (0.43)	1.55 (0.98)	1.58* (0.96)	5.22*** (0.85)
Inflation target	2.45*** (0.34)	2.38*** (0.32)	2.35*** (0.35)	4.79*** (0.90)	4.35*** (0.83)	4.52*** (0.64)
Capital account openness	0.74*** (0.12)	0.74*** (0.12)	0.75*** (0.13)	0.91*** (0.30)	0.98*** (0.30)	1.82*** (0.26)
Financial development	-0.25 (0.26)	-	-	-1.96** (0.78)	-	-
GDP per capita	2.61*** (0.38)	2.46*** (0.38)	2.38*** (0.54)	25.13*** (3.26)	21.83*** (2.74)	-
Constant	-36.00*** (1.83)	-35.72*** (2.08)	-35.34*** (2.80)	-	-	-
Observations	2,189	2,213	2,252	1,210	1,219	1,219
Countries	89	89	89	89	89	89
Without fiscal regime	40	40	40	43	43	43
With fiscal regime	49	49	49	46	46	46
LR statistic	938.18	973.86	907.28	1082.29	1091.87	973.85
Value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Log likelihood	-396.16	-398.79	-293.47	-108.21	-111.90	-170.91

Source: Authors' estimations.

CONCLUSIONS

The 1990s ushered the world not only into a democracy wave, following the collapse of the former Soviet Union, but also a wave of fiscal rules, where the number of countries adopting this fiscal regime steadily rose from only 10 in 1990 to reach 97 in 2009, including 46 with supra-national rules in place, mostly from EU members. This paper, therefore, asks the all important research and policy question as to why do countries adopt fiscal rules?

In this context the paper contributes to a small nascent literature, comprised of only two previous studies, by significantly extending the analytical framework for analyzing the potential determinants of the choice of *de jure* national fiscal rules. We provide detailed theoretical arguments for five sets of potential determinants spanning political institutions; fiscal policy conditions; monetary and exchange-rate regimes; financial market development and overall development. On view of the overlap between the two democratic and fiscal waves this paper's most notable contribution to the literature, we would argue, should be the introduction of democracy and political checks and balance as two pivotal institutional determinants, which were not accounted for by the received literature.

Moreover, aside from significantly expanding the sample, this paper briefly reviews the state of non-linear panel data econometrics for discrete dependent variable in order to motivate the model selection process—from a menu of random-fixed and logit-probit sets of regression models, in a literature that is largely in a state of flux and, therefore, mired with many unresolved econometric issues. Though naturally such literature would not offer definitive guidance on the strengths and weaknesses of the different estimators, our review broadly suggests that random-effects probit models and conditional fixed-effects logit models should be preferred to other estimators in our case, given the relatively large sample size we have on both the time series and cross-sectional dimensions. The regression results of both models strongly corroborate the prediction of the paper's conceptual framework.

We find that in the full sample that includes developed and developing countries all variables are robustly significant determinants of fiscal rules, except for government spending pro-cyclicality and domestic financial development. Thus we broadly corroborate earlier findings in the received literature, but more importantly we also find that the new variables are robustly associated with the adoption of fiscal rules. For example, for the monetary and exchange-rate regime variables, our results suggest that inflation-targeting countries, and to a lesser extent those with a fixed exchange-rate regime, have stronger incentive to adopt fiscal rules. And with regard to the financial market variables, we find that open capital account economies, rather than those with financially developed ones per se, are likely to also have fiscal rules in place.

Perhaps the most important finding of this paper relates to the role of political institutions, which were all (democracy, federalism, checks and balances, and government stability) found to be robustly significant.

However, it is interesting to note that while democracy is an important determinant of fiscal rules, checks and balances tend to have an independent and even stronger effect. Moreover, except for fiscal federalism all other three political variables are not significant when only developed countries are included in the regressions, which reflect the lack of large variations on these variables for this particular group of countries. Instead, the key determinants of the adoption of fiscal rules for these countries are inflation target, federalism and GDP per capita. Furthermore, when we broaden the concept of fiscal rules to include both national and supra-national ones, checks and balances and the government budget balance cease to be significant. Again, as we argue above the broadening of the fiscal rules concept might have diluted the role of these two factors due to the fact that under monetary unions fiscal rules act like a mechanical eligibility criteria for member countries; while neither checks and balances nor budgetary discipline were rigorously enforced as the recent country experiences make clear.

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APPENDIX

Table A.1

Data definition and sources

Variable	Definition	Source
Fiscal rules	Defined as a fiscal rule is defined as a permanent constraint on fiscal policy through simple numerical limits on budgetary aggregates.	Kopits and Symanski (2008) and International Monetary Fund (2009).
Dependency ratio	Population between 15 and 64 years of age as share of total population.	Variable SP_POP_1564_TO_ZS World Development Indicators (WDI) by the World Bank (2011).
Real income per capita	GDP per capita in constant 2000 US$.	Variable NY_GDP_PCAP_KD World Development Indicators (WDI) by the World Bank (2011).
Government budget balance	Cash surplus/deficit (% of GDP).	Variable GC_BAL_CASH_GD_ZS World Development Indicators (WDI) by the World Bank (2011), complemented by data from country authorities (ministries and central banks) to fill missing information.
Pro-cyclical government expenditures	Five-year rolling correlation of HP- filtered final consumption expenditures of General government (constant 2000 US$) to HP-filtered GDP (constant 2000 US$).	Variables NE_CON_GOVT_KD and NY_GDP_MKTP_KD World Development Indicators (WDI) by the World Bank (2011).
Financial development	Domestic credit to private sector (% of GDP).	Variable FS_AST_PRVT_GD_ZS World Development Indicators (WDI) by the World Bank (2011).
Political risk and checks and balances	Political Constraint Index (POLCON-V), quantitative measure of the institutional constraints faced by authorities. It ranks countries from 0 (high) to 1 (low).	Originally by Henisz (2000) and later refined and extended by Henisz and Zelner (2010).
Democracy	Democracy and Polity 2 indices of the Polity IV.	Developed by Integrated Network for Societal Conflict Research (INSCR).
Government stability	ICRG Index.	Obtained from the WDI 2010.
Inflation targeting	Dummy variable: 1 if the central bank operates formally an inflation targeting scheme and 0 otherwise.	Calderón and Schmidt-Hebbel (2008) and own updates using data from the reports at http://www.centralbanknews.info/p/inflation-targets.html
Capital account openness	KAOPEN measure, based on binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).	Chinn and Ito (2008), updated by the authors to 2009.
Exchange rate regime	Fixed exchange systems include dollarization, currency boards, and monetary unions. Any other system is not considered as fixed regime.	Reinhart and Rogoff (2004) *de facto* classification, extended to 2009 using IMF country reports.
Federalism	Dummy variable = 1 if the country defines itself formally as a federal entity.	Information from Forum of Federations web page.

Table A.2

Fiscal rules, federalism, and inflation targeting

	Fiscal rules		Federal country	Inflation targeting
	National	Supra-nat.		
Angola	2005			
Ant & Barb.		1998		
Argentina	2000		1	
Australia	1998		1	1993
Austria	1999	1995	1	
Belgium		1992	1	
Benin		1999		
Botswana	2003			2008
Brazil	2000		1	1999
Bulgaria	2003			2007
B. Faso		1999		
Cameroon		1996		
Canada	1991		1	1991
Cape Verde	1998			
CAF		1996		
Chad		1996		
Chile	2000			1991
Colombia	1997			2000
Comoros	2001		1	
Congo, Rep.		1996		
Costa Rica	2001			
Coted'Ivoire		1999		
Cyprus		2003		
Czech Rep.	2005	2004		1998
Denmark	1992	1992		
Dominica		1998		
Ecuador	2003			
Estonia	1993	2004		
Finland*	1999	1995		1993
France	1998	1992		
Gabon		1996		
Germany	1975	1993	1	
Ghana				2007
Greece		1992		
Grenada		1998		
G.-Bissau		1999		
Hong Kong	1997			
Hungary	2007	2004		2002
Iceland	2004			2001
India	2003		1	
Indonesia	1975			2005
Ireland		1992		
Israel	1992			1992

Table A.2 (continued)

	Fiscal rules		Federal country	Inflation targeting
	National	Supra-nat.		
Italy		1992		
Japan	1975			
Kenya	1997			
Korea, Rep.				1998
Latvia		2003		
Lithuania	1997	2004		
Luxembourg	1990	1992		
Madagascar	2006			
Mali		1999		
Malta		2004		
Mauritius	2008			
Mexico	1975		1	1999
Namibia	2001			
Netherlands	1994	1992		
New Zealand	1994	1994		1990
Niger		1999		
Nigeria	2004		1	
Norway	2001			2001
Pakistan	2005		1	
Panama	2002			
Peru	2000			2002
Philippines				2002
Poland	1997	2004		2004
Portugal	2002	1992		
Romania		2007		2005
Senegal		1999		
Singapore	1991			
Slovak Rep.		2004		2005
Slovenia	2001	2004		
South Africa			1	2000
Spain*	2003	1992		1995
Sri Lanka	2003			
St. Kitts Nevis		1998	1	
St. Lucia		1998		
St. Vincent		1998		
Sweden	1996	1995		1993
Switzerland	2003		1	2000
Thailand				2000
Togo		1999		
Turkey				2006
UAE			1	
United Kingdom	1997	1992		1992
Venezuela	1999		1	

Notes: Dates reported for fiscal rules and for inflation targeting are the years when the corresponding regimes were started. (*) Finland and Spain had inflation targeting schemes but abandoned them when joining the euro.
Sources: See Appendix Table A.1.

ENDOGENOUS EXCHANGE-RATE PASS-THROUGH AND SELF-VALIDATING EXCHANGE RATE REGIMES

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I. INTRODUCTION

A long-standing question in open macroeconomics concerns the choice of currency denomination of nominal prices and contracts. A firm serving the export market may choose to set prices in its domestic currency, in the currency of the market of destination, or in a vehicle currency, possibly indexing these prices—fully or partially—to exchange rate movements.[1] To the extent that nominal prices remain sticky, the choice among these alternatives has crucial consequences for the design of stabilization policy—by determining the degree of exchange rate pass-through on export/import prices.[2] However, the causal relation may also go in the opposite direction, as the currency denomination choice may itself depend, among other factors, on the stabilization strategy pursued by policymakers.

In this paper, we analyze the interaction between firms' export pricing and monetary policy, and discuss its potential macroeconomic implications for business cycle synchronization and the choice of an exchange rate regime. In the framework of a highly stylized monetary model, we first provide an analytical characterization of the optimal export pricing by imperfectly monopolistic firms subject to nominal rigidities. We show that, when choosing the currency denomination of exports (and/or the degree of indexation to the exchange rate) firms optimize over the covariance between the (log of the) exchange rate and the (inverse of the) markup. Intuitively, the currency denomination of exports affects the exposure of firms' marginal revenue to the shocks moving the exchange rate and demand in the destination markets. Depending on the covariance of these shocks with the shocks affecting marginal costs, firms can optimize their profit stream from the export markets, in the face of production and demand risk, including monetary policy risk.

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1 For a review of the empirical evidence see Goldberg and Knetter (1997), Goldberg and Tille (2008), Gopinath and Rigobón (2008) among others.

2 See Betts and Devereux (2000), Obstfeld and Rogoff (2000), Engel (2002), Corsetti and Pesenti (2005). Corsetti. Dedola and Leduc (2010) provides a synthesis of the debate.

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By way of example, consider a firm producing in a country where monetary policy is relatively noisy, that is, frequent nominal shocks tend to simultaneously raise nominal wages and depreciate the exchange rate. In this environment, by choosing to preset prices in foreign currency a firm can secure that, whenever an unexpected monetary expansion causes nominal wages and thus its marginal cost to rise, its export revenues in domestic currency will correspondingly increase per effect of the nominal depreciation—with clear stabilizing effects on the firm's markup. The opposite will be true for a foreign firm exporting to the same country. By choosing to preset prices in local currency, this firm can insulate its revenue, and therefore its markup, from monetary noise.

In the second part of the paper, we turn to the analysis of optimal monetary policy, building on the well-known result that the design of optimal monetary rules in open economies crucially depends on the degree of exchange rate pass-through, i.e., on whether firms invoice their exports in their own currency (the hypothesis of producer currency pricing, or PCP, in which case the pass-through of exchange rate into import prices is full) or in local currency (the hypothesis of local currency pricing, or LCP, corresponding to zero pass through). Since in our model firms choose optimal pass-through taking into account monetary policy, in equilibrium monetary policy and firms' pricing strategies depend on each other. We show that this two-way interaction raises the possibility of equilibria in which the choice of the exchange rate regime and export pricing becomes self-validating, in the sense that central banks and firms adopt optimal policies conditional on beliefs about each other behavior.

Our findings warn against reliance on the conventional view, that business cycle synchronization and macroeconomic convergence are pre-conditions to the implementation of a currency area, as they crucially reduce the costs of giving up national monetary policy— i.e., of giving up the ability to deliver differentiated policy responses to country-specific disturbances hitting the economy. In our model, the private sector responds to a credible adoption of an exchange rate peg by choosing pricing strategies that are optimal in the absence of exchange rate flexibility. Conditional on central banks' beliefs that firms set export prices in foreign currency, then, a fixed exchange rate turns out to be the (conditionally) optimal monetary regime from the vantage point of the national policymakers as well. Specifically, national outputs become more correlated for any given stochastic pattern of the shocks to fundamentals, thus reducing the (perceived) need for differentiated national monetary policies. Despite the absence of structural changes, economies that adopt a fixed exchange rate regime may end up satisfying the criteria for an Optimum Currency Area (henceforth OCA), according to the theory spelled out by the classic contributions by Mundell (1961), McKinnon (1963), Kenen (1969) and Ingram (1973).[3]

3 Modern applications and revisions include, among others, Eichengreen (1990, 1992), Dowd and Greenaway (1993), Tavlas (1993), Bayoumi and Eichengreen (1994), Melitz (1996), Bayoumi (1997), and Alesina and Barro (2002). See Buiter, Corsetti and Pesenti (1998), ch.10, for a critical survey of the literature.

In the vast literature on the subject, early arguments for an endogenous OCA emphasize that the change in monetary regime could act as a catalyst of business cycle synchronization via trade integration. For instance, Frankel and Rose (1998) stress that the reduction of foreign exchange transaction costs associated to the adoption of a common currency promotes cross-border trade: to the extent that the process of integration enhances intra-industry trade rather than product specialization, national business cycles can be expected to become more synchronized, driven by sectoral demand shocks and productivity innovations affecting all countries at the same time. Higher national output correlation then reduces the need for exchange rate adjustments to stabilize national employment and prices, and minimizes the welfare costs of giving up national currencies.[4]

Our characterization of endogenous currency areas is different. Namely, we show that it is still possible for a monetary union to satisfy ex-post the OCA criterion even if monetary integration fails to boost economic convergence and intra-industry trade. To distinguish our theory from arguments appealing to increasing economic symmetry resulting from economic integration, throughout our analysis we assume that countries are perfectly specialized in the production of one type of good independently of the exchange rate regime.

In our stochastic setting, national welfare is measured by the expected utility of the representative household. The adoption of such non-arbitrary metrics allows us to rank equilibria in welfare terms. The result is that a fixed exchange rate and a currency union are Pareto-inferior to the Friedman-style optimal float. Although in our model the private and the public sector do the right thing—in terms of policy and pricing strategies—once the equilibrium without exchange rate flexibility is selected, there is still room for welfare improvement by creating conditions for relative price adjustment via changes of the exchange rate. A move toward more volatile rates and less synchronized business cycles would bring about the appropriate change in firms' pricing and pass-through strategies, which in turn would validate the floating regime as optimal.

While the model considered in this paper is highly stylized, in part reflecting the advantages of working with closed-form solutions in levels rather than relying on linear approximations, the principle it illustrates is more general. The literature provides examples of the potential range of application of our analysis, as in Chang and Velasco (2006) model of optimal currency denomination of debt contracts, once again regulated by an assessment of the covariance between contractual payment and revenues, expressed in the same currency. A related analysis by Goldberg and Tille (2008) extends the choice of currency denomination of exports to multiple currencies, thus including vehicle currencies.

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4 Not everyone agrees with this argument: for instance Eichengreen (1992) and Krugman (1993) stress that monetary integration could lead to greater specialization in production, thus lowering output correlation and making regions more vulnerable to local shocks. On an empirical basis, however, the evidence presented by Frankel and Rose (1998) supports the view that trade links raise income correlations. Moreover, Rose and Engel (2000) show that membership in a common currency area increases international business cycle correlations by a significant amount.

Our contribution is related to a small but influential literature, modeling the specific determinants of the currency denomination of exports as an endogenous choice. Namely, Bacchetta and van Wincoop (2005), Devereux, Engel and Stoorgard (2004), and Friberg (1998) develop models where firms can choose whether to price exports in domestic or in foreign currency, knowing that price updates will be subject to frictions. As emphasized by this literature, a rich set of factors—from the market share of exporters to the incidence of distribution and the availability of hedging instruments—potentially play a crucial role in this choice (see Engel (2006) for a synthesis). Relative to this literature, our contribution emphasizes the covariance between exchange rates and markups as the key element of optimal strategies of currency denomination and pricing, rather than the variance of the exchange rate. Also, in our model firms are allowed to index, if only imperfectly, their prices in the export markets to the exchange rate (say, by posting an exchange rate clause in their catalogs for overseas sales). This modeling choice enhances the flexibility and generality of the pricing framework, allowing for a clear and transparent analytical characterization of the equilibrium.

This paper is organized as follows. Section 2 develops the model. Section 3 studies price-setters' optimal behavior and endogenous pass-through strategies for given monetary policies. Section 4 instead focuses on optimal monetary policies given firm pricing strategies. The previous two pieces of analysis are brought together in section 5, in which we characterize the equilibrium of the economy. A final section discusses our main results.

II. THE MODEL

Our model shares the standard elements in modern monetary analysis: imperfect competition in production, nominal rigidities in the goods markets, and forward-looking price-setting behavior by firms (although we do not assume staggered price setting).[5] Drawing on Corsetti and Pesenti (2005), our setup allows for imperfect pass-through of exchange rate onto export prices. Different from our earlier contribution, here we further study how the degree of pass-through is endogenously chosen ex-ante by exporters on the basis of information on shocks and policy rules, in the form of a rule of limited price flexibility contingent on exchange rate movements. Taking firms' pass-through strategies as given, we characterize state-contingent monetary policy rules. In a world equilibrium, both the degree of pass-through and monetary policy are jointly determined by optimizing agents.

2.1 Consumer Optimization

We model a world economy with two countries, H (Home) and F (Foreign), each specialized in one type of traded good. Each good is produced in a number of

5 Related contributions in the recent literature include Obstfeld and Rogoff (2000, 2002), Devereux and Engel (2003), Corsetti and Pesenti (2001, 2005), Benigno (2004), Canzoneri, Cumby and Diba (2004).

varieties defined over a continuum of unit mass. Varieties are indexed by h in the Home country and f in the Foreign country. Each country is populated by households defined over a continuum of unit mass. Households are indexed by j in the Home country and j^* in the Foreign country.
Home agent j's lifetime expected utility $\mathcal{W}$ is defined as:

$$\mathcal{W}_{t-1}(j) \equiv E_{t-1}\sum_{\tau=t}^{\infty}\beta^{\tau-t}[lnC_{\tau}(j)-\kappa\ell_{\tau}(j)] \quad 0<\beta<1\ ,\kappa>0\,, \tag{1}$$

where β is the discount rate. The instantaneous utility is a positive function of the consumption index $C(j)$ and a negative function of labor effort $\ell(j)$ Foreign agents' preferences are similarly defined: the discount rate is the same as in the Home country, while κ^* in the Foreign country need not coincide with κ in the Home country.
$C(j)$ and its Foreign analogue are Cobb-Douglas baskets of the Home and Foreign goods:

$$C_t(j) \equiv C_{H,t}(j)^{\gamma} C_{F,t}(j)^{1-\gamma}\,,\ C_t^*(j^*) \equiv C_{H,t}^*(j^*)^{\gamma} C_{F,t}^*(j^*)^{1-\gamma}\ \ 0<\gamma<1, \tag{2}$$

where the weights γ and 1– γ are identical across countries. $C_{H,t}(j)$ and $C_{(F,t)}(j)$ are CES baskets of, respectively, Home and Foreign varieties:

$$C_{H,t}(j)=\left(\int_0^1 C_t(h,j)^{1-\frac{1}{\theta}}dh\right)^{\frac{\theta}{\theta-1}}\ ,\ \ C_{F,t}(j)=\left(\int_0^1 C_t(f,j)^{1-\frac{1}{\theta^*}}df\right)^{\frac{\theta^*}{\theta^*-1}}\ , \tag{3}$$

where $C_t(h, j)$ and $C_t(f, j)$ are, respectively, consumption of Home variety h and Foreign variety j by Home agent j at time t. Each Home variety is an imperfect substitute for all other Home varieties, with constant elasticity of substitution across varieties θ. We assume that θ is larger than the elasticity of substitution between Home and Foreign types. Similarly the elasticity of substitution among Foreign varieties is $\theta^*>1$. The consumption indices in the Foreign country, $C_{H,t}^*(j^*)$ and $C_{F,t}^*(j^*)$, are analogously defined.

We denote the prices of varieties h and f in the Home market (thus expressed in the Home currency) as $p(h)$ and $p(f)$, and the prices in the Foreign market (in Foreign currency) as $p^*(h)$ and $p^*(f)$. For given prices of the individual varieties, we can derive the utility-based price indices P_H, P_F, P and their Foreign analogs.[6] In particular, the utility-based CPIs are:

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6 For instance, the utility-based price index $P_{H,t}$, is defined as the minimum expenditure required to buy one unit of the composite good $C_{H,t}$ and is derived as $P_{H,t}=\left[\int_0^1 p_t(h)^{1-\theta}dh\right]^{\frac{1}{1-\theta}}$.

$$P_t = \frac{P_{H,t}^{\gamma} P_{F,t}^{1-\gamma}}{\gamma_W}, \quad P_t^* = \frac{\left(P_{H,t}^*\right)\left(P_{F,t}^*\right)^{1-\gamma}}{\gamma_W} \quad \gamma_W \equiv \gamma^{\gamma}(1-\gamma)^{1-\gamma}. \tag{4}$$

Home households hold the portfolio of Home firms, and two international bonds, B and B^*, denominated in Home and Foreign currency, respectively. Both international bonds are in zero net supply. Households receive wages and profits from the firms. The individual flow budget constraint for agent in the Home country is:

$$\begin{aligned} &B_t(j) + \varepsilon_t B_t^*(j) \le (1+i_{t-1}) B_{t-1}(j) + \left(1+i_{t-1}^*\right)\varepsilon_t B_{t-1}^*(j) + W_t \ell_t(j) \\ &+\int_0^1 \pi_t(h)dh - \int_0^1 p_t(h) C_t(h,j)dh - \int_0^1 p_t(f) C_t(f,j)df. \end{aligned} \tag{5}$$

In the expression above, the nominal yields i_t and i_t^* are paid at the beginning of period t+1 and are known at time t. Taking prices as given, Home household j maximizes (1) subject to (5) with respect to consumption, labor effort, and bond holdings. A similar optimization problem is solved by Foreign household j^*. Agent j's optimal demand for varieties h and f is a function of the relative price and total consumption of Home and Foreign goods, respectively:

$$C_t(h,j) = \left(\frac{p_t(h)}{P_{H,t}}\right)^{-\theta} C_{H,t}(j), \quad C_t(f,j) = \left(\frac{p_t(f)}{P_{F,t}}\right)^{-\theta^*} C_{F,t}(j), \tag{6}$$

and, similarly, the demand for Home and Foreign consumption goods is a constant fraction of agent j's total consumption expenditure:

$$P_t C_t(j) = \frac{1}{\gamma} P_{H,t} C_{H,t}(J) = \frac{1}{1-\gamma} P_{F,t} C_{F,t}(j). \tag{7}$$

The intertemporal allocation is determined according to the Euler equation:

$$1 = (1+i_t) E_t Q_{t.t+1}(j), \tag{8}$$

where $Q_{t,t+1}(j)$ is agent j's stochastic discount rate:

$$Q_{t,t+1}(j) \equiv \beta \frac{P_t C_t(j)}{P_{t+1} C_{t+1}(j)}. \tag{9}$$

The condition for optimal labor effort equates the real wage to the marginal rate of substitution between consumption and leisure:

$$W_t = \kappa P_t C_t(j). \tag{10}$$

The above equation implies that consumption and discount rates are equalized across agents, so that $Q_{t,t+1}(j) = Q_{t,t+1}$.

2.2 Nominal Rigidities, Exchange Rate Pass-through, and Price Setting

Each variety h is produced by a single Home firm and sold in both countries under conditions of monopolistic competition. Output is denoted Y. Technology is linear in household's h labor, $\ell(h)$:

$$Y_t(h) = Z_t \ell_t(h), \tag{11}$$

where Z is a country-specific productivity shock. Similarly, output of Foreign variety f is a function of Foreign labor $\ell^*(f)$ and the productivity shock in the Foreign country, Z^*.

Home firms take the nominal price of labor, W_t, as given. The nominal marginal cost, MC_t, is identical across firms:

$$MC_t(h) = MC_t = W_t / Z_t, \tag{12}$$

and Home firms' nominal profits Π_t are defined as:

$$\Pi_t(h) = \left(p_t(h) - MC_t\right)\int_0^1 C_t(h,j)dj + \left(\varepsilon_t p_t^*(h) - MC_t\right)\int_0^1 C_t^*(h,j^*)dj^*, \tag{13}$$

where E is the nominal exchange rate, expressed as Home currency per unit of Foreign currency. Foreign variables are similarly defined.

It is assumed that individual firms set the nominal price of their product one period in advance, and stand ready to meet demand at given prices for one period. In terms of our notation, Home firms selling in the Home market choose $p_t(h)$ at time $t-1$ by maximizing the present discounted value of profits:

$$p_t(h) = \arg\max E_{t-1} Q_{t-1,t} \Pi_t(h), \tag{14}$$

accounting for (6). Domestic firms optimally set prices equal to expected nominal marginal cost, appropriately discounted and augmented by the equilibrium markup $\theta / (\theta - 1)$:

$$p_t(h) = \frac{\theta}{\theta - 1} \frac{E_{t-1}(MC_t Q_{t-1,t}\, p_t(h)^{-\theta} P_{H,t}^{\theta} C_{H,t})}{E_{t-1}(Q_{t-1,t}\, p_t(h)^{-\theta} P_{H,t}^{\theta} C_{H,t}}. \tag{15}$$

Accounting for (7) and (9), the previous expression can be rewritten as:

$$p_t(h) = P_{H,t} = \frac{\theta}{\theta - 1} E_{t-1} MC_t = \frac{E_{t-1}(P_t C_t / Z_t)}{\Phi}, \tag{16}$$

where we define $\Phi \equiv (\theta - 1)/\theta\kappa$. As we will see below, the Φ constant measures the expected level of labor effort in the Home country.

Home firms selling abroad also set nominal prices one period in advance. Different from most models in the literature, we do not impose a priori the restriction that export prices are set in Home currency, implying that all unexpected fluctuations in the exchange rate are 'passed through' one-to-one onto export prices in Foreign currency (in the literature this scenario is referred to as 'Producer Currency Pricing' or PCP). At the same time, we do not impose the opposite restriction that export prices are set in Foreign currency, implying that Foreign-currency prices of Home goods do not respond at all to unexpected exchange rate fluctuations (i.e. the case of 'Local Currency Pricing' or LCP). We consider instead the more general case in which Home firms preset export prices in Foreign currency, but are able to modify them after observing exchange rate changes, following Corsetti and Pesenti (2005) and Obstfeld (2002). In our setup, the extent to which the Foreign-currency prices of Home exports adjust—contingent on the realization of the exchange rate—is a choice variable, determined by Home firms at time $t-1$. In other words, the elasticity of exchange rate pass-through can endogenously be zero (as in the LCP case), one (as in the PCP case), or any intermediate number.

Formally, by definition of pass-through elasticity $\eta_t^* \equiv \delta \ln p_t^*(h)/\delta \ln(1/\varepsilon_t)$, Foreign-currency prices of Home varieties are:

$$p_t^*(h) \equiv \frac{\tilde{p}_t(h)}{\varepsilon_t^{\eta_t^*}} \quad 0 \le \eta_t^* \le 1, \tag{17}$$

where $\tilde{p}_t(h)$ is the predetermined component of the Foreign-currency price of good h that is not adjusted to variations of the exchange rate during period t.[7] At time t, Home firms choose $\tilde{p}_t(h)$ and η_t^* one period in advance in order to maximize expected discounted profits accounting for Foreign demand (i.e., the Foreign analog of (6)). The actual $p_t^*(h)$, however, depends on the realization of the exchange rate at time t.[8]
In equilibrium we obtain:

$$p_t^*(h) = \frac{\theta}{\theta - 1} \frac{1}{\varepsilon_t^{\eta^*}} \frac{E_{t-1}(MC_t Q_{t-1,t}\, p_t^*(h)^{-\theta} P_{H,t}^{*\theta} C_{H,t}^*)}{E_{t-1}(Q_{t-1,t}\, p_t^*(h)^{-\theta} P_{H,t}^{*\theta} C_{H,t}^* \varepsilon_t^{1-\eta^*})}. \tag{18}$$

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7 For instance, if $\eta^* = 1$, pass-through in the Foreign country is complete—as in the PCP case. If $\eta^* = 0$ we have $p_t^*(h) = \tilde{p}_t(h)$ which coincides with the price chosen by the Home producer in the LCP case.

8 The optimal degree of pass-through may well vary over time. The model could be easily extended to encompass the case in which the pass-through elasticity is a non-linear function of the exchange rate (e.g., η^* is close to zero for small changes of the exchange rate E but close to one for large exchange rate fluctuations). The key results of our analysis would remain unchanged.

Using (7) and (9) letting $\Theta \equiv \gamma/(1-\gamma)(P_t^* C_t^* \varepsilon_t / P_t C_t)$, we can also write:

$$p_t^*(h) \equiv P_{H,t}^* = \frac{\tilde{p}_t(h)}{\varepsilon_t^{\eta_t^*}} = \frac{\theta}{\theta - 1} \frac{E_{t-1}\left(\frac{MC_t \Theta_t}{\varepsilon_t^{1-\eta^*}}\right)}{\varepsilon_t^{\eta^*} E_{t-1}\Theta_t} = \frac{E_{t-1}\left(\frac{P_t C_t \Theta_t}{Z_t \varepsilon_t^{1-\eta^*}}\right)}{\Phi \varepsilon_t^{\eta^*} E_{t-1}\Theta_t}. \tag{19}$$

Analogous expressions can be derived for the prices set by Foreign firms in the Foreign and the Home market. In the case of Foreign exports the notation is:

$$p_t(f) = \tilde{p}_t^*(f)\varepsilon_t^{\eta_t}, \quad 0 \le \eta_t \le 1, \tag{20}$$

where the degree of pass-through in the Home country, η_t, need not be equal to that in the Foreign country, η_t^*. The optimal pricing strategy is such that:

$$P_{F,t}^* = \frac{\theta^*}{\theta^* - 1} E_{t-1}\left(MC_t^*\right), \qquad P_{F,t} = \frac{\theta^*}{\theta^* - 1} \varepsilon_t^{\eta_t} \frac{E_{t-1}(MC_t^* \varepsilon_t^{1-\eta_t} / \Theta_t)}{E_{t-1}(1/\Theta_t)}. \tag{21}$$

Clearly, Home firms are willing to supply goods at given prices as long as their ex-post markup does not fall below one:

$$P_{H,t} \ge MC_t, \qquad P_{H,t}^* \ge \frac{MC_t}{\varepsilon_t}. \tag{22}$$

Otherwise, agents would be better off by not accommodating shocks to demand. In what follows, we restrict the set of shocks so that the 'participation constraint' (22) and its Foreign analog are never violated.

2.3 Monetary Policy

The government controls the path of short-term rates i, and provides a nominal anchor for market expectations. To characterize monetary policy, it is analytically convenient to introduce a forward-looking measure of monetary stance, μ_t, defined such that:

$$\frac{1}{\mu_t} = \beta(1 + i_t) E_t\left(\frac{1}{\mu_{t+1}}\right), \tag{23}$$

or, integrating forward:

$$\frac{1}{\mu_t} = E_t \lim_{N \to \infty} \beta^N \frac{1}{\mu_{t+N}} \prod_{\tau=0}^{N-1} (1 + i_{t+\tau}). \tag{24}$$

Monetary policy is assumed to make the variable μ_t/μ_{t-1} stationary around a constant long-run inflation target $1 + \pi$. In a non-stochastic steady state

μ grows at the rate $1+\pi$, and the steady-state nominal interest rate is $1+i=(1+\pi)/\beta$. Home monetary easing at time t (μ_t temporarily above trend) reflects a temporary interest rate cut (i.e., $1+i_t<(1+\pi)/\beta$).

Note that in equilibrium μ_t is equal to P_tC_t (and μ_t^* is equal to $P_t^*C_t^*$): a monetary expansion delivers increased nominal spending.[9] A monetary union in our framework is defined as a regime in wich $i_t=i_t^*$ for all t. If both countries adopt the same numeraire, this implies $\mu_t=\mu_t^*$.

2.4 Market Clearing and the Closed-Form Solution

The resource constraint for variety h is:

$$Y_t(h)\geq\int_0^1 C_t(h,j)dj+\int_0^1 C_t^*(h,j^*)dj^*, \tag{25}$$

while the resource constraint in the Home labor market is:

$$\int_0^1 \ell_t(j)dj\geq\int_0^1 \ell_t(h)dh. \tag{26}$$

The resource constraint for Foreign variety f and Foreign labor are similarly defined. Finally, international bonds are in zero net supply:

$$\int_0^1 B_t(j)dj+\int_0^1 B_t(j^*)dj^*=\int_0^1 B_t^*(j)dj+\int_0^1 B_t^*(j^*)dj^*=0. \tag{27}$$

In our analysis below we focus on symmetric equilibria in which, at some initial point in time $t=0$, agents worldwide have zero net financial wealth. As shown in Corsetti and Pesenti (2001, 2005), in equilibrium both net wealth and the current account are endogenously zero at any subsequent point in time: Home imports from Foreign are always equal in value to Foreign imports from Home. Since agents are equal within countries (though not necessarily symmetric across countries) we can drop the indices j and j^* and interpret all variables in per-capita (or aggregate) terms. As trade and the current account are always balanced, countries consume precisely their aggregate sales revenue:

$$\Theta_t=1,\quad (1-\gamma)P_tC_t-\gamma\varepsilon_tP_t^*C_t^*=0. \tag{28}$$

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9 This result can be obtained by comparing (23) with the Home Euler equation under logarithmic utility (8) i.e. $1/P_tC_t=(1+i_t)E_t(1/P_{t+1}C_{t+1})$.

Table 1

The closed-form solution of the model

$$\varepsilon_t = \frac{1-\gamma}{\gamma}\frac{\mu_t}{\mu_t^*} \tag{29}$$

$$MC_t = \kappa\mu_t / Z_t \tag{30}$$

$$MC_t^* = \kappa^*\mu_t^* / Z_t^* \tag{31}$$

$$P_{H,t} = \frac{\theta}{\theta-1}E_{t-1}\left(MC_t\right) \tag{32}$$

$$P_{F,t} = \frac{\theta^*}{\theta^*-1}\varepsilon_t^{\eta_t}E_{t-1}\left[MC_t^*\varepsilon_t^{1-\eta_t}\right] \tag{33}$$

$$P_{H,t}^* = \frac{\theta}{\theta-1}\frac{E_{t-1}\left[MC_t / \varepsilon_t^{1-\eta_t^*}\right]}{\varepsilon_t^{\eta_t^*}}. \tag{34}$$

$$P_{F,t}^* = \frac{\theta^*}{\theta^*-1}E_{t-1}(MC_t^*) \tag{35}$$

$$C_t = \frac{\gamma_W\left(\frac{\theta-1}{\theta}\right)^{\gamma}\left(\frac{\theta^*-1}{\theta^*}\right)^{1-\gamma}\mu_t\varepsilon_t^{-\eta_t(1-\gamma)}}{\left[E_{t-1}\left(MC_t\right)\right]^{\gamma}\left[E_{t-1}\left(MC_t^*\varepsilon_t^{1-\eta_t}\right)\right]^{1-\gamma}} \tag{36}$$

$$C_t^* = \frac{\gamma_W\left(\frac{\theta-1}{\theta}\right)^{\gamma}\left(\frac{\theta^*-1}{\theta^*}\right)^{1-\gamma}\mu_t^*\varepsilon_t^{\eta_t^*\gamma}}{\left[E_{t-1}\left(MC_t / \varepsilon_t^{1-\eta_t^*}\right)\right]^{\gamma}\left[E_{t-1}\left(MC_t^*\right)\right]^{1-\gamma}} \tag{37}$$

$$\ell_t = \left(\frac{\theta-1}{\theta\kappa}\right)\left[\gamma\frac{MC_t}{E_{t-1}\left(MC_t\right)} + (1-\gamma)\frac{MC_t / \varepsilon_t^{1-\eta_t^*}}{E_{t-1}\left[MC_t / \varepsilon_t^{1-\eta_t^*}\right]}\right] \tag{38}$$

$$\ell_t^* = \left(\frac{\theta^*-1}{\theta^*\kappa^*}\right)\left[(1-\gamma)\frac{MC_t^*}{E_{t-1}\left(MC_t^*\right)} + \gamma\frac{MC_t^* / \varepsilon_t^{1-\eta_t}}{E_{t-1}\left[MC_t^*\varepsilon_t^{1-\eta_t}\right]}\right] \tag{39}$$

Table 1 presents the general solution of the model, in which all endogenous variables (29) through (39) are expressed in closed form as functions of real shocks (Z_t and Z_t^*) and monetary stances μ_t and μ_t^*.[10]

10 Algebraic details can be found in the appendix of Corsetti and Pesenti (2004). Note that the solution does not hinge upon any specific assumptions or restriction on the nature of the shocks.

Interpreting table 1: since the equilibrium current account is always balanced (see (28) above) and the demand for imports is proportional to nominal expenditures $P_t C_t$ and $P_t^* C_t^*$, the nominal exchange rate E_t in (29) is proportional to $P_t C_t / P_t^* C_t^*$, that is, a function of the relative monetary stance. The relations (30) and (31) link marginal costs to macroeconomic shocks and monetary policy. Domestic prices of domestic goods are predetermined according to (32) and (35), while import prices vary with the exchange rate, depending on the degree of exchange rate pass-through according to (33) and (34). Equilibrium consumption is determined in (36) and (37). Finally, employment and output levels are determined according to (38) and (39).

III. THE CHOICE OF CURRENCY DENOMINATION OF EXPORTS AND OPTIMAL EXCHANGE RATE PASS-THROUGH

What is the optimal degree of exchange rate pass-through onto export prices of Home goods in the Foreign market? Taking monetary stances and policy rules as given, Home firms choose η_t^* as to maximize expected discounted profits. In a symmetric environment with $p_t^*(h) = P_{h,t}^*$ the first order condition is:[11]

$$1 = \frac{\theta\kappa}{\theta - 1} \frac{E_{t-1}[\ln \varepsilon_t (P_t^* C_t^* / Z_t) / P_{H,t}^*]}{E_{t-1}(\ln \varepsilon_t)} \frac{\gamma}{1-\gamma} . \tag{40}$$

Comparing (40) with (18) and (29), it follows that the optimal pass-through η_t^* is such that:

$$E_{t-1}\left[\frac{\mu_t}{Z_t \varepsilon_t^{1-\eta_t^*}}\right] E_{t-1}(\ln \varepsilon_t) = E_{t-1}\left[\ln \varepsilon_t \left(\frac{\mu_t}{Z_t \varepsilon_t^{1-\eta_t^*}}\right)\right], \tag{41}$$

that is:

$$Cov_{t-1}\left(MC_t / \varepsilon_t^{1-\eta_t^*}, \ln \varepsilon_t\right) = 0 . \tag{42}$$

This is a critical condition. At an optimum, the (reciprocal of the) markup in the export market must be uncorrelated with the (log of the) exchange rate. Trivially, if E_t is constant or fully anticipated, any degree of pass-through is consistent with the previous expression. But if E_t is not perfectly predictable, the

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11 The optimal pass-through maximizes $E_{t-1}\left[Q_{t-1,t}, \Pi_t(h)\right]$, *thus maximizes the expression:*

$$E_{t-1}\left[Q_{t-1,t}\left(\tilde{p}_t(h) / P_{H,t}^*\right)^{-\theta} C_{H,t}^* \left\{\tilde{p}_t(h) \varepsilon_t^{1-\eta_t^*-\theta_t^*+\theta\eta_t^*} - MC_t \varepsilon_t^{\theta\eta_t^*}\right\}\right].$$

The first order condition yields:

$$0 = E_{t-1}\left[Q_{t-1,t}\left(\tilde{p}_t(h) / (\varepsilon_t^{\eta_t^*} P_{H,t}^*)\right)^{-\theta} C_{H,t}^* \ln \varepsilon_t \left\{(\theta - 1)\tilde{p}_t(h) \varepsilon_t^{1-\eta_t^*} - \theta MC_t\right\}\right].$$

And accounting for the equilibrium expressions Q, P_H^*, C_H^* *and MC, as well as (28), it is possible to rewrite the first order condition above as in (40).*

optimal degree of pass-through will depend on the expected monetary policies and the structure of the shocks. By the same token, the optimal pass-through chosen by Foreign firms selling in the Home market requires:

$$Cov_{t-1}\left(MC_t^* \varepsilon_t^{1-n_t}, \ln\left(1/\varepsilon_t\right)\right) = 0\,. \tag{43}$$

To build intuition, observe that in equilibrium, Home ex-post real profits in the Foreign market[12] are proportional to $\tilde{p}_t(h) - MC_t / E_t^{1-\eta_t^*}$,that is, they are a concave function of E_t for $\eta_t < 1$.[13] This implies that, keeping everything else constant, exchange rate shocks reduce expected profits from exports. In general, however, to assess the overall exposure of profits to exchange rate uncertainty it is crucial to know whether the underlying shocks make marginal costs and exchange rate co-vary positively.

Suppose, for instance, that there are no productivity shocks. If exogenous monetary shocks in the Home country, μ_t, are the only source of uncertainty, condition (42) becomes:

$$Cov_{t-1}(\mu_t^{\eta_t^*}, \ln \mu_t) = 0, \tag{44}$$

which is solved by $\eta_t^* = 0$. Home monetary shocks affect symmetrically Home marginal costs MC_t and the Home discount rate Q_t, leaving their product unchanged. They also affect the exchange rate: E_t depreciates in those states of nature in which μ_t increases. Currency depreciation increases Home firms' nominal sales revenue per unit of exports (by a factor $1-\eta_t^*$) and increases Foreign demand for Home goods (by a factor η_t^*). By setting a zero degree of pass-through, or $\eta_t^* = 0$, Home exporters insure that both their export markup and the relevant demand curve for their products abroad are unaffected by monetary shocks.

Instead, if the only source of uncertainty is μ^*, condition (42) becomes:

$$Cov_{t-1}\left(\left(\mu_t^*\right)^{\eta_t^*-1}, -\ln \mu_t^*\right) = 0, \tag{45}$$

which is solved by $\eta_t^* = 1$. Home marginal costs are uncorrelated with the exchange rate. By choosing full pass-through and letting export prices absorb exchange rate changes, Home firms can insulate their export sales revenue from currency fluctuations and avoid any uncertainty of markup and profitability

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12 Ex-post real profits from selling in the Foreign market are $Q_{t-1,t}\left(\varepsilon_t p_t(h)\varepsilon_t^{-\eta^*} - MC_t\right)C_{H,t}^*$. *Using the equilibrium expression for* C_H^*, *E, and Q, the previous expression can be rewritten as:*

$\beta(1-\gamma)\frac{\mu_{t-1}}{\tilde{p}_t(h)}(\tilde{p}_t(h) - MC_t / \varepsilon_t^{1-\eta_t^*})$. *Recall that E is proportional to* μ_t / μ_t^*, $Q_{t-1,t}$ *is proportional to* $1/\mu_t$, MC_t *is proportional to* μ_t / Z_t *and* $C_{H,t}^*$ *is proportional to* $\mu_t^* E_t^{\eta_t^*}$.

13 This result does not rely on the linearity of labor effort disutility. Suppose that the latter is nonlinear, say in the form $-\ell^v / v$. *It can be shown that profits are concave in the nominal exchange rate for any* $v \geq 1$.

in the Foreign market. Note that these examples shed light on the reason why countries with high and unpredictable monetary volatility should also exhibit a high degree of pass-through, and vice versa—a view emphasized for instance by Taylor (2000).[14]

The same intuition carries over to the case in which there is both monetary and real uncertainty. In this case, patterns of endogenous intermediate pass-through can emerge, as the following example illustrates. If the Home monetary authority adopted the policy $\mu_t = Z_t^2 / \mu_t^*$, then it would be optimal for Home firms to choose $\eta_t^* = 0.5$. Abroad, we would need $MC_t^* E_t^{1-\eta_t}$ to be uncorrelated with the exchange rate. This would be the case, for instance, if $\mu_t^* = \left(Z_t^*\right)^5 / Z_t^4$ and $\eta_t = 0.6$.

In the literature that analyzes the currency denomination of exports as an endogenous choice by profit maximizing firms—see Bacchetta and Van Wincoop (2005), Devereux, Engel and Stoorgard (2004), and Friberg (1998) among others—this choice is influenced by a number of factors, ranging from the market share of exporters to the incidence of distribution and the availability of hedging instruments (see Engel (2006) for a synthesis). Relative to this literature, however, condition (42) emphasizes how the focus of the analysis should be shifted from the variance of the exchange rate towards the co-movements between the exchange rates on one hand and marginal revenues and marginal costs on the other.

Our framework naturally lends itself to the task of exploring the interactions between the choice of currency denomination of exports and monetary policy. Regarding this interaction, an early hypothesis is put forward by Taylor (2000), who specifically links low pass-through to a low trend-inflation environment (see Campa and Goldberg (2005) for evidence). Our analysis suggests that systematic effects of monetary policy stabilization do mainly work through the covariance between exporters' marginal costs and their revenues from the foreign market.

Intuitively, consider a firm producing in a country where monetary policy is relatively noisy, that is frequent nominal shocks tend to simultaneously raise nominal wages and depreciate the exchange rates. In this environment, by choosing LCP, a firm can secure that, whenever an unexpected monetary expansion causes nominal wages and thus its marginal cost to rise, its export revenues in domestic currency will correspondingly increase per effect of the nominal depreciation—with clear stabilizing effects on the firm's markup. The opposite will be true for a foreign firm exporting to the same country. By choosing PCP this firm can insulate its revenue, and therefore its markup, from monetary noise.

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14 When monetary policy is exogenous (suboptimal) and firms are only allowed to choose between zero and 100 percent pass-through (that is, between local-currency and producer-currency pricing), the results above are consistent with the analysis of Devereux, Engel, and Stoorgard (2004), and Bacchetta and Van Wincoop (2004).

IV. OPTIMAL MONETARY POLICY FOR GIVEN EXCHANGE RATE PASS-THROUGH

Consider now the policymakers' problem in a world Nash equilibrium where national monetary authorities are able to commit to preannounced rules. In specifying this equilibrium, we assume that policy makers take as given each other's monetary stance, as well as the degree of exchange rate pass-through onto export pricing. We motivate the latter assumption by observing that central bankers may rely on a vast body of empirical findings point to a low elasticity of import prices to the exchange rate (see Corsetti, Dedola and Leduc (2008) for a theoretical assessment of these studies). Nonetheless, it is worth stressing from the start that, as a consequence of this assumption, the Nash equilibrium we solve for is conditional on policymakers' beliefs concerning equilibrium pass-through. A different allocation would follow, for instance, if we posited that policymakers take equilibrium prices, rather than pass-through, as given. We will return on this point below.[15]

In our Nash equilibrium, the Home monetary authority seeks to maximize the indirect utility of the Home representative consumer (1) with respect to $\{\mu_{t+\tau}\}_{\tau=0}^{\infty}$, given $\{\mu_{\tau}^{*}, Z_{\tau}, Z_{\tau}^{*}, \eta_{\tau}, \eta_{\tau}^{*}\}_{\tau=t}^{\infty}$. The Foreign authority faces a similar problem. Table 2 presents the closed-form reaction functions, the solution of which is the global Nash equilibrium up. Each reaction function is written in two ways: as a function of marginal costs and markups, or as a function of employment gaps and deviations from the law of one price.

The optimal policy requires that the Home monetary stance be eased (μ increases) in response to a positive domestic productivity shock (Z rises). Absent a policy reaction, a positive productivity shock would create both an output and an employment gap. In fact, ℓ would fall below $\Phi = (\theta - 1)/(\theta\kappa)$. Actual output Y would not change, but potential output, defined as the equilibrium output with fully flexible prices, would increase. In light of this, optimal monetary policy leans against the wind and moves to close the employment and output gaps.

In general, however, the optimal response to a Home productivity shock will not close the output gap completely. Home stabilization policy, in fact, induces fluctuations in the exchange rate uncorrelated with Foreign marginal costs. For the reasons seen above, these exchange rate shocks reduce Foreign firms' expected profits in the Home market. When pass-through in the Home market is incomplete, the elasticity of Foreign profits relative to the exchange rate is decreasing in $\tilde{p}^{*}(f)$. Then, charging a higher price $\tilde{p}^{*}(f)$ is a way for Foreign exporters to reduce the sensitivity of their export profits to exchange rate variability. But the higher average export prices charged by Foreign firms translate into higher average import prices in the Home country, reducing Home residents' purchasing power and welfare.

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15 For an analysis of optimal monetary behavior under discretion see Corsetti and Pesenti (2005).

Table 2

Monetary authorities' optimal reaction functions

$$\gamma+(1-\gamma)(1-\eta_t)=\frac{\gamma MC_t}{E_{t-1}(MC_t)}+\frac{(1-\gamma)(1-\eta_t)MC_t^{*}\varepsilon_t^{1-\eta_t}}{E_{t-1}\left(MC_t^{*}\varepsilon_t^{1-\eta_t}\right)}$$

$$=\frac{\gamma\frac{\theta\kappa}{\theta-1}\ell_t}{\gamma+(1-\gamma)\frac{P_{\mathrm{H},t}}{\varepsilon_t P_{\mathrm{H},t}^{*}}}+\frac{(1-\gamma)(1-\eta_t)\frac{\theta^{*}\kappa^{*}}{\theta^{*}-1}\ell_t^{*}}{\gamma+(1-\gamma)\frac{P_{\mathrm{F},t}}{\varepsilon_t P_{\mathrm{F},t}^{*}}} \qquad (46)$$

$$1-\gamma+\gamma\left(1-\eta_t^{*}\right)=\frac{(1-\gamma)MC_t^{*}}{E_{t-1}\left(MC_t^{*}\right)}+\frac{\gamma\left(1-\eta_t^{*}\right)MC_t/\varepsilon_t^{1-\eta_t^{*}}}{E_{t-1}(MC_t/\varepsilon_t^{1-\eta_t^{*}})}$$

$$=\frac{(1-\gamma)\frac{\theta^{*}\kappa^{*}}{\theta^{*}-1}\ell_t^{*}}{1-\gamma+\gamma\frac{\varepsilon_t P_{F,t}^{*}}{P_{F,t}}}+\frac{\gamma\left(1-\eta_t^{*}\right)\frac{\theta\kappa}{\theta-1}\ell_t}{1-\gamma+\gamma\frac{\varepsilon_t P_{H,t}^{*}}{P_{H,t}}} \qquad (47)$$

This is why the Home monetary stance required to close the domestic output gap is not optimal when pass-through is incomplete. Relative to such a stance, domestic policymakers can improve utility by adopting a policy that equates, at the margin, the benefit from exchange rate flexibility (that is, from keeping domestic output close to its potential level) with the loss from exchange rate volatility (that is, the fall in purchasing power and real wealth due to higher average import prices).

As long as η is below one, the Home monetary stance tightens when productivity worsens abroad and loosens otherwise. Rising costs abroad (a fall in Z^{*}) lower the markup of Foreign goods sold at Home. If Home policymakers were not expected to stabilize the markup by raising rates and appreciating the exchange rate, Foreign firms would charge higher prices onto Home consumers. Only when $\eta=1$ do Foreign firms realize that any attempt by the Home authorities to stabilize the markup is bound to fail, as both P_F and the exchange rate fall in the same proportion.

With complete pass-through in both countries, the policies in a Nash equilibrium satisfy:

$$\frac{\mu_t}{Z_t}=E_{t-1}\left(\frac{\mu_t}{Z_t}\right) \qquad \mu_t^{*}/Z_t^{*}=E_{t-1}(\mu_t^{*}/Z_t^{*}). \qquad (48)$$

The optimal policy consists in a commitment to provide a nominal anchor for the economy,[16] and deviate from such stance only when productivity shocks in the economy threaten to destabilize marginal costs and move employment and output far from their potential levels. Output gaps are fully closed and employment remains unchanged at the potential level Φ or Φ^*. Both domestic and global consumption endogenously co-move with productivity shocks. Thus, the Nash optimal monetary policy leads to the same allocation that would prevail were prices fully flexible. This result restates the case for flexible exchange rates made by Friedman (1953): even without price flexibility, monetary authorities can engineer the right adjustment in relative prices through exchange rate movements. In our model with PCP, expenditure-switching effects makes exchange rate and price movements perfect substitutes.

The Nash equilibrium will however not coincide with a flexible-price equilibrium when the pass-through is less than perfect in either market. Consider the case of LCP. Here, the optimal monetary policy in each country cannot be inward-looking, but must respond symmetrically to shocks anywhere in the world economy—the optimal monetary policies in table 2 can be written as:

$$\mu_t = \left[\gamma \frac{1/Z_t}{E_{t-1}\left(\mu_t / Z_t\right)} + (1-\gamma) \frac{1/Z_t^*}{E_{t-1}\left(\mu_t / Z_t^*\right)} \right]^{-1} . \tag{49}$$

$$\mu_t^* = \left[\gamma \frac{1/Z_t}{E_{t-1}\left(\mu_t^* / Z_t\right)} + (1-\gamma) \frac{1/Z_t^*}{E_{t-1}\left(\mu_t^* / Z_t^*\right)} \right]^{-1} \tag{50}$$

expressions which imply $\mu = \mu^*$.[17]

In our model, the exchange rate is a function of the relative monetary stance μ_t/μ_t^*. Our analysis then suggests that exchange rate volatility will be higher in a world economy close to purchasing power parity, and lower in a world economy where changes in the exchange rate generate large deviations from the law of one price.[18] In fact, if the exposure of firms' profits to exchange rate fluctuations is limited, inward-looking policymakers assign high priority to stabilizing domestic output and prices, with 'benign neglect' of exchange rate movements.

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16 As is well known (see e.g. Woodford (2003)), rules such as (48) define the monetary stances up to the scale of nominal variables. In fact, the equations of (48) are solved by $\mu_t = \alpha_t Z_t$, and $\mu_t = \alpha_t^* Z_t^*$ where α_t and α_t^* are variables forecastable at time t−1, pinning down nominal expectations in each country. In models with one-period nominal price rigidities, the variables α_t and α_t^* are arbitrary. Under the assumption that the policymakers target the CPI inflation rate, we would have $\alpha_t = P_{t-1}(1+\pi)$.

For an analysis of the conditions for a unique equilibrium, see Adao, Correia, and Teles (2011).

17 Once again, these rules define the monetary stances up to the scale of nominal variables. Note that in a monetary union, goods prices cannot diverge and the nominal anchors mentioned in the footnote above must satisfy $\alpha_t = \alpha_t^*$.

18 This result has been stressed by Devereux and Engel.

Otherwise, policymakers 'think globally', taking into account the repercussions of exchange rate volatility on consumer prices; hence, the monetary stances in the world economy come to mimic each other, reducing currency volatility.

The characterization of a (conditionally) optimal monetary union (or conditionally optimal fixed exchange rate regime) is a simple corollary of the analysis above. We define a monetary union $\mu_t=\mu^*_t$ as optimal if the single monetary stance is optimal for both countries. It is straightforward to show that when shocks are perfectly correlated, the optimal allocation is such that $MC_t=E_{t-1}(MC_t)$ and $MC^*_t = E_{t-1}(MC^*_t)$ regardless of the degree of pass-through. Optimal monetary policies support a fixed exchange rate regime and an optimal monetary union while fully closing the national output gaps. If shocks are asymmetric, a monetary union is optimal only when both countries find it optimal to choose a symmetric monetary stance, that is, when pass-through is zero worldwide according to (49) and (50).

V. ENDOGENOUS EXCHANGE RATE REGIMES

The conventional wisdom about the choice of exchange rate regime is that asymmetries in business cycles weaken the case for fixed exchange rates or the adoption of a single currency. With domestic monetary authorities unable to use differentiated policy responses to the disturbances hitting the economy, business cycle synchronization and macroeconomic convergence are emphasized as pre-conditions to the implementation of single currency areas, as they obviously reduce the costs of giving up national monetary policy.

In what follows, we build on our model to provide an instance of an economy in which a move toward symmetric monetary policy increases endogenously business cycle synchronization and convergence even if there is no change in the magnitude and sign of fundamental shocks. In other words, independently of any structural change in the economy, the adoption of a credible fixed exchange rate regime can be supported in equilibrium as a self-validating optimal monetary arrangement, in the sense that endogenous changes in private agents' expectations and behavior eliminate all the (perceived) incentives for monetary authorities to pursue independent strategies of national output stabilization in response to asymmetric shocks.

We show that, conditional on beliefs about exchange rate pass-through, the model admits two equilibria. While exporters could in principle choose any intermediate level of pass-through, in equilibrium pass-through is either 100 percent or zero, as profit maximization turns out to require 'corner' pricing strategies.[19] There is one equilibrium in which firms choose to preset prices in

19 Related literature focuses on the choice of pricing strategies where monetary authorities are assumed to implement non-optimizing, noisy policies (as in the work by Bacchetta and van Wincoop (2004) and Devereux, Engel and Stoorgard (2004)) rather than optimal rules.

domestic currency, and let the foreign price adjust according to the law of one price. With complete pass-through, monetary policies are fully inward-looking: they implement stabilization rules that close national output gaps completely in every period. This equilibrium is inconsistent with fixed exchange rates, and implies low correlation among output levels—depending on the cross-country correlation of fundamental shocks. The exchange rate plays the role stressed by Friedman (1953): it brings about the required relative price adjustments that are hindered by the presence of nominal price rigidities.

But there is another equilibrium in which firms are believed to preset prices in the consumers' currency, so that there is no response of prices to the exchange rate. With zero pass-through in the world economy, optimal monetary policies are perfectly symmetric across countries, that is, they both respond to the same average of national shocks. This equilibrium is thus consistent with OCA: there is no cost in giving up monetary sovereignty because, even if national monetary authorities remained independent, they would still choose to implement the same policy rules, moving interest rates in tandem and responding symmetrically to world-wide shocks. National outputs are perfectly correlated even when shocks are asymmetric. Most interestingly, in our model the same result would follow assuming that the two national policymakers cooperate with each other.

The two equilibria are however not equivalent in terms of welfare: OCA is Pareto-inferior to the Friedman-style optimal float in the first equilibrium. In the OCA equilibrium, the private and the public sectors act rationally—in terms of policy and pricing strategies— once the equilibrium without exchange rate flexibility is selected, conditional on beliefs about export pricing. Yet, there is still room for welfare improvement by creating conditions for relative price adjustment via changes of the exchange rate. A move toward more volatile rates and less synchronized business cycles would bring about the appropriate change in firms' pricing and pass-through strategies, which in turn would validate the floating regime as optimal.

5.1 Optimal Exchange Rate Pass-through and Monetary Policy in Equilibrium

To recapitulate our main analytical findings: Home and Foreign firms choose the levels of pass-through η_t^* and η_t on the basis of their information at time t–1 regarding marginal costs and exchange rates at time t, by solving (42) and (43). Home and Foreign monetary authorities take the levels of pass-through η_t^* and η_t as given and determine their optimal monetary stances by solving the conditions (46) and (47). We now consider the joint determination of μ_t, μ^*_t, η_t and η_t^* satisfying the four equations above in the non-trivial case in which the shocks Z_t and Z_t^* are asymmetric.

The following allocation is an equilibrium:

$$MC_t = E_{t-1}\left(MC_t\right),\ MC_t^* = E_{t-1}\left(MC_t^*\right),\quad \eta_t = \eta_t^* = 1. \tag{51}$$

Purchasing power parity holds and there is full pass-through of exchange rate changes into prices. Monetary policies fully stabilize the national economies by closing output and employment gaps. Exchange rates are highly volatile, their conditional variance being proportional to the volatility of Z_t/Z_t^*. We will refer to this equilibrium as an optimal float (OF).

The logic underlying the OF case can be understood as follows. Suppose Foreign firms selling in the Home market choose $\eta_t=1$ and let Home-currency prices of Foreign goods move one-to-one with the exchange rate, stabilizing their markups. Then the Home monetary authority chooses as a rule to stabilize Home output fully, no matter the consequences for the exchange rate (the volatility of which does not affect Foreign exporters' profits and therefore does not affect, on average, the price of Foreign goods paid by Home consumers). Note that when $\eta_t=1$, Home output stabilization implies that MC_t is constant, and therefore uncorrelated with the exchange rate. Home firms, then, will optimally set their pass-through abroad and choose $\eta_t^*=1$ in order to stabilize their export markup. Since Home firms are now fully insulated from exchange rate fluctuations, the Foreign monetary authority optimally chooses to stabilize Foreign output with benign neglect of the exchange rate, so that MC_t^* is a constant. But in this case Foreign firms optimally choose $\eta_t=1$, as we had assumed initially: the OF case is an equilibrium.

Consider now the following allocation:

$$1=\gamma\frac{MC_t}{E_{t-1}(MC_t)}+(1-\gamma)\frac{MC_t^*}{E_{t-1}\left(MC_t^*\right)},\quad \varepsilon_t=const,\quad \eta_t=\eta_t^*=0. \tag{52}$$

This is the LCP scenario brought to its extreme consequences: there is no pass-through of exchange rate changes into prices, but this hardly matters since the exchange rate is fixed! Optimal national monetary policies are fully symmetric, thus cannot insulate the national economies from asymmetric shocks: it is only on average that they stabilize the national economies by closing output and employment gaps—the most apparent case of an optimal currency area.

To see why the above is an equilibrium, note that if Home and Foreign firms choose $\eta_t=\eta_t^*=0$, Home and Foreign authorities are concerned with the price-distortions of exchange rate volatility. They will optimize over the trade-off between employment stability and consumers' purchasing power. While they choose their rules independently of each other, the rules they adopt are fully symmetric, thus leading to exchange rate stability. But if the exchange rate is constant during the period, the choice of the pass-through is no longer a concern for Home and Foreign firms: zero pass-through is as good as a choice as any other level of η_t and η_t^*. Such weak preference implies that the monetary union is an equilibrium.

5.2 Nash Versus Coordination

Would the two allocations above still be equilibria, if national authorities could commit to coordinated policies, maximizing some weighted average of expected utility of the two national representative consumers? This is an important question, as one may argue that policymakers in a monetary union would set their rules together (taking private agents' pricing and pass-through strategies as given), rather than independently. By the same token, if there were large gains from cooperation in a floating exchange rate regime, there would also be an incentive for policymakers to design the optimal float in a coordinated way. One may conjecture that, once cooperative policies are allowed for, the equilibrium allocation becomes unique.

Interestingly, it turns out that the possibility of cooperation does not modify at all the conclusions of our analysis. It can be easily shown that optimal policy rules conditional on $\eta_t=\eta_t^*=1$ are exactly the same in a Nash equilibrium and under coordination: there are no gains from cooperation in the PCP scenario which replicates the flex-price allocation.[20] Also, as shown in Corsetti and Pesenti (2004), optimal policy rules conditional on $\eta_t=\eta_t^*=0$ are exactly the same in a Nash equilibrium and under coordination: there are no gains from cooperation: since exchange rate fluctuations are the only source of international spillover, there cannot be gains from cooperation when non-cooperative monetary rules already imply stable exchange rates.[21] While there are policy spillovers for any intermediate degree of pass-through ($0>\eta, \eta^*>1$), they disappear in equilibrium under the two extreme pass-through scenarios. In the only two cases relevant for our equilibrium analysis, optimal monetary policy rules are exactly the same whether or not the two national policymakers cooperate.

Macroeconomics and Welfare Analysis

Can a monetary union or a regime of irrevocably fixed exchange rate be a self-validating OCA? Our model suggests yes. Policy commitment to monetary union—i.e., the adoption of the rules (49-50)—leads profit-maximizing producers to modify their pricing strategies, lowering their pass-through elasticities. Such behavioral change makes a currency area optimal, even if macroeconomic fundamentals and the pattern of shocks (Z_t and Z_t^* in our framework) remain unchanged across regimes.

A crucial result is that, under an OCA, output correlation is higher than under the alternative OF equilibrium. In fact, under OF, monetary policies are such that employment in both countries is always stabilized (both ex-ante and ex-post)

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20 This result is stressed by Obstfeld and Rogoff (2000, 2002).

21 With LCP, expected utility at Home is identical to expected utility in the Foreign country up to a constant that does not depend on monetary policy. For any given shock, consumption increases by the same percentage everywhere in the world economy. Even if ex-post labor moves asymmetrically (so that ex-post welfare is not identical in the two countries, as is the case under PCP), ex ante the expected disutility from labor is the same as under flexible prices.

at the constant levels $\ell = \Phi$ and $\ell^* = \Phi^*$. This implies that output correlation under OF depends on the degree of asymmetry of the fundamental shocks:

$$Corr_t\left(Y_t^{OF}, Y_t^{*OF}\right) = Corr_t\left(Z_t \ell_t^{OF}, Z_t^* \ell_t^{*OF}\right) = Corr_t(Z_t, Z_t^*). \tag{53}$$

Instead, in a monetary union, employment levels are functions of relative shocks:

$$\frac{\theta\kappa}{\theta - 1}\ell_t^{OCA} = \frac{\mu_t^{OCA} / Z_t}{E_{t-1}(\mu_t^{OCA} / Z_t)}, \frac{\theta^*\kappa^*}{\theta^* - 1}\ell_t^{*OCA} = \frac{\mu_t^{OCA} / Z_t^*}{E_{t-1}(\mu_t^{OCA} / Z_t^*)}, \tag{54}$$

where μ^{OCA} is the solution of the system(49)-(50). This implies that output levels and $Y_t^{OCA} = Z_t \ell_t^{OCA}$ are $Y_t^{*OCA} = Z_t^{*OCA} \ell_t^{*OCA}$ perfectly correlated:

$$Corr\left(Y_t^{OCA}, Y_t^{*OCA}\right) = Corr_t\left(\mu_t^{OCA}, \mu_t^{OCA}\right) = 1, \tag{55}$$

so that $Corr_t\left(Y_t^{OCA}, Y_t^{*OCA}\right) \geq Corr(Y^{OF}, Y^{*OF})$, consistent with the traditional characterization of OCAs.

It is nonetheless possible to rank the OF and the OCA regimes in welfare terms. Focusing on the Home country, expected utility $\mathcal{W}$ in (1) can be written as:

$$\mathcal{W}_{t-1} = \mathcal{W}_{t-1}^{FLEX} - \{\gamma E_{t-1} \ln\left[E_{t-1}\left(\frac{\mu_t}{Z_t}\right) / \frac{\mu_t}{Z_t}\right] + (1-\gamma) E_{t-1} \ln\left[E_{t-1}\left(\frac{\left(\mu_t^*\right)^{\eta_t} \mu_t^{1-\eta_t}}{Z_t^*}\right) / \left(\frac{\left(\mu_t^*\right)^{\eta_t} \mu_t^{1-\eta_t}}{Z_t^*}\right)\right]\}, \tag{56}$$

where $\mathcal{W}^{FLEX}$ is defined as the utility that consumers could expect to achieve if prices were fully flexible, thus independent of monetary regime. By Jensen's inequality, the term in curly brackets is always non-negative: expected utility with price rigidities is never above expected utility with flexible prices. At best, what monetary policy rules can do is to bridge the gap between the two.

Observe that under the OF equilibrium (51) the term in square bracket becomes zero and $\mathcal{W}^{OF} = \mathcal{W}^{FLEX}$. But this implies that $\mathcal{W}^{OF} \geq \mathcal{W}^{OCA}$, an inequality that holds with strong sign when shocks are asymmetric. It follows that an optimal currency area is always Pareto-inferior vis-à-vis a Friedman style optimal flexible exchange rate arrangement.

Indeed, it is easy to show that the optimal float allocation is the solution to a Nash equilibrium in which monetary authorities take firms' prices, rather than pass-through coefficients, as given. In this case, the monetary reaction function is no longer constraints by specific beliefs about firms' pricing strategies. Rather, central banks in either country focus on actual export pricing, which, as we have explained above, are quite sensitive to stabilization rules.

CONCLUSION

One of the main contributions of the recent open-economy monetary literature consists in assessing the international dimensions of optimal monetary policy and the potential welfare gains from following rules that are not strictly inward-looking, that is, deviate from canonical closed-economy prescriptions. One aspect that has received a great deal of attention concerns firms' export pricing decisions as a key determinant of optimal stabilization policy. In this paper, we take a step further, and recognize that export pricing strategies themselves, and in particular the choice of currency denomination of exports, are a function of stabilization policy. We first characterize analytically the optimal choice by firms within a stylized framework. While to a large extent specific to the model, this analytical characterization allows us to shed light on a general principle: the degree of exchange rate pass-through affects the exposure of firms' profits to supply and demand shocks in both the domestic and the destination markets. To the extent that the firm can choose its pass-through, it will do so optimally accounting for the covariance between exchange rates and markups.

In general equilibrium, the interaction between export pricing and monetary policy gives rise to the possibility of self-validating currency and monetary regimes. In particular, we have provided an example of a global economy with standard features where there can be two equilibria, as the choice between pricing-to-market and law of one price depends on optimal choices by firms in response to policy decisions. This result suggests that credible policy commitment to monetary union may lead to a change in pricing strategies, making a monetary union the optimal monetary arrangement in a self-validating way.

It is worth emphasizing that, conditional on the central bank's beliefs about firms' pricing, a common monetary policy is optimal because, for given producers' pricing strategies, the use of the exchange rate for stabilization purposes would entail excessive welfare costs, in the form of higher import prices and lower purchasing power across countries. Once a monetary union takes off and firms adapt their pricing strategies to the new environment, the best course of action for the monetary authorities is to avoid any asymmetric policy response to asymmetric shocks. As a result, even in the absence of structural effects brought about by monetary integration, the correlation of national outputs increases.

But our model also suggests that the argument for self-validating optimal currency areas could be used in the opposite direction, as an argument for self-validating optimal floating regimes. For a given pattern of macroeconomic disturbances, in fact, policy commitment to a floating regime may be the right choice despite the observed high synchronization of the business cycle across the countries participating in a monetary union: in equilibrium there will be an endogenous change in pricing strategies (with higher pass-through levels in all countries) which support floating rates as the optimal monetary option. In fact, the two institutional corner solutions for exchange rate regimes can be Pareto ranked in welfare terms, leaving the optimal float the unambiguous winner.

Two observations are in order, regarding the fact that the model we adopt in this paper assumes a high degree of risk sharing. As a future direction for research, and in light of the evidence against efficient integration of financial markets, it would be appropriate to revisit the same topic in a model with financial frictions and imperfections (a point stressed by Corsetti, Dedola and Leduc (2010)). While this perspective may make it harder to derive a clean case of self-validating regimes, the main message of our contributions would remain valid. An ex-post increase in business cycle synchronization is at best a very imperfect criterion to assess the success of monetary integration.

Second, once we move away from the strong conditions ensuring risk sharing, it would be appropriate to reconsider in a model where firms can hedge (if only imperfectly) exchange rate risk. In a more general model (say, allowing for non-traded goods), monetary policy and exchange rate movements will generally not be unable to stabilize sectoral outputs and domestic and international relative prices. Efficient markets for hedging instruments may then be a precondition for reaping the benefits of floating exchange rates. Incidentally, this is an argument which has been repeatedly emphasized by Vittorio Corbo, to whom this book is dedicated. We indeed find appropriate to end this article with a quotation of Vittorio's work on exchange rate regimes, taken from one of his papers addressing the issue "Is it time for a common currency for the Americas?" (Corbo 2001, 2002).

> While few countries are willing to follow the path of dollarization, a larger number is moving toward more flexible systems. However, more flexible systems must be accompanied by the development of forward and future exchange rate markets, to enable market participants to hedge against exchange rate volatility. Otherwise, the costs of real exchange rate variability could be high. As countries move toward the use of more flexible exchange rate arrangements, they will need to make the selection of the monetary anchor more explicit. Here, much progress has been made in the region in implementing quite successful full-fledged inflation-targeting frameworks. Thus, for a country that has built strong macro fundamentals and has a safe and sound financial system, the alternative of keeping its own currency, combining a floating exchange rate system with inflation targeting, may be a better choice (Corbo 2002: p. 109).

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NOTAS DE INVESTIGACIÓN

Esta sección tiene por objetivo divulgar artículos breves escritos por economistas del Banco Central de Chile sobre temas relevantes para la conducción de las políticas económicas en general y monetarias en particular. Las notas de investigación, de manera frecuente, aunque no exclusiva, responden a solicitudes de las autoridades del Banco.

MEDICIÓN DEL RIESGO (NEUTRAL) CAMBIARIO CHILENO:INCORPORACIÓN DE LA INFORMACIÓN DE MERCADO DE LAS OPCIONES*

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I. INTRODUCCIÓN

Existen diversos trabajos que calculan y predicen la volatilidad del tipo de cambio y la probabilidad de su variación utilizando la información histórica de su evolución. Típicamente, la volatilidad se ha calculado utilizando modelos GARCH. Asimismo, se ha utilizado la percepción de los agentes de mercado contenida en los precios de las opciones financieras para medir las probabilidades de eventos de riesgo, como el VIX o el seguimiento de algunos contratos como el *risk-reversal* (*RR*). Otra metodología ampliamente utilizada es la de Malz (1997), la cual es una aproximación de la "sonrisa de la volatilidad" y que ha sido implementada para Chile en Ceballos (2010).

Sin embargo, las metodologías más utilizadas suponen una distribución normal para las variaciones del tipo de cambio, la cual no se observa necesariamente en los datos. Por tanto, ¿cuál es la manera más eficiente de calcular las probabilidades de depreciación/apreciación extremas que consideren distribuciones no necesariamente normales? Este trabajo amplía los modelos anteriores al considerar medidas de valores extremos (por ej. la probabilidad de que el tipo de cambio se deprecie un 20% en tres meses) utilizando datos de opciones financieras *at-the-money* (ATM) o *straddle, Butterfly* (BF) o *strangle*

* *Este artículo representa las opiniones de sus autores y no necesariamente refleja la opinión del Consejo del Banco Central de Chile. Se agradece los valiosos comentarios de Rodrigo Alfaro y Nicolás Álvarez. Cualquier error en este trabajo es de exclusiva responsabilidad de los autores.*
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y *risk reversal* (*RR*). Las opciones financieras contienen información relevante sobre un activo subyacente y las probabilidades de eventos de riesgo; por tal motivo son importantes a la hora de tratar de interpretar las creencias de los participantes del mercado respecto de la trayectoria futura de algún activo en particular. Así, las cotizaciones de estos contratos permiten inferir las funciones de distribución de probabilidad o, en forma más específica, la probabilidad de ocurrencia de eventos extremos.

Al observar el precio de las opciones y revertir el proceso de valoración, es posible inferir las volatilidades utilizadas por el mercado en el cálculo. Estas volatilidades implícitas han sido ampliamente utilizadas para la construcción de indicadores de riesgo como son VIX y el seguimiento de algunos contratos como el RR para el caso de monedas y de *stock*. Recientemente, estas volatilidades implícitas han sido analizadas para tratar de medir la respuesta sobre las percepciones de eventos extremos de los agentes de mercado alrededor de los anuncios de la implementación de políticas monetarias no convencionales (Hattori et al., 2013)

En este contexto, una forma aceptada para obtener las distribuciones de probabilidad es el uso de la metodología de Malz (1997) que, a partir de la interpolación de unos pocos datos y mediante una función paramétrica, brinda una aproximación a la sonrisa de volatilidad (*volatility smile*). Esta metodología es especialmente recomendable en mercados donde no se dispone de valores de opciones para una gama de precios de ejercicio con un mismo vencimiento, como es el caso de Chile. Asimismo, la metodología permite variaciones de precios que no necesariamente tienen una distribución normal[1] presentando una flexibilidad adicional ante la distribución implícita obtenida mediante el modelo de Black-Scholes (BS)[2]. Esto se traduce, principalmente, en que las probabilidades de depreciación no son precisamente simétricas a las probabilidades de apreciación.

Una aplicación para la paridad peso-dólar en el mercado cambiario en Chile ha sido implementada por Ceballos (2010). En este trabajo se amplía lo aplicado por Ceballos al considerar medidas (neutrales[3]) de valores extremos. Así, se calcula la probabilidad de que el tipo de cambio nominal (TCN) se deprecie o aprecie un "*r*" por ciento sobre un determinado umbral dentro de una ventana de tres meses, utilizando siempre la información de mercado proveniente de la cotización de instrumentos de opciones conocidas como *At-the-money* (***ATM***), *Risk-Reversal* (***RR***) y *Strangle* (***STR***) que se describen en la siguiente sección.

Utilizando datos del tipo de cambio CLP/USD de la última década, se observa que la distribución de las variaciones no se comporta como una distribución normal y, por tanto, las probabilidades de apreciación y depreciación para un mismo nivel son distintas. De hecho, se encuentra que la probabilidad de depreciación es mayor que la de apreciación, y que esta aumenta considerablemente antes

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1 Hull (2009).

2 Black and Scholes (1973), Merton (1973).

3 Una medida de riesgo neutral es una medida de probabilidad tal que el valor actual de un activo financiero es igual al valor esperado, bajo dicha medida, de los pagos futuros descontados por la tasa de interés libre de riesgo.

y durante los períodos de turbulencia financiera. Asimismo, la aplicación de la metodología propuesta, muestra que si bien la probabilidad de depreciación se ha incrementado en el último trimestre del 2015, luego de un período de relativa estabilidad, esta no alcanza los niveles observados en la última crisis financiera.

II. MARCO ANALÍTICO

Este documento calcula las probabilidades de depreciación/apreciación del tipo de cambio utilizando medidas de riesgo neutral. Estos se basan en el "primer teorema fundamental de valoración de activos", el cual sostiene que, si en un mercado financiero existe una única medida de riesgo neutral, entonces existe un único precio, libre de arbitraje, para cada activo en el mercado (ley de un solo precio).

Para valorar un activo, se calcula el valor esperado de los pagos futuros ajustados por las preferencias por riesgo de cada agente. No obstante, los factores de descuento varían entre ellos, por lo que es difícil determinar sus preferencias por riesgo individual. Sin embargo, es posible obtener una medida de probabilidad riesgo-neutral[4] a partir de los precios observados en el mercado, los cuales incorporan los premios por riesgo de todos los agentes. En ese sentido, se puede derivar una relación entre el precio de las opciones europeas y la distribución de probabilidades de riesgo-neutral, tal como se menciona en Breeden y Litzenberg (1978).

En cuanto a los instrumentos con opciones, es común que en el mercado de monedas fuera de bolsa (*over-the-counter*, OTC) se coticen en términos de volatilidad implícita, en vez del precio, y por el delta de Black-Scholes, en lugar del precio de ejercicio.

El delta de una opción mide la sensibilidad del valor de una opción ante cambios en el valor del subyacente. Así, para una opción de TC, el delta indica cuánto cambia la prima de la opción ante cambios en una unidad en el *spot*. Como ejemplo, si una opción tiene un delta de 50 y el precio del *spot* cambia en 1%, se espera que la prima cambie en 5%[5]. Analíticamente, el delta guarda una relación inversa con el precio de ejercicio y, mediante la fórmula de BS para el caso de una opción de compra, se puede expresar como sigue:

$$\delta = e^{-i\tau} * N\left(\frac{ln\left(\frac{F_t}{X}\right) + \left(\frac{\sigma^2}{2}\right)\tau}{\sigma\sqrt{\tau}}\right), \qquad (1)$$

donde X es el precio de ejercicio de la opción; F es el valor del *forward* del tipo de cambio en la fecha t; τ es el número de años para el vencimiento de la opción; i es la tasa de interés interna; σ es la volatilidad del precio del activo subyacente[6], y N hace referencia a la distribución normal.

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4 La distribución de probabilidad riesgo-neutral difiere de la distribución de probabilidad real, debido a que los agentes demandan un premio por riesgo, pero que bajo probabilidades riesgo-neutral ya se ajusta por dicho premio. Es posible utilizar el cambio de medida para obtener las probabilidades reales a partir de las probabilidades riesgo-neutral.

5 The Foreign Exchange Market Manual, Bloomberg.

6 Uwe (2006).

Por otro lado, las tres combinaciones de opciones más comúnmente transadas son:

1. ***At-the-money*** (*ATM*) o ***straddle*** es una estrategia que se forma con la combinación de una *call* y una *put* con un precio de ejercicio igual al precio *forward*, ambos con el mismo plazo.

$$ATM = \sigma(0{,}50) \tag{2}$$

donde $\sigma(0{,}50)$ es la volatilidad *at-the money 50-delta*.
El apostar por esta estrategia implica esperar cambios importantes en el precio del subyacente aunque se desconoce la dirección de dicho cambio. La máxima pérdida esperada por parte del comprador de la opción sería la prima pagada por suscribir el contrato. Entonces, a través de este instrumento se puede obtener el segundo momento (varianza o volatilidad) del subyacente.

2. ***Risk Reversal*** (***RR***) es una estrategia que resulta de combinar una posición larga en una opción *call* con precio de ejercicio mayor al *forward* y una posición corta en una opción *put* con precio de ejercicio inferior al *forward*, ambas con el mismo *delta*. Se cotiza como el *spread* entre la volatilidad implícita de la *call* y la correspondiente a la *put*.

$$RR = \sigma_c^{0,25} - \sigma_p^{0,25} \tag{3}$$

Los resultados obtenidos dependerán del sesgo de la distribución de probabilidad del activo subyacente, por ello su comportamiento ayuda a conocer el sesgo que viene anticipando el mercado. Cuando el *RR* es positivo el mercado espera una mayor volatilidad con una depreciación de la moneda local, que cuando se esperaría una apreciación. De esta forma, podemos determinar el tercer momento de la distribución (asimetría).

3. ***Strangle*** (***STR***) o ***Butterfly*** es una combinación de compra de una *call* con precio de ejercicio mayor que el *forward* y una *put* con precio de ejercicio inferior al *forward*, ambos con el mismo plazo y el mismo *delta*. Esto último implica que el precio de ejercicio de ambas opciones presenta la misma distancia respecto del *forward*. Su cotización viene expresada por el promedio de las opciones menos la volatilidad de la opción con precio de ejercicio igual al *forward* (***ATM***)

$$STR = 0{,}5\left(\sigma_p^{0,25} + \sigma_c^{0,25}\right) - ATM, \tag{4}$$

donde $\sigma_c^{0,25}$ es la 25–*delta call* (que es equivalente a una $\sigma_p^{0,75}$) y $\sigma_p^{0,25}$ es una 25–*delta put*.

Esta estrategia apuesta también por cambios importantes del tipo de cambio, aunque a un costo menor comparado con un ***ATM*** (se compran instrumentos *out of the money* en lugar de *at the money*); como contrapartida, el precio del subyacente debe moverse en mayor medida que la estrategia anterior para realizar la ganancia. En otros términos, esta cotización indica el cuarto momento de la distribución del subyacente, la curvatura (*curtosis*).

De acuerdo con la metodología de Malz (1997), al incorporar las volatilidades de los instrumentos de opciones presentadas en las ecuaciones (2), (3) y (4)

y aplicarlas en una función cuadrática se obtiene la curva de sonrisas de volatilidad siguiente:

$$\sigma(\delta) = ATM - 2RR(\delta - 0{,}5) + 16\,STR(\delta - 0{,}5)^2 \tag{5}$$

Una vez obtenidas las volatilidades implícitas de mercado en función de los *deltas* $\sigma(\delta)$ se debe encontrar la volatilidad implícita que corresponde a cada precio de ejercicio. Es decir, se requiere que la volatilidad implícita esté expresada en términos del precio de ejercicio (X), y no en términos de delta (δ). Sin embargo, como el *delta* está determinado por la volatilidad implícita (ecuación 1) se resuelven (1) y (5) de forma simultánea.

Cabe notar que, si la distribución del subyacente fuera normal, solo sería necesario el precio del *straddle*, ya que los otros no tendrían valor. En ese caso, la volatilidad implícita utilizando Black-Scholes coincidiría con $\sigma(\delta)$. Cuanto mayor sean la asimetría y la *curtosis*, mayor será la diferencia en la volatilidad calculada.

Finalmente, y para el objetivo de este trabajo, utilizamos la fórmula de la opción binaria[7] para obtener así las probabilidades buscadas.

Opción binaria

Al estar particularmente interesados en los valores extremos de realización, es decir, en un área particular de las colas de la distribución de los precios de ejercicio, fijamos como objetivo de análisis las probabilidades de que el *forward* del tipo de cambio se deprecie o aprecie r% en tres meses, donde r es 5, 10 y 20% en las aplicaciones empíricas.

Una forma directa de obtener la probabilidad de un evento en particular es utilizando la fórmula de la *call* binaria (o digital), la misma que indica la probabilidad de que el precio del activo subyacente supere un determinado nivel o caiga bajo un cierto límite considerado al momento de la compra del contrato.

Con la fórmula de la *call* binaria y los valores obtenidos de (1) y (5) se puede estimar la probabilidad de cambios bruscos que estamos buscando.

Una opción binaria paga una cantidad fija en un cierto evento y cero de otro modo; así la valorización de una *call* binaria indica el valor presente del área bajo la curva hacia la derecha del precio de ejercicio (X). En general, el precio de una *call* binaria está dado por:

$$C = e^{-i\tau} P\{F_T > X\} = e^{-i\tau} N(d_2) \tag{6}$$

donde:

$$d_2 = \frac{ln(F|X) - (\sigma^2)\tau}{\sigma\sqrt{\tau}} \tag{7}$$

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7 Alternativamente, en lugar de la opción binaria, vía Black-Scholes se puede hallar la función de precios para la call, utilizando las volatilidades encontradas de 1 y 5 que dependen de los precios de ejercicio (X).

donde F es el precio *forward* del activo subyacente, X el precio de ejercicio, σ y τ la volatilidad y la madurez como ya es usual. De modo similar, el precio de una *put* cuando $F(T) < X$ se puede calcular como

$$e^{-i\tau}P\{F_T < X\} = e^{-i\tau}N(-d_2) \tag{8}$$

III. DATOS Y RESULTADOS

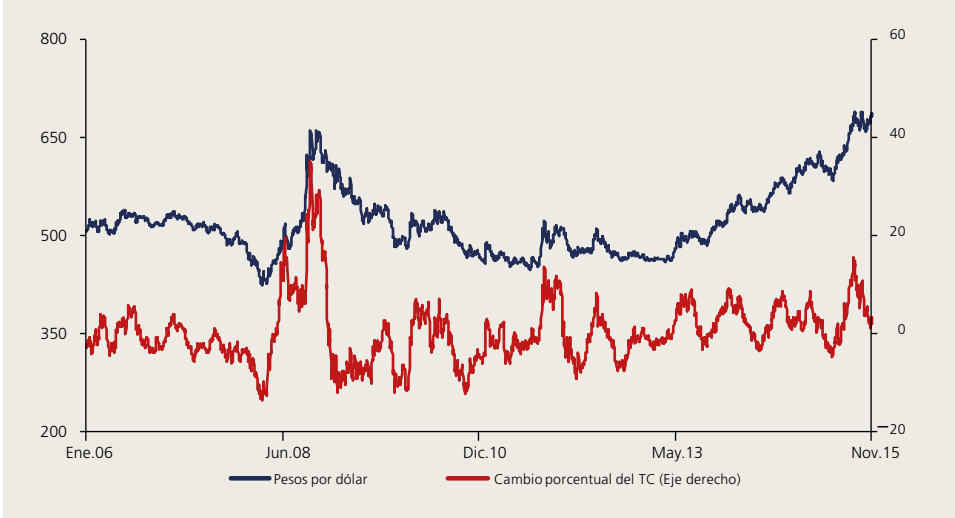
Los datos de *ATM*, *RR* y *STRA* provienen de Bloomberg, mientras las series dólar *spot* y dólar *forward* provienen del Banco Central de Chile. Los datos tienen una frecuencia diaria para el período de enero del 2006 a noviembre del 2015, con lo cual se dispone de 2.463 observaciones.

Asimismo, consideramos como la tasa de descuento local la tasa de depósitos *prime* debido a que representa la principal fuente de financiamiento de los agentes del mercado. Por otro lado, la tasa de descuento externa corresponde a la tasa *Libor*.

En el período analizado, el nivel del tipo de cambio ha fluctuado entre un piso de 431 y un máximo de 706 pesos por dólar, con una tendencia a la depreciación en el último tramo de la muestra. Asimismo, se aprecian episodios en que la depreciación en tres meses superó el 20%, en tanto los movimientos más extremos de apreciación bordean el 10%. De esta forma, la probabilidad incondicional de depreciación superior al 5, 10 y 20% es de 19, 5 y 2%, mientras la probabilidad de apreciación para esas mismas variaciones es de 17, 3 y 0% (gráfico 1).

Gráfico 1

Tipo de cambio *spot* y variación porcentual en tres meses (*)

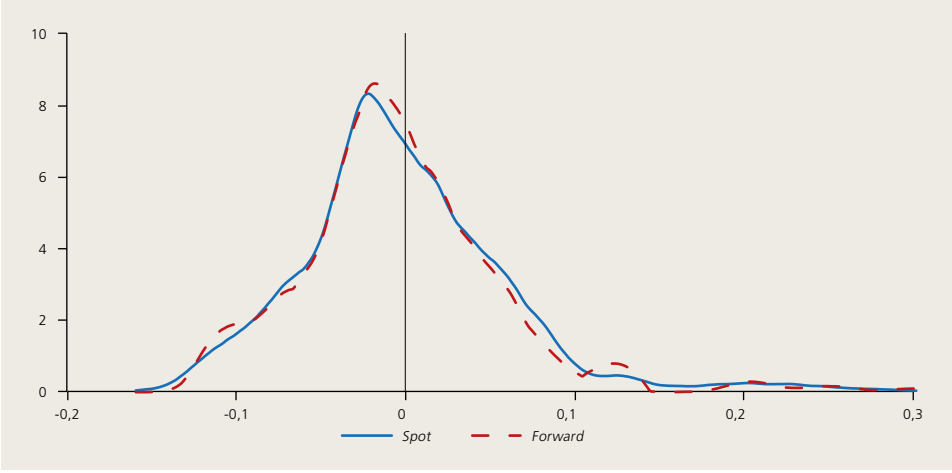


Fuente: Banco Central de Chile.

(*) Cambio porcentual del TC observado en tres meses.

Gráfico 2

Distribución del tipo de cambio *spot* y *forward* (*)



Fuente: Elaboración propia.

(*) *Epanechnikov kernel density estimator.*

La distribución de los retornos del tipo de cambio *spot* y *forward* no son simétricas, pues presentan un mayor sesgo hacia variaciones de depreciación del tipo de cambio (coeficiente de asimetría mayor que cero), así como un nivel de *curtosis* mayor que una distribución normal (gráfico 2). Los tests de normalidad Kolmogorov-Smirnov, Shapiro-Wilk y Shapiro-Francia, rechazan la normalidad de la distribución del tipo de cambio tanto *spot* como *forward*[8]. Por tanto, la utilización de la metodología propuesta en este trabajo tendría ventajas frente a otras, que asumen normalidad en la distribución del subyacente.

El gráfico 3 muestra las series de probabilidad de que el tipo de cambio se deprecie o aprecie en 5, 10 y 20% en un período de tres meses, obtenidas a partir de la metodología presentada anteriormente, y el gráfico 4 resume las probabilidad de depreciación y apreciación promedio de todo el período.

Los resultados muestran que, para el peso chileno, las probabilidades de sufrir eventos de depreciación son mayores que las de una apreciación. En términos relativos, las diferencias en estas probabilidades se hacen mayores cuando se evalúan probabilidades de eventos más extremos. Esta característica de asimetría en las probabilidades es concordante con los valores positivos que toman las cotizaciones ***RR*** (promedio igual a 2,83, con un valor mínimo de 0,68, que, como se ha señalado, indica el sesgo esperado de la volatilidad de una depreciación o apreciación, y en donde un valor ***RR*** positivo indica una mayor volatilidad de depreciación.

8 *Los p-values de los test son cercanos a cero.*

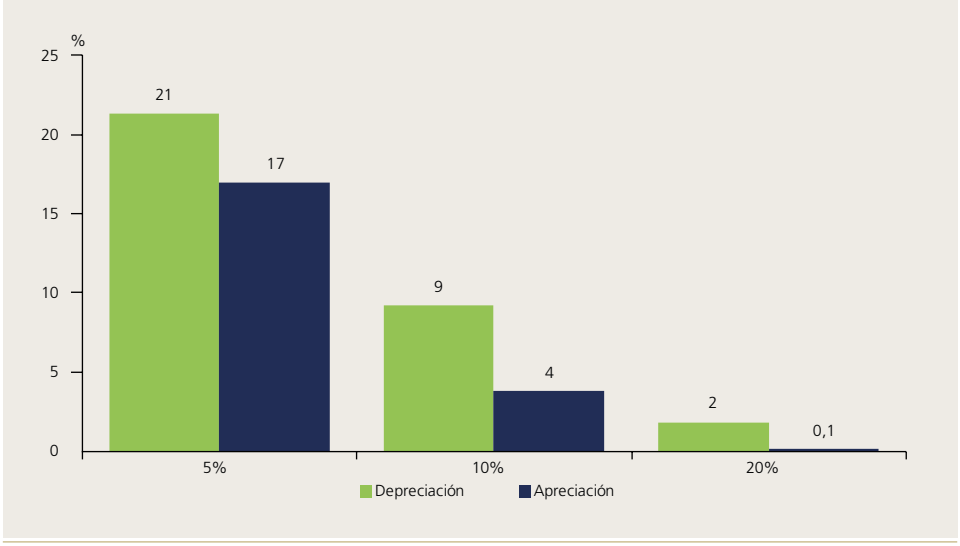
Gráfico 3

Probabilidad de depreciación y apreciación del tipo de cambio

Fuente: Elaboración propia.

Gráfico 4

Probabilidades promedio de depreciación y apreciación del período



Fuente: Elaboración propia.

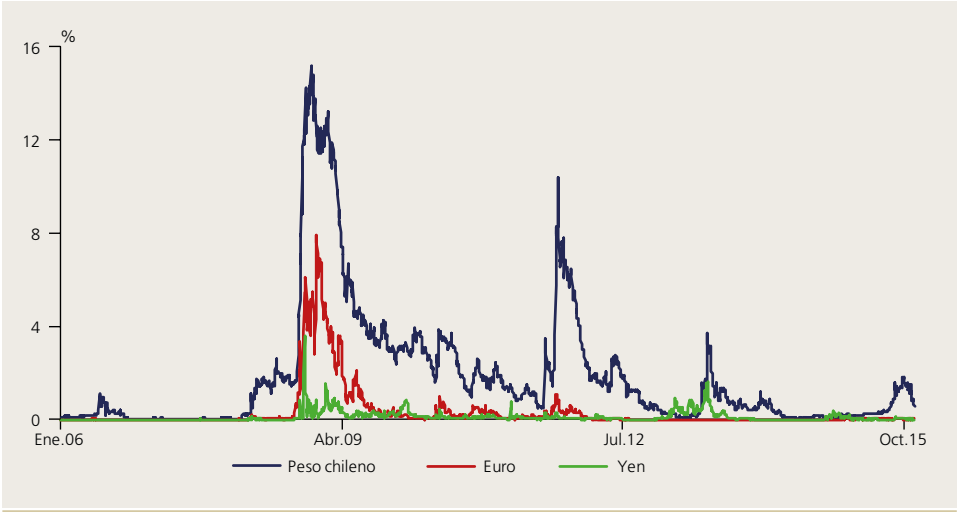
Asimismo, y como es de esperar, los resultados mostrados en los gráficos previos indican que a mayor grado de depreciación/apreciación le corresponde una menor probabilidad de ocurrencia. También se obtiene que a cambios proporcionales entre el precio de ejercicio y el precio *forward* le corresponden probabilidades que (en promedio) cambian de forma no lineal. En otras palabras, los promedios de depreciación de 5, 10 y 20% están asociados a probabilidades con promedio de ocurrencia de 21, 9 y 2%.

Dado que importan más los eventos de depreciación que los de apreciación del tipo de cambio[9], analizamos la probabilidad de depreciación del 20% y la comparamos con la depreciación estimada del euro y del yen japonés[10], contra el dólar. La probabilidad esperada de depreciación máxima del peso corresponde al período de noviembre 2008, en donde se alcanzan niveles del 15% durante el período de crisis asociado a la incertidumbre internacional debido al evento de *Lehman Brothers*. Para este mismo período, la probabilidad estimada de depreciación del 20% para el euro y el yen japonés respecto del dólar, alcanzó niveles de 8 y 3,8% respectivamente.

Otro episodio de volatilidad que implicó una alta probabilidad de depreciación (niveles cercanos al 10%) se dio en octubre del 2011, el cual habría estado relacionado con la intensificación de la crisis financiera europea[11]. Recientemente, si bien se observa un aumento de la probabilidad de depreciación cambiaria, estos niveles se encuentran por debajo de los observados en los dos eventos previos de incertidumbre financiera (gráfico 5).

Gráfico 5

Probabilidades de depreciación del 20%



Fuente: Elaboración propia.

9 La depreciación del tipo de cambio puede tener un efecto importante, por ejemplo, en el aumento del valor de la deuda externa de las empresas, o en un mayor costo de su refinanciamiento.

10 Se estima las probabilidades de depreciación para el euro y el yen bajo la misma metodología desarrollada en la sección II.

11 Informe de Estabilidad Financiera 2011, segundo semestre.

Finalmente, utilizamos una función lineal para simplificar el cálculo de las probabilidades de depreciación. De esta forma, definimos la siguiente ecuación:

$$\begin{aligned} Pr\left(x \geq r\right) = \rho\left(r\right) = \beta_0 + \gamma_0 ln\left(1+r\right) + \\ \beta_1 ATM + \gamma_1 ln\left(1+r\right) ATM + \\ \beta_2 RR + \gamma_2 ln\left(1+r\right) RR + \\ \beta_3 STR + \gamma_3 ln\left(1+r\right) STR, \end{aligned} \tag{9}$$

donde r(r) es la probabilidad de variación mayor que r calculada con el modelo de Malz. Por ejemplo, la probabilidad de depreciación del 10% equivaldría a r(0,1). Además, se utiliza la transformación p/(1-p) para ampliar el rango de la probabilidad de [0, 1] a]-∞, +∞[y ser utilizado en la función lineal.

Las estimaciones se realizaron utilizando un *pool* MCO separado, debido a la asimetría de la distribución, para depreciaciones y apreciaciones cambiarias de 5, 10 y 20% con los datos para Chile. Los resultados se muestran en el siguiente cuadro, donde se aprecian lo suficientemente altos como para asegurar una buena aproximación. Sin embargo, el modelo para una apreciación del 20% no entregaría resultados muy precisos, debido, principalmente, a la casi nula ocurrencia de variaciones del tipo de cambio en torno a -20%.

Asimismo, se realizaron estimaciones para cada r por separado, en las cuales se testeó que los parámetros fueran iguales al modelo general, no pudiendo rechazar esta hipótesis.

El uso de los parámetros mostrados entrega una forma sencilla de estimar las probabilidades para distintos niveles de apreciación y depreciación cambiaria en la mayoría de los casos.

Cuadro

Regresión MCO

(variable dependiente: $p/(1-p)$)

	Depreciación				Apreciación			
	General	5%	10%	20%	General	-5%	-10%	-20%
Constante	-0,013	0,006	-0,090	-0,047	-0,176	-0,138	-0,092	-0,006
	[0,004]*	[0,001]*	[0,001]*	[0,000]*	[0,005]*	[0,001]*	[0,001]*	[0,000]*
Ln(1+*r*)	-0,283				-0,765			
	[0,033]*				[0,033]*			
ATM	0,027	0,021	0,013	0,003	0,036	0,032	0,011	0,001
	[0,001]*	[0,000]*	[0,000]*	[0,000]*	[0,001]*	[0,000]*	[0,000]*	[0,000]*
Ln(1+*r*)***ATM***	-0,130				0,168			
	[0,004]*				[0,004]*			
RR	-0,020	-0,015	0,001	0,010	-0,025	-0,025	0,000	0,001
	[0,001]*	[0,000]*	[0,000]*	[0,000]*	[0,002]*	[0,000]*	[0,000]	[0,000]*
Ln(1+*r*)***RR***	0,175				-0,130			
	[0,011]*				[0,011]*			
STR	0,148	0,108	0,065	-0,007	0,081	0,079	0,007	-0,006
	[0,006]*	[0,002]*	[0,001]*	[0,001]*	[0,007]*	[0,001]*	[0,001]*	[0,000]*
Ln(1+*r*)***STR***	-0,851				0,430			
	[0,048]*				[0,048]*			
N	7.389	2.463	2.463	2.463	7.389	2.463	2.463	2.463
R^2	0,9	0,97	0,99	0,97	0,8	0,99	0,97	0,66
R^2 ajustado	0,9	0,97	0,99	0,97	0,8	0,99	0,97	0,66

Fuente: Elaboración propia.
N*** p<0,1; ** p<0,05; * p<0,01.

IV. CONCLUSIONES

Este trabajo estima las probabilidades de cambios extremos en la trayectoria futura del tipo de cambio sobre la base de la información contenida en opciones financieras transadas en el mercado local.

Se encuentra que, para un mismo nivel de variación del tipo de cambio, la probabilidad de depreciación es mayor que la probabilidad de apreciación, es decir, existe asimetría. Esta mayor probabilidad es más alta cuando se evalúan probabilidades de cambios mayores (eventos más extremos), lo cual es coherente con la serie de valores positivos del ***RR*** (estrategia que presenta un sesgo de depreciación si la cotización es mayor que cero). El promedio histórico de la probabilidad de depreciación del 20% se encuentra al nivel del 2%, por lo que cabe esperar, que períodos persistentes con probabilidades superiores a este promedio se encuentren asociados a períodos de mayor incertidumbre.

Recientemente, se observa un alza significativa de la probabilidad de depreciación cambiaria. Sin embargo, estos niveles se encuentran por debajo de los observados en otros períodos de incertidumbre.

Asimismo, las estimaciones lineales de la probabilidad de depreciación o apreciación, en función de las estrategias descritas, entregan una buena aproximación para su cálculo.

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APÉNDICE A

CUADRO A1

Descripción y fuente de los datos (*)

Variable	*Spot*	*Forward*-90	*Prime*-90	*ATM*	*RR*	*STR*
Media	0,009	0,010	4,711	11,821	2,834	0,570
Mediana	-0,001	-0,001	5,278	10,880	2,500	0,590
Moda	-	0,150	5,880	10,000	1,650	0,300
Mínimo	-0,134	-0,126	0,510	5,500	0,677	-0,450
Máximo	0,370	0,525	11,410	30,800	13,195	1,415
Desv. estándar	0,066	0,076	1,918	4,159	1,774	0,245
Coef. de asimetría	1,325	2,368	-0,330	1,842	2,759	0,330
Curtosis	4,097	10,380	0,318	4,529	8,971	-0,616
N° de obervaciones	2.463	2.463	2.463	2.463	2.463	2.463

Fuente: Elaboración propia.

(*) Las dos primeras columnas muestran el cambio en tres meses del tipo de cambio *spot* y *forward*.

ANÁLISIS DE MICRODATOS DE LAS TASAS DE INTERÉS COMERCIALES POR SECTOR ECONÓMICO*

Pablo Filippi F.**
Patricio Hevia G.**
César Vásquez C.**

I. INTRODUCCIÓN

Esta nota presenta un análisis de la tasa de interés comercial cobrada por los bancos en Chile, describiendo su nivel y dispersión para los distintos sectores económicos. Se caracterizan los créditos de las empresas y su principal producto financiero: los créditos en cuotas pactados en pesos. Los créditos se desagregan por sector económico, monto y plazo, con el fin de identificar el principal factor que determina la dispersión de las tasas de interés.

La motivación de esta nota tiene dos aristas. Primero existe la necesidad de trabajar en pos del cierre de brechas de información, evidenciadas en la crisis del sistema financiero del 2008. Por este motivo, el Fondo Monetario Internacional (FMI) y el Consejo de Estabilidad Financiera (FSB) publicaron una iniciativa de 20 recomendaciones para mejorar las estadísticas económicas y financieras. Esta nota está en línea principalmente con dos de estas iniciativas: i) intensificar el monitoreo del crédito para promover la estabilidad financiera y ii) disponer de mayor información por sector económico (FSB, 2014) [1].

Una segunda motivación es el estudio de la heterogeneidad de la tasa de créditos comerciales en cuotas[2]. El interés surge por conocer si los movimientos de esta tasa están relacionados con un grupo determinado de agentes del mercado o con todos los agentes por igual. En específico, se abordan las siguientes preguntas: ¿Existen diferencias en el nivel de la tasa a la que se enfrentan los distintos sectores económicos?, ¿El monto y plazo del crédito son factores que determinan distintos niveles de tasas de interés? Esto es importante para luego comprender cómo los *shocks* exógenos afectarán la tasa, en qué medida lo harán y como se distribuirá este *shock* entre los distintos agentes.

Diversos estudios, entre ellos Stigler (1961), Salop y Stiglitz (1982) y Roberts y Supina (1997), señalan que la diversidad de precios en torno a un mismo

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1 *Iniciativa sobre brechas de datos (DGI, por su sigla en inglés), presentado en conjunto por el FMI y el FSB.*

2 *La tasa de créditos comerciales en cuotas es publicada en la Base de Datos Estadísticos del BCCh.*

producto puede estar relacionada con distintas características del mercado, tales como: orden de preferencias de los agentes, servicios asociados a la venta de un producto, lugar geográfico del mercado, poder de mercado tanto del oferente como del demandante, y costos de búsqueda de los demandantes, entre otros. En otras palabras, la dispersión de precios estaría relacionada con la heterogeneidad de características que poseen tanto los oferentes como los demandantes que participan en un mismo mercado y en torno a un mismo producto.

Este trabajo sigue los lineamientos que ya han desarrollado otros bancos centrales. En el Banco Central de Portugal, Santos (2013), realiza estadística descriptiva a base de un set de microdatos. El análisis se realiza mediante la desagregación según agente económico, tamaño y plazo del crédito, para luego desarrollar un modelo econométrico sobre los factores que influyen en el nivel de la tasa de interés comercial. Concluye que el tamaño de un crédito tiene correlación negativa con el nivel de la tasa de interés. En el Banco Central do Brasil, Nakane (2003) realiza una descripción de la dispersión de las tasas de interés para Brasil y encuentra que la dispersión disminuye cuando el costo de búsqueda es menor. En el Banco de España, Martin (2005) analiza la dispersión de las tasas de interés en España y obtiene conclusiones similares: la dispersión disminuye al existir mayores beneficios asociados a buscar la mejor tasa, y cuando el costo de búsqueda es menor o existe un mayor acceso a la información.

La principal innovación de esta nota está en el uso de microdatos para el análisis del comportamiento de las tasas de interés en el mercado chileno. La disponibilidad de fuentes de microdatos posibilita el análisis empírico con diversos niveles de agregación, su caracterización según sector económico y el análisis de la dispersión de los datos. Por microdatos se entiende el dato caracterizado a nivel de operación de crédito que realiza una institución financiera con un agente.

Este documento presenta dos resultados a destacar. El primero plantea que los distintos sectores económicos enfrentan tasas de interés similares para créditos de montos semejantes. De este modo, se establece que la dispersión entre las tasas de interés está determinada principalmente, por el monto del crédito otorgado, siendo el plazo un factor a considerar solo para los créditos de montos entre 200 y 5.000 UF. La segunda conclusión plantea que, para cada sector económico, en términos de nivel y variaciones, la tasa de interés total cobrada (aquella que incorpora todas las operaciones) es similar a la tasa de los créditos de montos superiores a 5.000 UF. Esto se debería a que los movimientos en la tasa de los créditos de este segmento son los que tienen la mayor incidencia en la tasa de interés de los créditos comerciales en cuotas. En otras palabras, el mercado de los créditos comerciales en cuotas, en términos de monto, está altamente concentrado en los préstamos mayores de 5.000 UF, los cuales representan el 15% del total de operaciones de crédito realizadas. Este sector a la vez presenta bajos valores de dispersión, no existiendo mayores diferencias al desagregar por sector económico o plazo.

El documento está estructurado de la siguiente manera. En la sección II se presenta la metodología utilizada para generar los estadísticos a calcular. La

sección III contiene la descripción de las fuentes y datos. En la sección IV se presentan los principales resultados del análisis descriptivo de la evolución de la tasa de interés promedio ponderado y su respectiva dispersión desagregada por sector económico, monto del crédito y plazo contractual. En la sección V se presentan las principales conclusiones y las líneas de trabajo futuro.

II. METODOLOGÍA

Las tasas de interés y sus estadísticos se computaron en frecuencia mensual a partir de las operaciones de crédito individuales. Con esta información se realizaron distintas agregaciones por sector económico al que pertenece quien demanda el crédito, monto y plazo del crédito. Con el total de operaciones de crédito realizadas en un mes se calculó, para cada agregación, la tasa de interés promedio ponderado por monto (*rp*), la dispersión ponderada (*dp*), y el coeficiente de variación (*cv*) originando, por cada uno de ellos, un punto mensual de la serie de tiempo. Los estadísticos se calcularon de manera ponderada con el fin de incorporar la información sobre cuál es la importancia relativa de cada operación de crédito respecto del total de los créditos.

1. Tasa de interés promedio ponderado

La tasa de interés promedio ponderado se define como el costo de oportunidad del valor del dinero a través del tiempo (Arraño, Filippi y Vásquez, 2015). La siguiente fórmula ejemplifica cómo se calcula el promedio ponderado de la tasa de interés para el grupo s, con n operaciones de créditos otorgados, en el mes m. Como se mencionó en el punto anterior, los distintos grupos conformados, s, están en función de tres conceptos: sector económico, monto y plazo.

$$Q_{s,m} = \sum_{i=1}^{n} q_{i,s,m} \tag{1}$$

$$w_{i,s,m} = \frac{q_{i,s,m}}{Q_{s,m}} \tag{2}$$

$$rp_{s,m} = \sum_{i=1}^{n} (r_{i,s,m} * w_{i,s,m}) \tag{3}$$

donde (1) define el monto total $Q_{s,m}$ como la suma de los montos de todas las n operaciones de créditos $q_{i,s,m}$. Luego en (2) se obtiene el ponderador de la operación i como el ratio entre $q_{i,s,m}$ y $Q_{s,m}$. Finalmente en (3), $rp_{s,m}$ es la tasa de interés promedio ponderado, $r_{i,s,m}$ es la tasa de la operación i y $w_{i,s,m}$ es el ponderador de la operación.

2. Dispersión ponderada

Desde el punto de vista económico, la dispersión de precios en torno a un producto específico estaría relacionada con la diversidad de características que poseen los

oferentes y demandantes que participan en un mercado en torno a un mismo producto. Esto generaría relaciones de mercado particulares que se materializan, por una parte, en distintos precios de transacción para un mismo producto y, por otra, en una diversidad de respuestas de los agentes del mercado frente a un mismo *shock*. Stigler (1961), Salop y Stiglitz (1982) y Roberts y Supina (1997), entre otros, señalan que la heterogeneidad de precios de un mismo producto puede estar relacionada con diversas características del mercado, entre ellos: diversidad de servicios asociados a la venta de un mismo producto, distintos lugares geográficos que generan diversidad de costos y orden de preferencias, diferencias de poder de mercado tanto de la oferta como de la demanda, y diversidad de costos de búsqueda de los demandantes, por nombrar algunos.

La siguiente fórmula (4) ilustra cómo se calcula la dispersión ponderada (*dp*) para el grupo *s* en el mes *m*. $N_{s,m}$ es el número total de operaciones del grupo agregado.

$$dp_{s,m} = \sqrt[2]{\frac{\sum_{i=1}^{n}\left(r_{i,s,m} - rp_{s,m}\right)^2 w_{i,s,m}}{(N_{s,m}-1)}} \tag{4}$$

3. Coeficiente de variación

El índice de *cv* estandariza la desviación de series que tienen distintas magnitudes de nivel, permitiendo la comparación de dispersiones entre ellas. Con esto, los valores de dispersión se acotan a magnitudes en torno al valor de uno. Cuanto mayor sea el *cv*, mayor dispersión tendrá la serie. El siguiente ratio (5) ilustra cómo se calcula el *cv* para un grupo del sector económico *s* del mes *m*:

$$cv_{s,m} = \frac{dp_{s,m}}{rp_{s,m}} \tag{5}$$

III. DESCRIPCIÓN DE FUENTES Y DATOS

La principal innovación de esta nota está en el uso de microdatos para el análisis del comportamiento de las tasas de interés en el mercado chileno. La disponibilidad de fuentes de microdatos posibilita el análisis empírico con diversos niveles de agregación, superando la limitante que ofrecen aquellas fuentes que entregan datos agregados según criterios que tienen un enfoque más normativo que de análisis económico. Cabe mencionar, que contar con la base de datos con que se lleva a cabo este estudio, y la calidad de ella, es producto de un trabajo conjunto entre el BCCh, la Superintendencia de Bancos e Instituciones Financieras (SBIF) y el sector bancario chileno, orientado a mejorar la calidad de los datos reportados.

Los datos del flujo de la deuda bancaria local de empresas son recopilados desde el archivo D32 "Tasas de Interés Diarias por Operaciones" de la SBIF, cuya fuente de información son las propias instituciones financieras. La principal característica de este archivo es ser censal a escala nacional, proveyendo

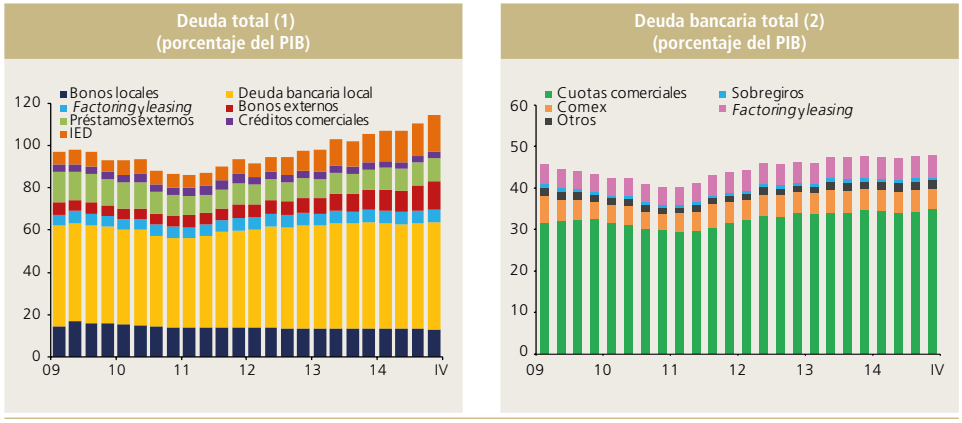
información individual del crédito en cuotas cursadas por los bancos en todas las oficinas del país. Se dispone de esta fuente de información desde julio del 2013 a la fecha con periodicidad diaria y por institución financiera.

Se analiza el crédito comercial en cuotas debido a su importancia sobre el total del financiamiento de las empresas. En el estudio sobre la evolución de la deuda de empresas por sector económico en Chile (Fernández y Vásquez, 2014), se aprecia que, del total adeudado por las empresas no financieras, un 50% en términos de Producto Interno Bruto (PIB) corresponde al financiamiento que mantienen con la banca en Chile. Al descomponer el *stock* de deuda bancaria local por tipo de instrumento, destaca la participación del crédito en cuotas[3]. Este representa alrededor de 72% del *stock* total de la deuda bancaria local, que medido en relación con el PIB equivale a un 32% (gráfico 1).

Para la clasificación del sector económico de la deuda bancaria local de empresas, se utilizó la información del directorio de empresas por actividad económica a nivel de 12 sectores (CAE 12) en donde se asigna a cada empresa un sector económico. El directorio es centralizado y generado por la División Estadísticas del BCCh a base de información sectorial entregada por el Servicio de Impuestos Internos (SII). La clasificación del directorio es una metodología utilizada en el BCCh consistente con la "Clasificación Industrial Internacional Uniforme (CIIU)" utilizada en otros organismos del país (Fernández y Vásquez, 2014).

Gráfico 1

Descomposición de deudas de empresas



Fuente: Banco Central de Chile a base de información de la SBIF.

(1) Basado en información a nivel de empresa con la excepción de *factoring* y *leasing*, bonos securitizados y efectos de comercio.

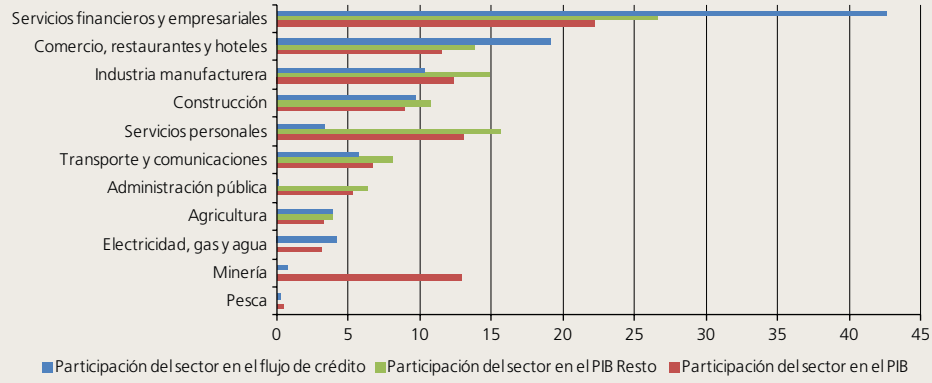
(2) Basado en información de balances individuales de bancos comerciales.

3 *Una definición del crédito en cuotas se puede encontrar en Arraño, Filippi y Vásquez (2015).*

Gráfico 2

Descomposición por sector económico del flujo de créditos comerciales y su participación en el PIB y el PIB resto

(porcentaje)



Fuente: Elaboración propia, a base de información de la SBIF y del BCCH.

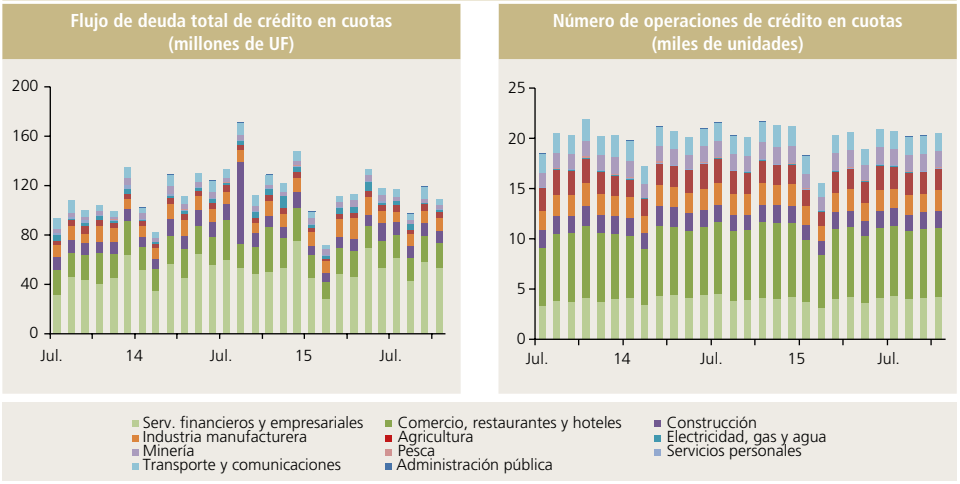
Los sectores económicos identificados se listan en el gráfico 2 junto a su participación en el flujo total del crédito en cuotas, comparados con su participación en el PIB y en el PIB resto[4]. Para el período estudiado, la ejecución de préstamos se realizó principalmente en los sectores de Servicios financieros y empresariales (SFE), Comercio, restaurantes y hoteles (CRH), Industria manufacturera (IMA) y Construcción (CON), que concentran 81,8% del total del flujo de colocaciones de la muestra. A la vez, estos sectores tienen una participación relevante en el PIB total y en el PIB resto, con 55% y 68%, respectivamente.

En el gráfico 3 se presenta el flujo y el número de operaciones de la deuda bancaria por sector económico, desde julio del 2013 hasta octubre del 2015. Esta desagregación muestra que el nivel de flujos, número de operaciones e importancia relativa de los sectores económicos se mantiene relativamente constante a través del tiempo. Otro aspecto que se puede observar es un posible comportamiento estacional, tanto en el flujo como en el número de operaciones. El comportamiento estacional se observa para los meses de diciembre, enero, febrero y marzo. La estacionalidad estaría relacionada con la Navidad, vacaciones e inicio del año laboral. La muestra actual de datos solo permite observación de este comportamiento en dos períodos. Si bien este comportamiento se ha respaldado con consultas a las propias instituciones financieras, en la medida que se cuente con más períodos de información se podrá verificar y cuantificar esta estacionalidad.

4 El BCCh distingue entre el PIB de recursos naturales y el PIB resto. Lo anterior está fundamentado en que los sectores ligados a recursos naturales, el nivel de producción tiene menos relación con las condiciones macroeconómicas agregadas y más con factores propios (Informe de Política Monetaria, septiembre 2015).

Gráfico 3

Flujo y número de operaciones por sector económico (1) (2)



Fuente: Elaboración propia a base de información de la SBIF y del BCCh.

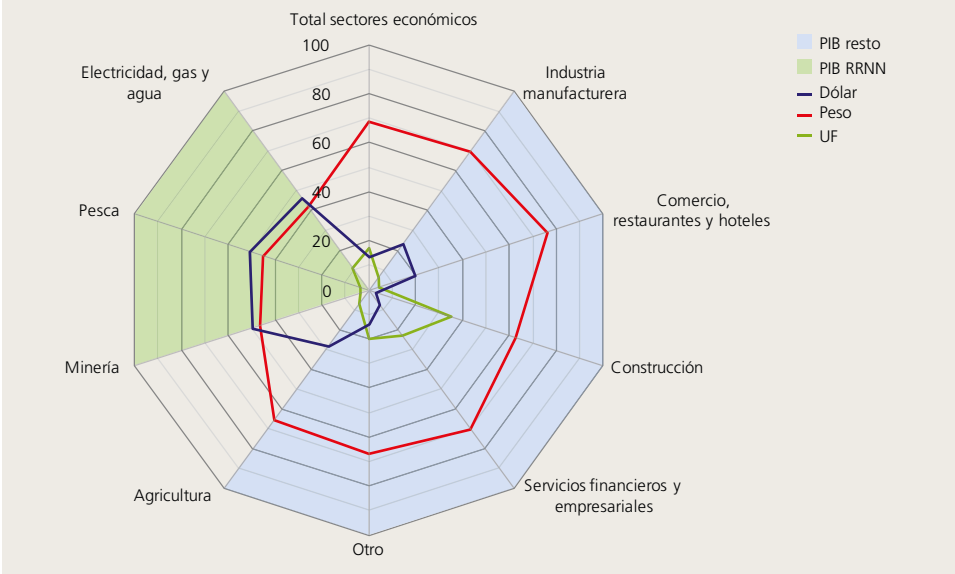
(1) Basado en información de flujos de créditos.

(2) Clasificación sectorial según CAE 12.

Gráfico 4

Participación por sector económico y moneda del flujo de créditos en cuotas

(porcentaje)



Fuente: Fuente: Elaboración propia a base de información de la SBIF y del BCCh.

El gráfico 4 presenta, para cada sector económico, la participación por moneda del total de los flujos del crédito en cuotas para el período entre julio del 2013 y septiembre del 2015. Si bien existen otras monedas para otorgar créditos bancarios en Chile, la muestra fue clasificada en sus tres principales monedas de transacción: el peso chileno (peso), la Unidad de Fomento (UF) y el dólar de Estados Unidos (dólar). El peso es la moneda en que se realizaron mayores flujos de montos dentro de los sectores que en conjunto conforman el PIB resto. Respecto al uso del dólar estadounidense, en el gráfico observa que los sectores relacionados al PIB de recursos naturales (minería, pesca y electricidad, gas y agua) utilizan más intensivamente el dólar para el crédito en cuotas. En el agregado de todos los sectores, el peso es la moneda con mayor uso para los créditos en cuotas, con un 69% del flujo total.

Con lo descrito, esta nota se focalizará en el análisis del crédito comercial en cuotas y en pesos para los cuatro principales sectores: SFE, CRH, IMA y CON. Este tipo de moneda y sectores es el que registra la mayoría de las operaciones de crédito en cuotas, tanto en monto como en número de operaciones. Si bien el sector agricultura utiliza intensivamente el crédito en cuotas en pesos, se desestima su análisis debido a su baja participación en el flujo de deuda total del crédito en cuotas (gráfico 3). De aquí en adelante el estudio solo hará referencia al crédito identificado en estos cuatro sectores.

El gráfico 5 presenta la dispersión empírica de las operaciones de crédito a base de la tasa de interés y el monto asociado a ella. La dispersión muestra cuatro quiebres que están claramente relacionados con los umbrales de monto y tasa que se establecen en la definición de la tasa máxima convencional (TMC)[5]. El primer grupo considera las operaciones que tienen monto menor de 50 UF; el segundo grupo se conforma por las operaciones con créditos mayores de 50 UF y menores de 200 UF; el tercer grupo tiene las operaciones entre 200 y 5.000 UF, y el cuarto grupo incluye aquellas operaciones con montos mayores de 5.000 UF. Para el análisis de los créditos según el monto se utilizan estos cortes.

El cuadro 1 presenta la participación de los cuatro sectores sobre el monto total (y monto total por sector) por tamaño de crédito. SFE es el sector que absorbe la mayor cantidad de montos de crédito, concentrando el 51% del monto total; de este, 91% se concentra en montos mayores de 5.000 UF, lo que representa 47% del monto total. En general, para los cuatro sectores, los montos se concentran en los créditos con operaciones mayores de 5.000 UF, abarcando entre 75% y 90% de los montos de cada sector. En el otro extremo, los créditos menores de 50 UF agrupan menos del 0,16% de los montos para cada sector, representando este tramo el 0,06% del monto total de los créditos.

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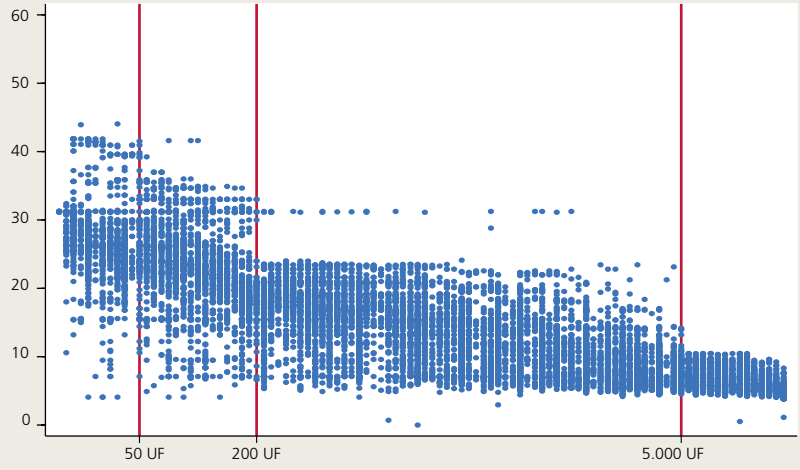
5 La Ley 18.010, "Establece normas para las operaciones de crédito y otras obligaciones de dinero que indica".

Gráfico 5

Dispersión de las operaciones de crédito por tasa de interés y monto

(porcentaje)



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Cuadro 1

Participación sobre el total flujos de créditos por sector económico y por tamaño del crédito (*)

(porcentaje)

Sector económico	0 a 50 UF	50 a 200 UF	200 a 5.000 UF	mayor a 5.000 UF	Total
CRH	**0,04**	**0,25**	**5,58**	**19,44**	**25,32**
	0,16	*0,98*	*22,06*	*76,80*	*100,0*
CON	**0,00**	**0,03**	**2,30**	**8,91**	**11,25**
	0,03	*0,28*	*20,46*	*79,23*	*100,00*
IMA	**0,01**	**0,06**	**2,53**	**9,10**	**11,71**
	0,07	*0,52*	*21,63*	*77,78*	*100,00*
SFE	**0,01**	**0,05**	**4,58**	**47,10**	**51,73**
	0,01	*0,09*	*8,85*	*91,05*	*100,00*
Total	**0,06**	**0,39**	**15,00**	**84,56**	**100,00**
	0,06	*0,39*	*15,00*	*84,56*	*100,00*

Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

(*) Se muestran dos cifras por casillero, en números sin formato se presenta la participación respecto del total de la muestra y en cursiva se presenta la participación por sector económico.

El cuadro 2 se presenta, para los cuatro sectores, el número de operaciones sobre el total de créditos (y total por sector) según tamaño del crédito. CRH es el sector que acumula el mayor número de operaciones, concentrando 47% del total. El intervalo de 200 a 5.000 UF es el que acumula el mayor número de operaciones, representando entre 53% y 68% de las operaciones de cada sector.

En los cuadros 1 y 2 se observa que, en los cuatros sectores, si bien el número de operaciones se concentra en el tramo de 200 a 5.000 UF, los montos se concentran en el intervalo mayor de 5.000 UF. Lo anterior evidencia que el 15% del total de la muestra (créditos mayores de 5.000 UF) concentra el 85% de los montos totales de los créditos. De este modo, este segmento registra una incidencia dominante y mayoritaria en la tasa agregada respecto del resto de los segmentos.

Cuadro 2

Participación sobre el total de créditos por sector económico y por tamaño del crédito (*)

(porcentaje)

Sector económico	0 a 50 UF	50 a 200 UF	200 a 5.000 UF	mayor a 5.000 UF	Total
CRH	**7,34**	**10,83**	**25,20**	**3,78**	**47,16**
	15,58	*22,97*	*53,44*	*8,02*	*100,00*
CON	**0,72**	**1,27**	**8,48**	**1,95**	**12,42**
	5,80	*10,22*	*68,27*	*15,71*	*100,00*
IMA	**1,96**	**2,62**	**9,45**	**2,03**	**16,06**
	12,18	*16,32*	*58,84*	*12,66*	*100,00*
SFE	**1,37**	**1,92**	**13,91**	**7,17**	**24,37**
	5,60	*7,90*	*57,09*	*29,41*	*100,00*
Total	**11,39**	**16,64**	**57,04**	**14,93**	**100,00**
	11,39	*16,64*	*57,04*	*14,93*	*100,00*

Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

(*) Se muestran dos cifras por casillero, en números sin formato se presenta la participación respecto del total de la muestra y en cursiva se presenta la participación por sector económico.

IV. RESULTADOS

1. Desagregación por sector económico

En el gráfico 6 se observa que las tasas de interés por sector económico presentan tendencias similares a la agregada[6]. Los sectores CRH, CON e IMA presentan diferencias de nivel sistemáticamente positivas respecto de la tasa agregada, en tanto que el sector SEF, muestra diferencias negativas. La diferencia de tasas entre SFE y el resto de sectores es en promedio, de 2 puntos porcentuales (pp).

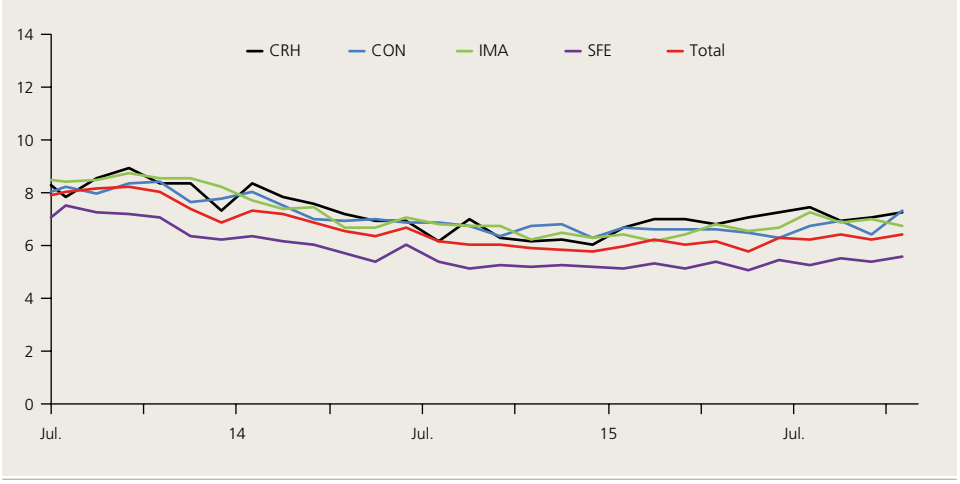
Al estandarizar las desviaciones usando el *cv*, se observa que sistemáticamente el sector CRH tiene el mayor valor de *cv* y que SFE posee el menor (gráfico 7). En cuanto a la evolución del *cv* todos los sectores presentan una tendencia similar a la agregada, registrando un leve aumento desde julio del 2014, lo cual es producto de una disminución de tasas cuya distribución se mantuvo sin cambios.

En los gráficos 6 y 7 se puede leer que el sector SFE posee la tasa más baja en comparación con el resto de los sectores, a la vez que, una menor dispersión de ellas. Lo anterior, junto a lo observado en el cuadro 1 para SFE, es indicio de que los créditos de alto monto de este sector tienen una tasa similar por operación.

Gráfico 6

Tasas de interés por sector económico

(porcentaje)



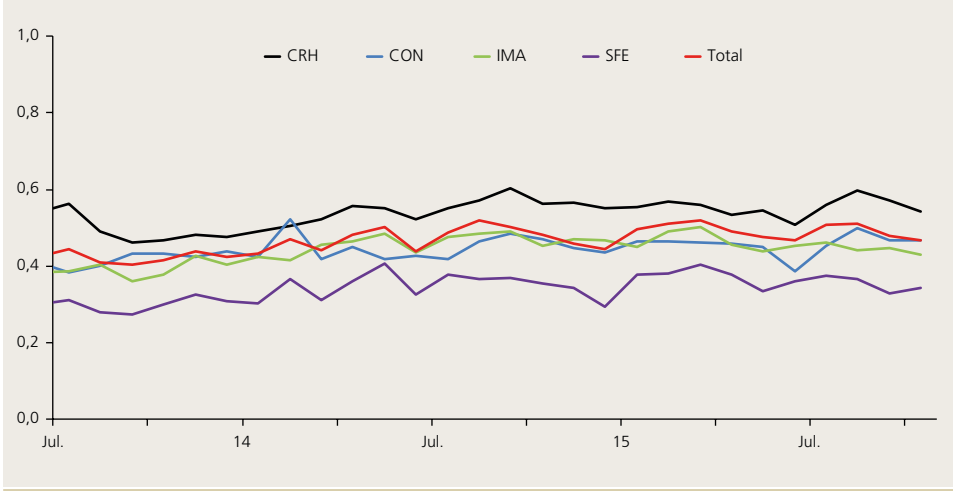
Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

6 La tasa agregada incluye todos los sectores, esto es que se suman además, los sectores no considerados en el análisis del microdato. Las diferencias entre la agregada con todos los sectores y solo con SFE, CRH, IMA y CON son de nivel no superior a un punto porcentual.

Gráfico 7

Coeficiente de variación por sector económico

(porcentaje)

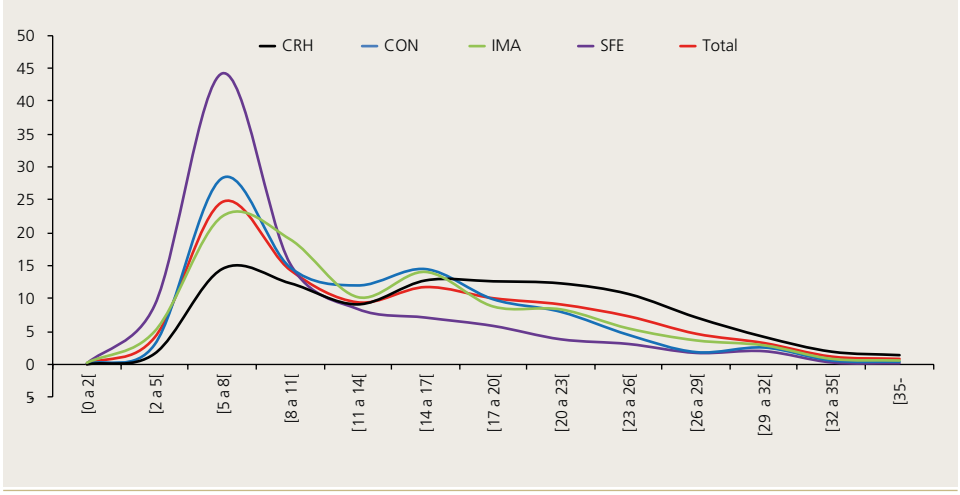


Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Gráfico 8

Histograma de tasas de interés por número de operaciones

(porcentaje)



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Para tener una mejor comprensión respecto a qué significa una diferencia de valor en *cv*, a partir de los microdatos, se presenta en el gráfico 8 el histograma del número de operaciones para julio del 2014 para cada sector económico.

Como se indicó en el párrafo anterior, destaca la alta concentración de tasas del sector SFE en el rango inferior de tasas (5 a 8%), lo que explica su bajo nivel de tasa ponderada y valor de *cv*. Un caso distinto es el sector CRH, que presenta una distribución más uniforme, lo que es consistente con una tasa más alta y un mayor *cv*. Otro aspecto interesante es que, exceptuando SFE, todos los sectores presentan una distribución con dos modas, lo que podría ser evidencia de la existencia de al menos dos mercados diferentes para los créditos dentro de un mismo sector económico. En otras palabras, la concentración en torno a tasas de interés distintas puede responder a características particulares de un grupo de crédito. En las secciones siguientes se analizará si el monto del crédito o el plazo es un factor determinante de agrupación.

A modo general, respecto del gráfico 8, es relevante considerar que todos los sectores tienen su distribución en un mismo rango de tasas, variando entre ellos la forma en que se distribuyen las operaciones. Otra manera de interpretar este gráfico puede ser que todos los sectores enfrentan las mismas tasas de interés y, al presentar distintas distribuciones, generan tasas agregadas que difieren entre los sectores.

A partir de este punto se puede concluir que los sectores económicos tienen comportamientos de tendencia similares tanto en la tasa de interés como en su *cv*. Respecto de sus distribuciones, estas dan indicio sobre la relevancia de descomponer los créditos.

Con el objetivo de profundizar en las características que determinan la heterogeneidad del mercado de colocaciones, en la siguiente parte se incorpora el factor tamaño del crédito como un componente de la desagregación.

2. Desagregación por tamaño del crédito y sector económico

Los gráficos 9 y 10 muestran, por sector económico y tamaño del crédito, la evolución de la tasa de interés y el *cv*. En el gráfico 9 el sector económico está subordinado al monto, mientras que en el gráfico 10 el orden es inverso. Esto, con el propósito de identificar cuál es el efecto del monto del crédito, y cuál por el sector económico.

El gráfico 9 muestra que, en cuanto al nivel de la tasa, de modo general para todos los sectores, a mayor monto del crédito menor la tasa cobrada, siendo la tasa del intervalo mayor de 5.000 UF la más baja. La diferencia de tasas entre los créditos con montos entre 0 y 50 UF y los de más de 5.000 UF es en promedio 20 pp. Entre ambos segmentos de mayor monto de operación, la diferencia es de 5 pp.

Resulta interesante observar que el tramo de operaciones con montos de créditos mayores de 5.000 UF registra valores muy similares, tanto en nivel como en tendencia, a la tasa del sector. La diferencia entre la tasa agregada del sector y la correspondiente al intervalo mayor de 5.000 UF corresponde a la incidencia del resto de los tramos de montos en la tasa agregada. En todos los

casos la incidencia es muy poco relevante. Esto deja en evidencia que, desde la tasa de interés agregada, se puede extraer información económica solo de los créditos de alto monto, pues no se observa el impacto de *shocks* en los créditos de montos menores de 5.000 UF. Se debe considerar que, si bien el intervalo mayor de 5.000 UF representa en general el 85% del monto total asignado en las colocaciones en estudio, en términos de cantidad de créditos otorgados, solo representa el 15% del total.

Para un mismo monto de crédito, los sectores económicos enfrentan tasas similares, llegando a presentar, como máximo, 2 pp de diferencia entre los sectores (gráfico 10).

Respecto al *cv*, en general para todos los sectores salvo SFE, el valor de este índice desagregado por tamaño de crédito es considerablemente menor que el *cv* total por sector, llegando a ser en algunos casos la mitad o menos del valor del índice agregado (gráfico 9). Esto indica que esta desagregación por monto permite conformar grupos más homogéneos. Comparando entre sectores, los *cv* desagregados por tamaño de crédito, presentan valores similares entre sí (gráfico 10).

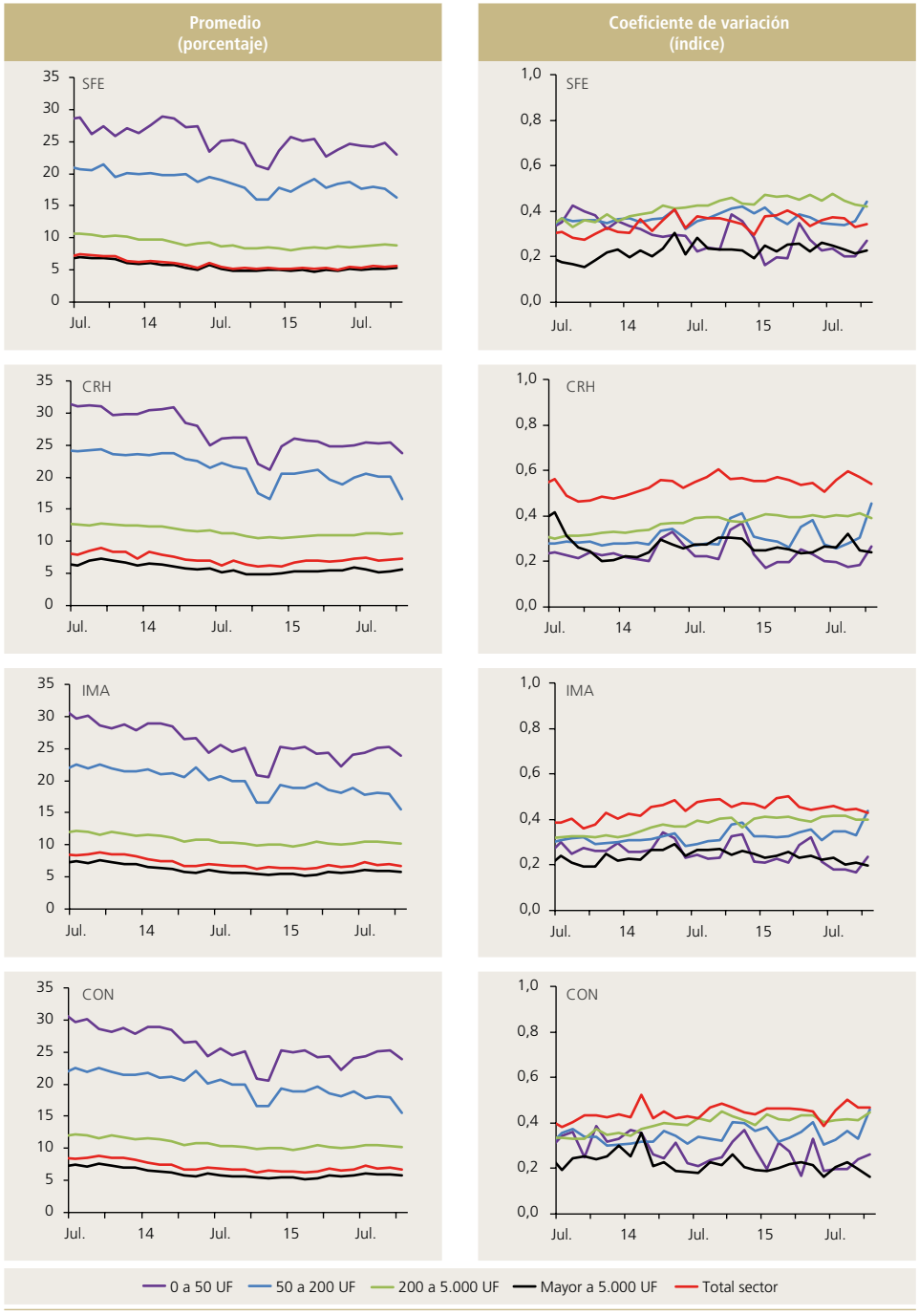
Por sector económico las tasas de interés y sus *cv* presentan niveles y comportamientos de tendencia similares. Los distintos segmentos de monto, evidencian diferencias de nivel y de comportamiento de tendencia. Para los segmentos de tramos menores de 200 UF, la disminución de las tasas ha ocurrido en paralelo con una disminución de la dispersión de las tasas, de modo que el *cv* se ha mantenido constante. Esto difiere del *cv* agregado por sector que presenta una leve alza. Este comportamiento se observa en las operaciones con montos superiores a 200 UF. Una explicación con mayor profundidad respecto a este comportamiento es materia de futuros estudios.

De este análisis se concluye que, la desagregación por tamaño de crédito resulta relevante para generar grupos de mayor homogeneidad, siendo marginal el aporte de desagregar por sector económico.

De este punto se concluye que la desagregación por tamaño de crédito resulta relevante para generar grupos de mayor homogeneidad. El aumento de heterogeneidad observado en los *cv* agregados para cada sector, no se observa a nivel de grupos por tamaño del crédito, por lo cual esto se debe a un efecto en la variación de las participaciones de los grupos en el agregado.

Gráfico 9

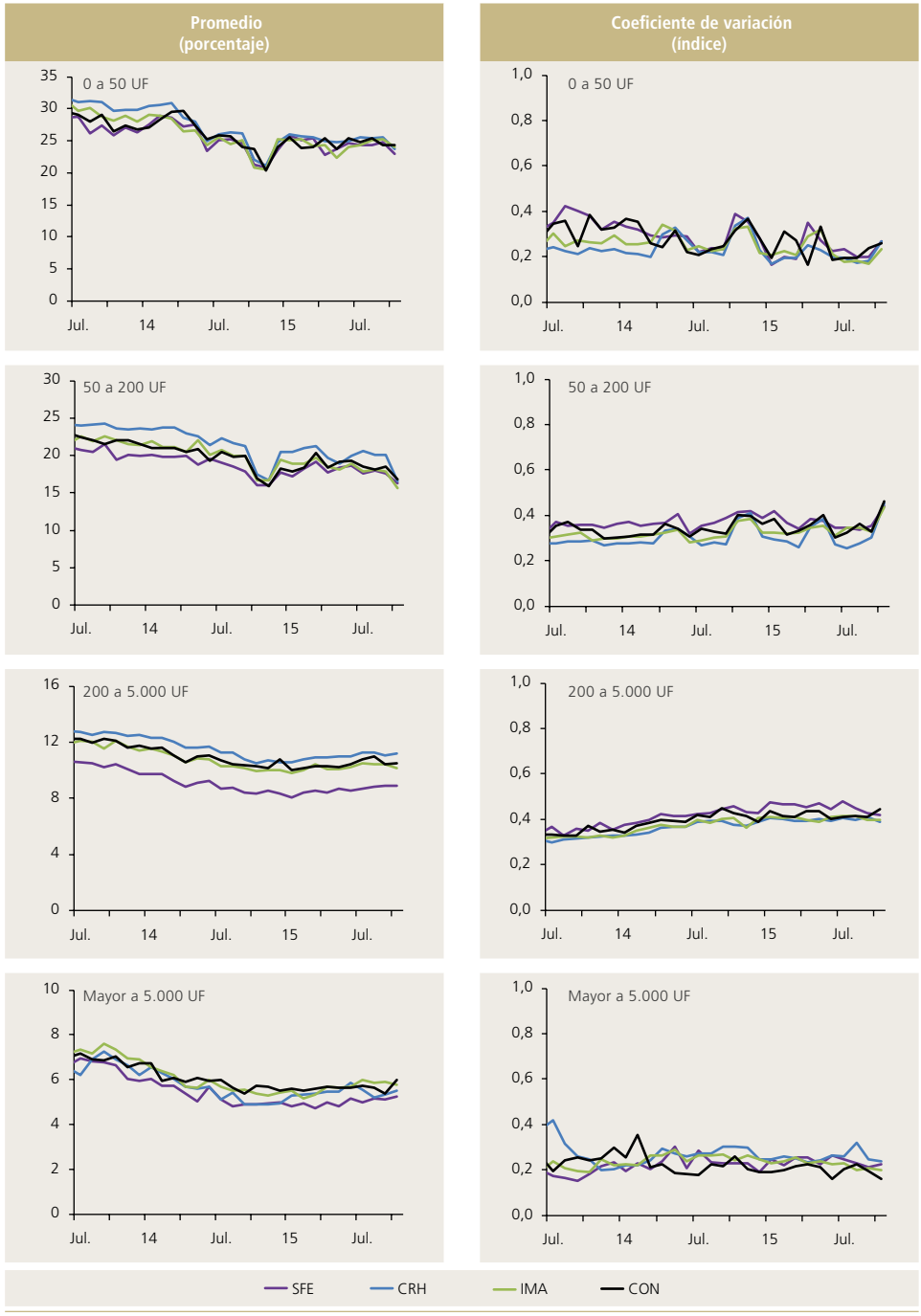
Tasa de interés promedio y coeficiente de variación por sector económico y tamaño del crédito



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Gráfico 10

Tasa de interés promedio y coeficiente de variación por tamaño de monto del crédito y sector financiero



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

3. Desagregación por sector económico, tamaño del crédito y plazo del crédito

Los gráficos 11 al 14 presentan la tasa de interés y el índice *cv* por sector económico, tamaño y plazo del crédito. Respecto al nivel de la tasa, para todos los sectores, las tasas por plazo presentan un comportamiento similar en tendencia, pero con distintos niveles. Las mayores diferencias ocurren en las tasas del grupo menor de 50 UF, pero estas disminuyen a medida que el monto se eleva.

Es interesante revisar la teoría económica sobre las tasas de interés respecto del plazo del crédito[7]. Si bien en la definición de tasas se entiende que a mayor plazo más alta la tasa, nuestro análisis de microdatos para los créditos comerciales en cuotas indican que esto es factible solo en los grupos de 200 a 5.000 UF y más de 5.000 UF, donde existe una diferencia de tasas positiva entre la del plazo mayor de un año y las de menor plazo. En cuanto al *cv*, en general se observa que, en los grupos de tamaños de créditos de 200 a 5.000 UF y en el de mayor de 5.000 UF, el índice *cv* disminuye con la desagregación en cada grupo. Distinto es lo que ocurre en los grupos de montos menores de 50 UF y en el de 50 a 200 UF, donde los índices son diferentes por plazo e inclusive mayores que el índice agregado de cada plazo.

Un antecedente relevante es que, en los tramos mayores de 200 UF, el número de operaciones es considerablemente mayor al de los menores a 200 UF (apéndice B). Cabe mencionar, que para los montos pequeños y plazos menores, en el mercado existe una mayor cantidad de productos financieros sustitutos, entre ellos las líneas de sobregiro de las cuentas corrientes y, en menor medida, tarjetas de crédito, lo que puede estar afectando la decisión de utilizar el crédito en cuotas para este segmento de monto y plazo contractual. De este modo, la distribución de operaciones para este sector puede estar siendo afectada por factores (productos sustitutos) que aquí no consideramos y que serán materia de futuros análisis.

Al comparar nivel de tasa e índice *cv* entre sectores económicos. Se evidencia nuevamente que los sectores económicos enfrentan tasas de interés similares para iguales agrupaciones de operaciones; en este caso monto y plazo. De este modo, incorporando el factor plazo en la desagregación, se observa que el mayor factor diferenciador de tasas es el monto del crédito.

A modo de ejercicio, en el apéndice A se presentan las correlaciones de las tasas de interés de los cuatro sectores económicos analizados hasta el nivel de desagregación por monto[8]. Los resultados respaldan lo ya expuestos: entre sectores económicos, las correlaciones son altas para niveles similares de desagregación. A la vez, la tasa agregada presenta altos niveles de correlación con las tasas de los créditos de montos altos, independientemente del sector y el monto.

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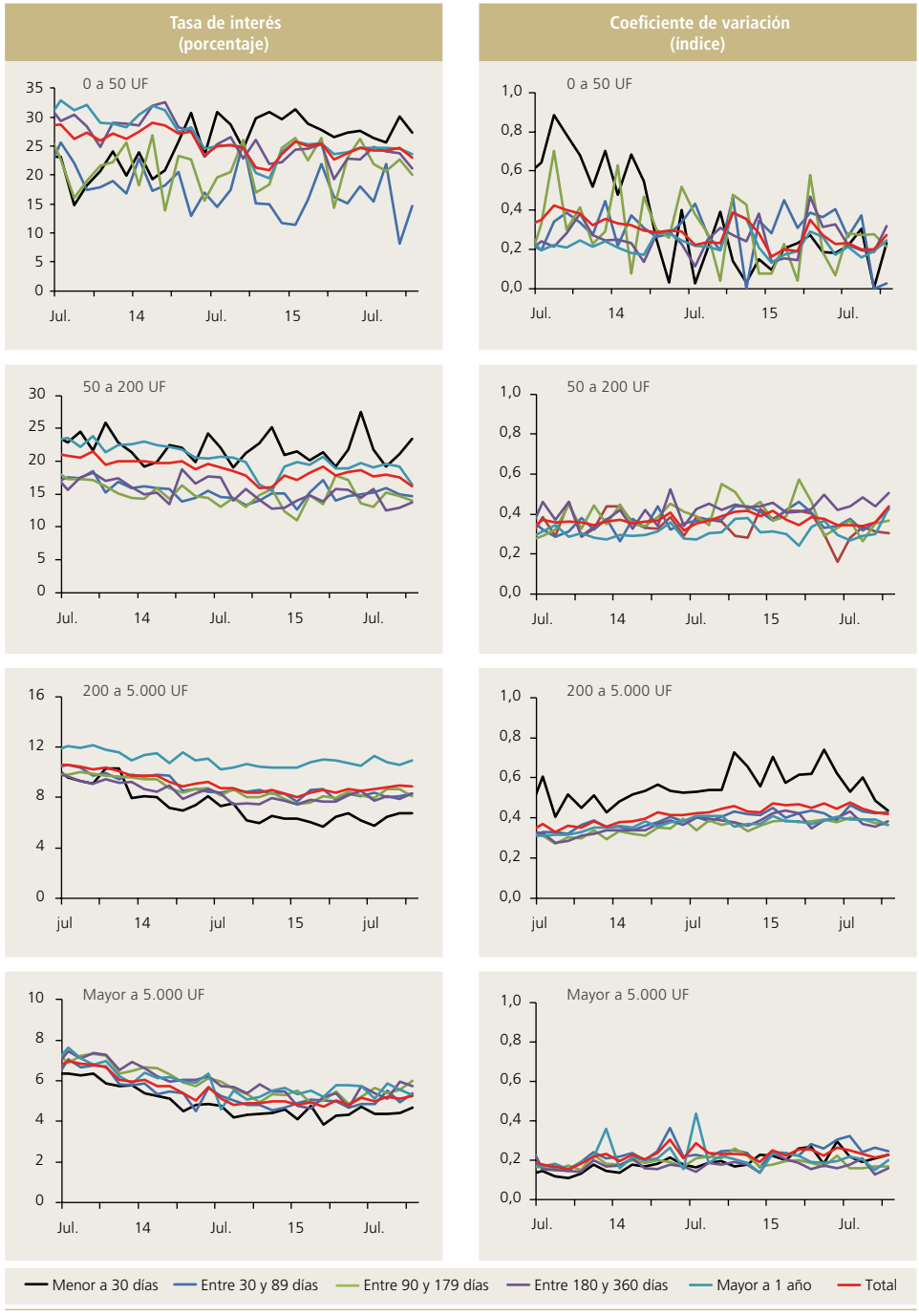
7 Una definición del plazo de las tasas y su nivel se puede encontrar en Arraño, Filippi y Vásquez (2015).

8 Al considerar la dimensión plazo contractual en la matriz de correlaciones el patrón de correlación es similar al encontrado en el apéndice A. Este análisis no ha sido incorporado en esta nota dado el incremento de tamaño de la matriz de correlaciones al considerar todas las dimensiones.

Gráfico 11

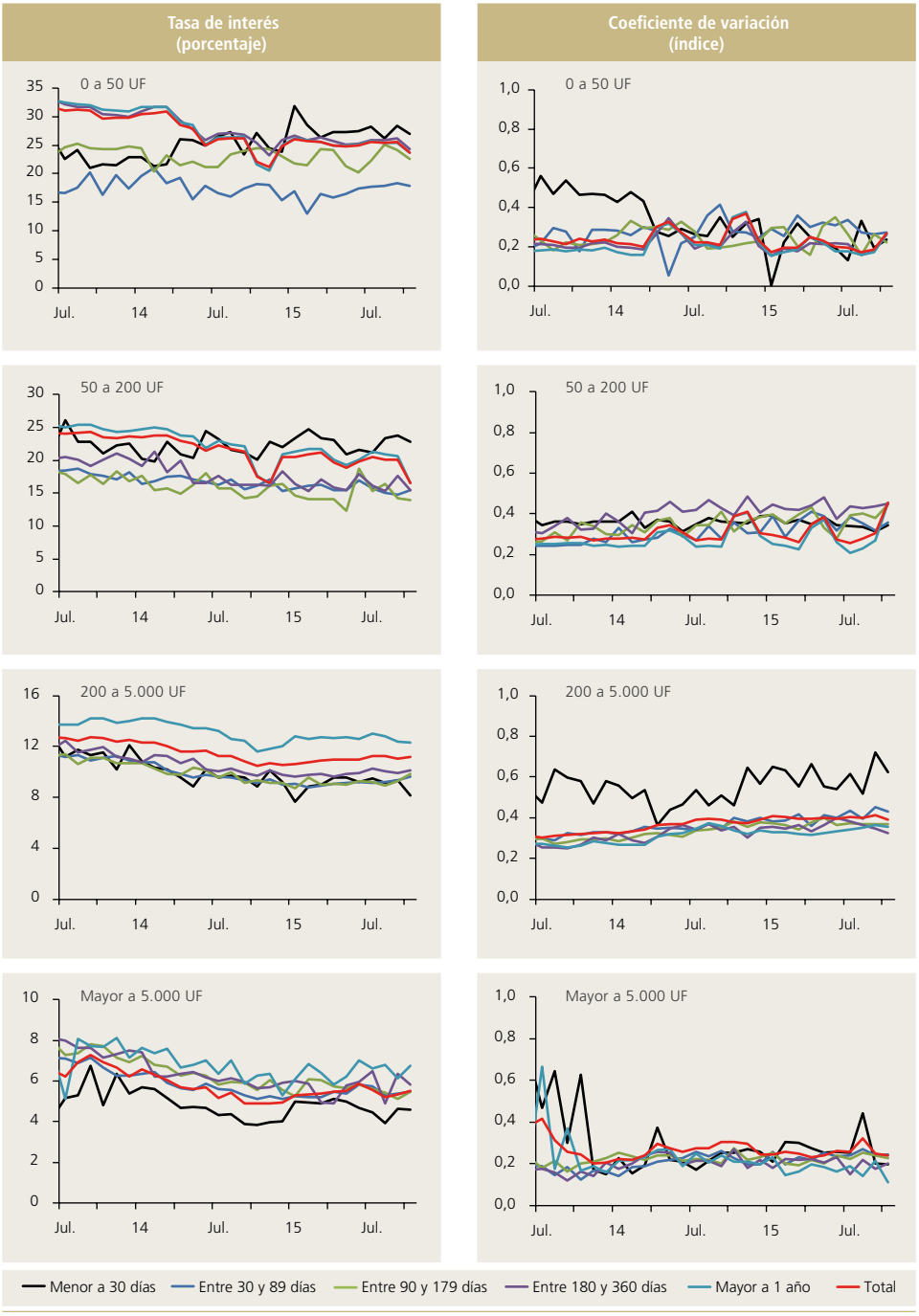
Tasa de interés y coeficiente de variación del sector SFE por tamaño y plazo del crédito



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Gráfico 12

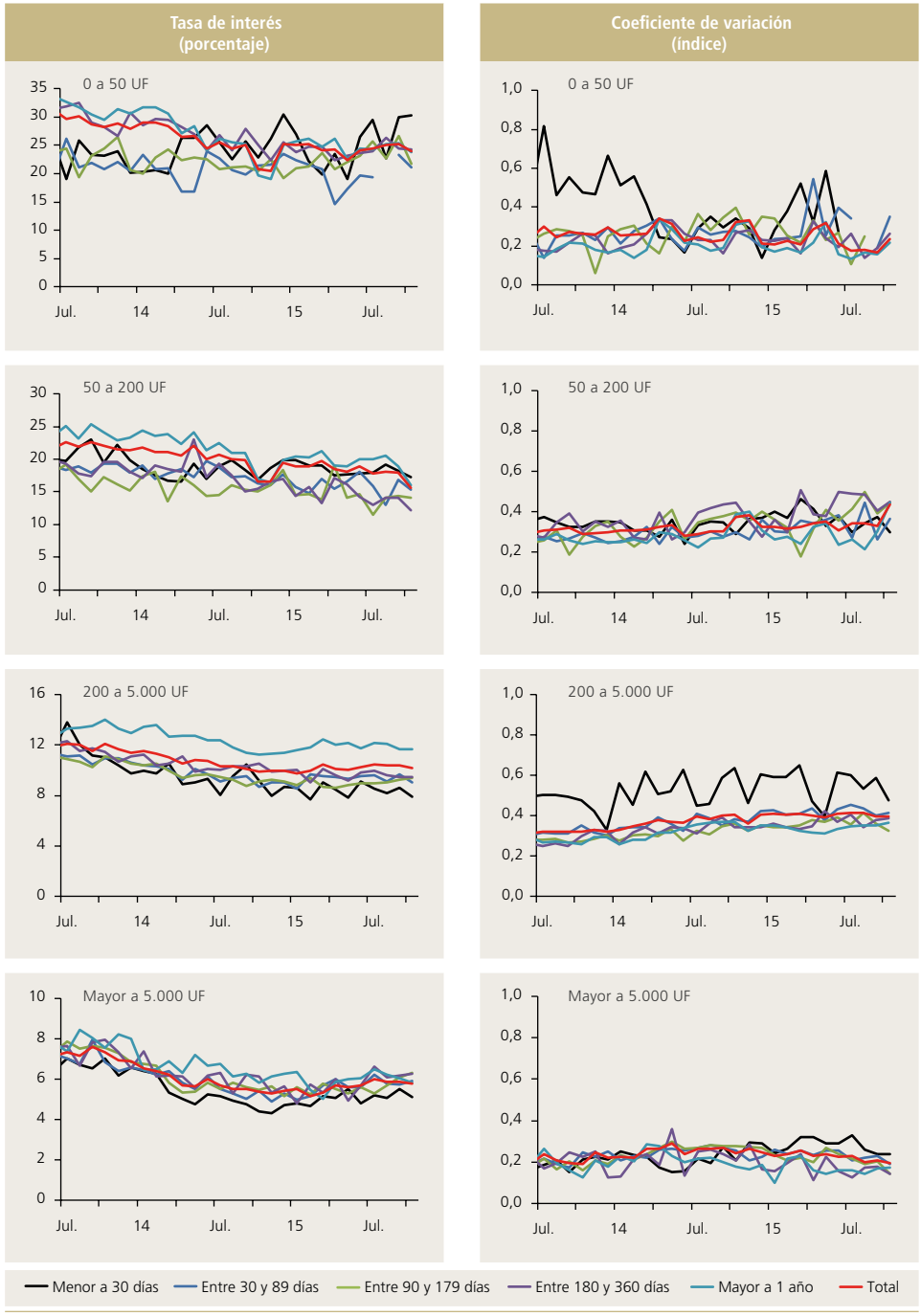
Tasa de interés y coeficiente de variación del sector CRH por tamaño y plazo del crédito



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Gráfico 13

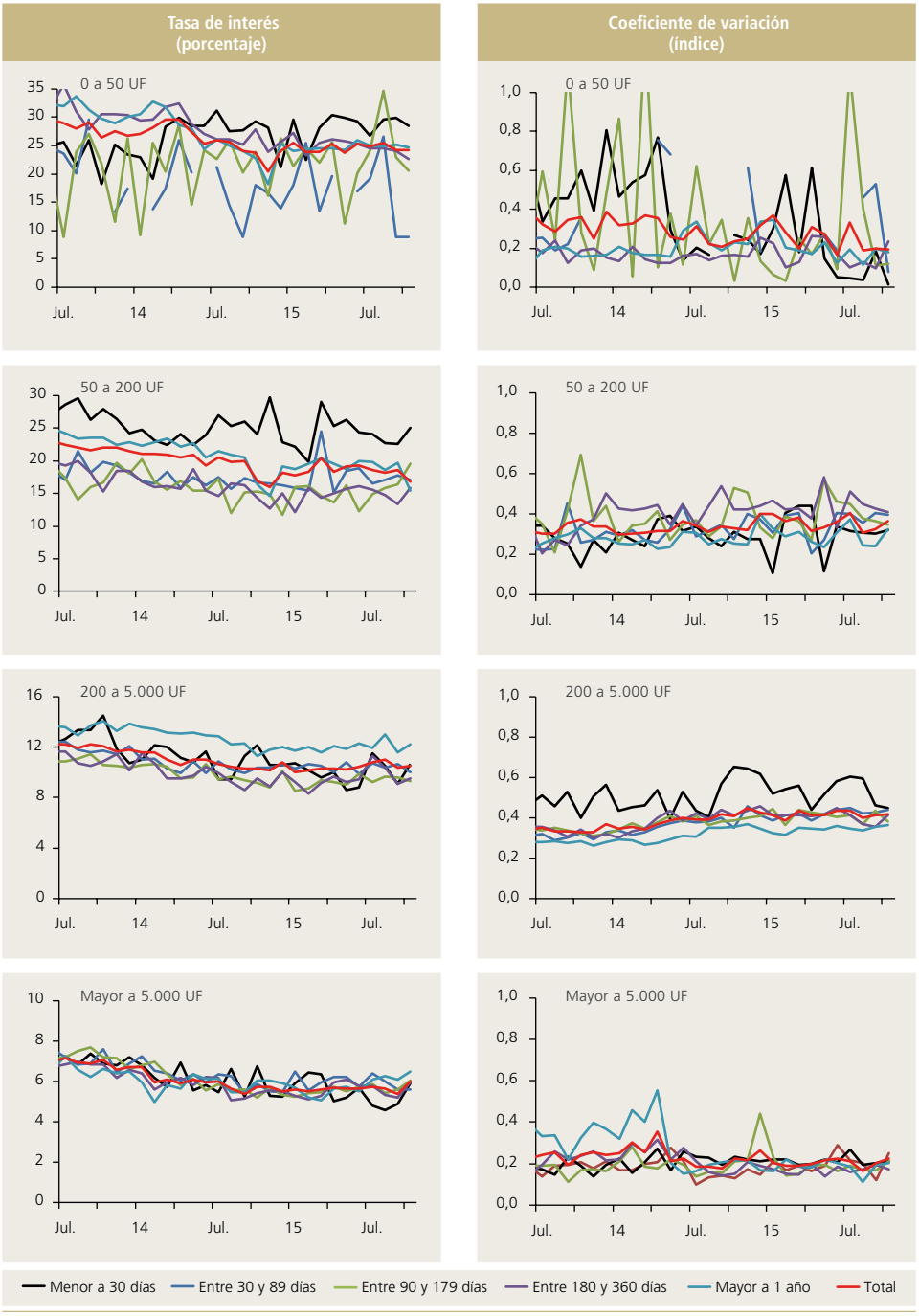
Tasa de interés y coeficiente de variación del sector IMA por tamaño y plazo del crédito



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

Gráfico 14

Tasa de interés y coeficiente de variación del sector CON por tamaño y plazo del crédito



Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

V. CONCLUSIONES

Este documento presenta dos resultados a destacar. El primero plantea que los distintos sectores económicos enfrentan tasas de interés similares para créditos de montos semejantes. De este modo, se concluye que la dispersión entre las tasas de interés está determinada principalmente por el monto del crédito otorgado, siendo el plazo un factor a considerar solo para los créditos de montos de entre 200 y 5.000 UF. La segunda conclusión plantea que, para cada sector económico, en términos de nivel y variaciones, la tasa de interés cobrada es similar a la tasa de los créditos con montos superiores a 5.000 UF. Esto se debería a que los movimientos de la tasa de los créditos de este segmento son los que tienen mayor incidencia en la tasa de interés de créditos comerciales en cuotas.

En cuanto al *cv* de las tasas, se encuentra que el principal factor que determina la heterogeneidad de las tasas es el monto del crédito. La diferencia entre las tasas de interés agregadas, a nivel de sector económico, radica en las diferentes distribuciones de montos de créditos de cada sector.

Por último, esta nota muestra que el mercado de los créditos comerciales en cuotas, en términos de monto, está altamente concentrado en los créditos superiores a 5.000 UF, que representa el 15% del total de operaciones de créditos realizadas. A la vez, este grupo presenta bajos valores de *cv*, no encontrándose mayores diferencias al desagregar por sector económico o plazo. En otras palabras, en este mercado los agentes tienen un alto grado de homogeneidad.

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APÉNDICE A

CORRELACIÓN ENTRE TASAS DE INTERÉS SEGÚN SECTOR ECONÓMICO Y MONTO DEL CRÉDITO OTORGADO

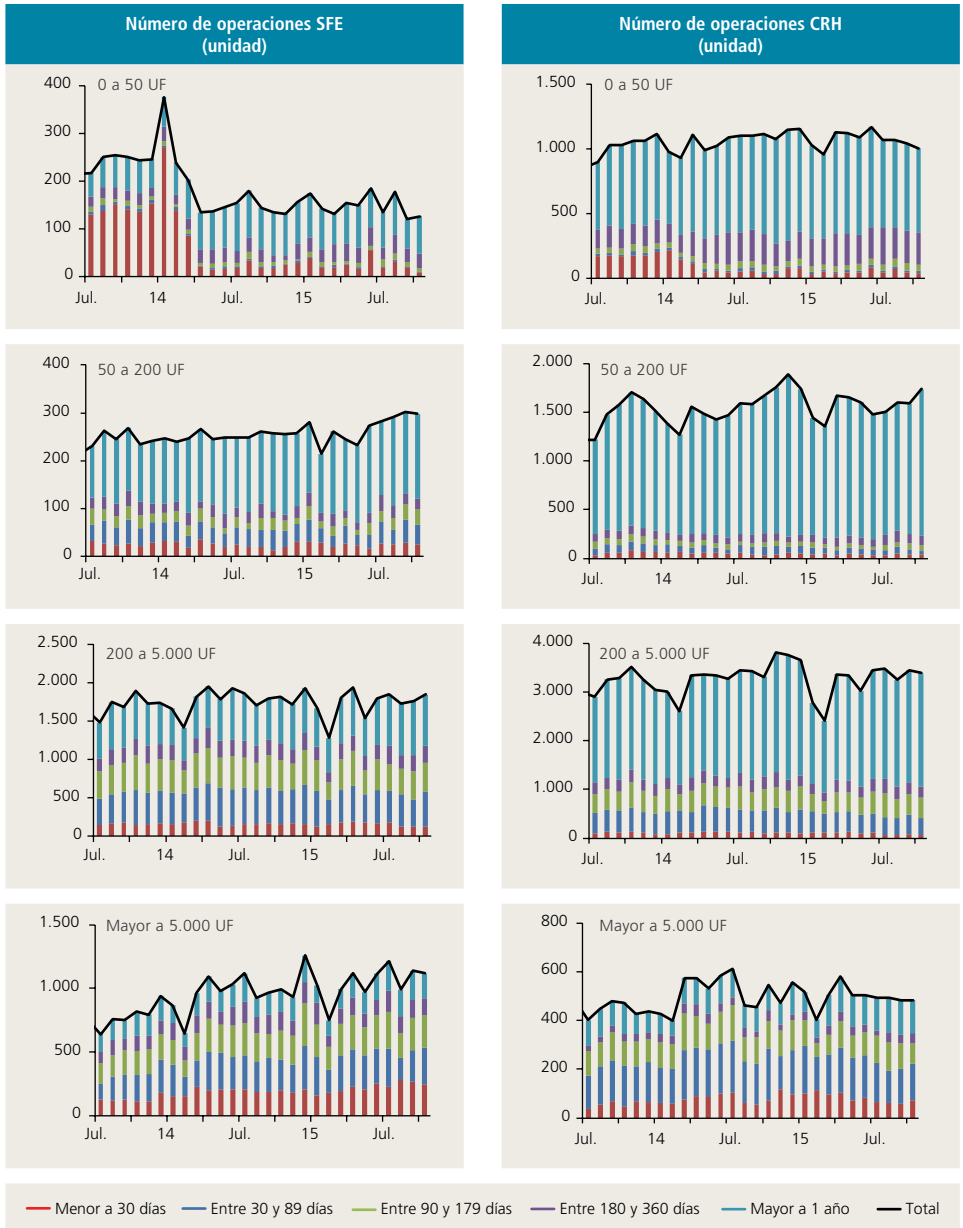
	Comercial cuotas	CHR	CON	IMA	SFE	CHR - 0 a 50 UF	CHR - 50 a 200 UF	CHR - 200 a 5.000 UF	CHR - mayor a 5.000 UF	CON - 0 a 50 UF	CON - 50 a 200 UF	CON - 200 a 5.000 UF	CON - mayor a 5.000 UF	IMA - 0 a 50 UF	IMA - 50 a 200 UF	IMA - 200 a 5.000 UF	IMA - mayor a 5.000 UF	SFE - 0 a 50 UF	SFE - 50 a 200 UF	SFE - 200 a 5.000 UF	SFE - mayor a 5.000 UF
Comercial cuotas	1,00																				
CHR	0,88	1,00																			
CON	0,93	0,81	1,00																		
IMA	0,92	0,86	0,88	1,00																	
SFE	0,98	0,82	0,92	0,92	1,00																
CHR - 0 a 50 UF	0,83	0,80	0,75	0,81	0,80	1,00															
CHR - 50 a 200 UF	0,73	0,65	0,62	0,72	0,70	0,94	1,00														
CHR - 200 a 5.000 UF	0,93	0,86	0,90	0,93	0,91	0,90	0,81	1,00													
CHR - mayor a 5.000 UF	0,92	0,96	0,86	0,90	0,88	0,84	0,73	0,91	1,00												
CON - 0 a 50 UF	0,72	0,66	0,61	0,64	0,68	0,89	0,84	0,79	0,71	1,00											
CON - 50 a 200 UF	0,76	0,69	0,66	0,77	0,73	0,91	0,94	0,85	0,76	0,79	1,00										
CON - 200 a 5.000 UF	0,93	0,79	0,90	0,93	0,93	0,82	0,76	0,94	0,86	0,69	0,78	1,00									
CON - mayor a 5.000 UF	0,92	0,77	0,96	0,90	0,93	0,76	0,66	0,91	0,85	0,64	0,73	0,91	1,00								
IMA - 0 a 50 UF	0,84	0,77	0,74	0,80	0,81	0,97	0,91	0,87	0,81	0,85	0,86	0,84	0,75	1,00							
IMA - 50 a 200 UF	0,73	0,61	0,65	0,71	0,71	0,90	0,96	0,80	0,72	0,79	0,94	0,77	0,72	0,86	1,00						
IMA - 200 a 5.000 UF	0,94	0,85	0,90	0,94	0,94	0,87	0,79	0,96	0,89	0,71	0,85	0,95	0,92	0,86	0,80	1,00					
IMA - mayor a 5.000 UF	0,94	0,86	0,91	0,99	0,95	0,81	0,70	0,93	0,91	0,67	0,75	0,95	0,92	0,80	0,70	0,94	1,00				
SFE - 0 a 50 UF	0,64	0,65	0,55	0,58	0,59	0,92	0,88	0,74	0,65	0,87	0,84	0,63	0,55	0,88	0,83	0,69	0,59	1,00			
SFE - 50 a 200 UF	0,78	0,73	0,66	0,75	0,76	0,89	0,92	0,85	0,80	0,82	0,92	0,78	0,71	0,84	0,91	0,81	0,75	0,81	1,00		
SFE - 200 a 5.000 UF	0,95	0,85	0,92	0,94	0,95	0,82	0,72	0,96	0,89	0,66	0,79	0,95	0,93	0,81	0,73	0,98	0,95	0,62	0,77	1,00	
SFE - mayor a 5.000 UF	0,97	0,82	0,91	0,93	1,00	0,79	0,69	0,91	0,88	0,67	0,72	0,94	0,93	0,80	0,70	0,93	0,96	0,57	0,76	0,95	1,00

Fuente: Fuente: Elaboración propia, a base de información de la SBIF y del BCCh.

APÉNDICE B

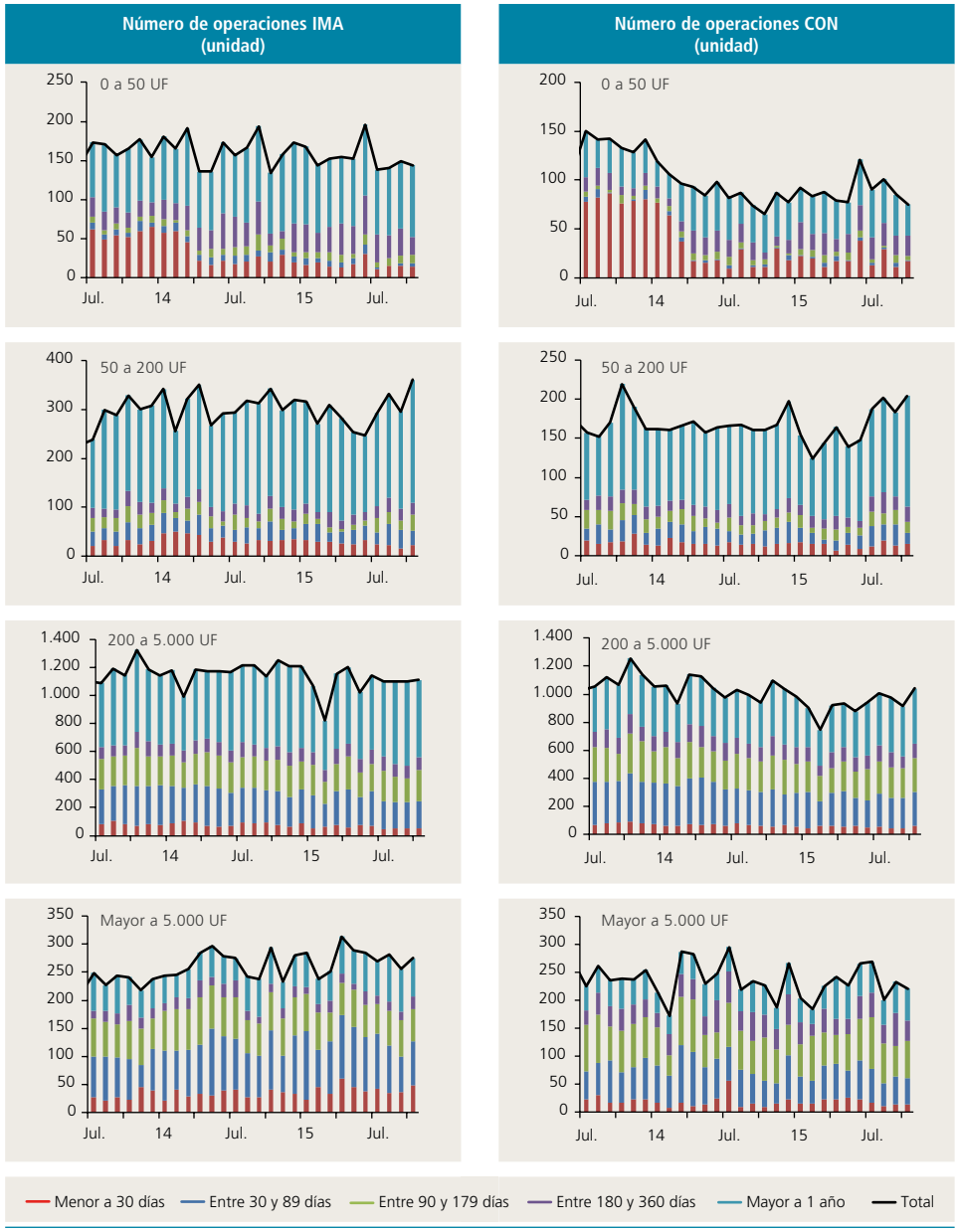
GRÁFICO B1

Número de operaciones de crédito por sector económico, tamaño de monto y plazo del crédito



Fuentes: Elaboración propia, a base de información de la SBIF y del BCCh.

GRÁFICO B1 (continuación)



Fuentes: Elaboración propia, a base de información de la SBIF y del BCCh.

REVISIÓN DE LIBROS

COMENTARIO AL LIBRO "FINANCIAL AND MACROECONOMIC CONNECTEDNESS"

de Francis X. Diebold y Kamil Yilmaz
Primera edición: 2015. Oxford University Press.

Danilo Leiva L.*

La conectividad es un hecho que surge a menudo en la vida moderna, desde las redes eléctricas hasta las redes sociales, y en ninguna parte juega un papel tan central como en las finanzas y la macroeconomía, dos áreas íntimamente conectadas. Las crisis mundiales de 1997-1998 (el "Contagio Asiático") y 2007-2009 (la "Gran Recesión") son dos recordatorios recientes. No obstante, las conexiones financiera y macroeconómica siguen siendo definidas y medidas de manera muy limitada y, por lo tanto, poco conocidas.

Las series de tiempo, ya sean económicas o financieras, tienden a moverse en conjunto, es decir experimentan comovimientos. Por ejemplo, cuando la volatilidad en el mercado de valores de Estados Unidos es alta, los mercados de bonos, divisas y varias clases de activos, en diferentes partes de mundo, también tienden a presentar niveles altos de volatilidad. Por otra parte, algunas series de tiempo son más informativas que otras acerca de futuros movimientos de la actividad económica y financiera. Si uno estuviera interesado en predecir el comportamiento a corto plazo de la bolsa francesa, las fluctuaciones en el mercado alemán de valores serían más informativas que las del mercado japonés de valores. El libro de Francis Diebold y Kamil Yilmaz propone un nuevo marco para definir y analizar los patrones de este tipo, y a la vez determinar cómo se extienden los choques exógenos entre grupos de activos financieros y de mercados, a través del tiempo.

El punto de partida consiste en la definición de la medida de dependencia estadística utilizada para medir conectividad. La conectividad de una serie de tiempo, x, (por ejemplo, la rentabilidad diaria del mercado de bonos en Japón, la volatilidad intradiaria del mercado de divisas de Estados Unidos, o la producción industrial en Francia) hacia una segunda serie de tiempo, y, mide la fracción de la variabilidad futura de y que es explicada por las variaciones presentes de x. Luego de detallar esta definición, se destacan tres aspectos de la medida de conectividad. En primer lugar, el grado de conectividad de una

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variable hacia otra puede variar con del tiempo. Debido a esto, es conveniente estimar la conectividad en diferentes momentos y examinar su comportamiento durante episodios específicos de alta relevancia, tales como crisis financieras y recesiones. En segundo lugar, a partir de conectividades bilaterales, se pueden obtener medidas agregadas de conectividad. Dichas medidas agregadas pueden usarse para cuantificar el grado de exposición que, por ejemplo, un determinado mercado financiero puede tener ante choques en los demás mercados con los cuales interactúa, o para medir el nivel de conectividad a nivel global, por ejemplo entre países. En tercer lugar, es importante destacar que la conectividad es una medida estadística descriptiva, que no representa relaciones de causalidad entre las series de tiempo.

Los precios de las acciones en los mercados de valores están basados en el flujo de caja futuro esperado, el cual resulta estar altamente relacionado con la actividad económica, convirtiendo al mercado de valores en el barómetro más importante de la actividad económica actual y futura. Diebold y Yilmaz analizan la conectividad entre los diez principales mercados de valores a nivel internacional. Esta lista incluye seis países industrializados (Alemania, Australia, Estados Unidos, Francia, Inglaterra y Japón) y cuatro países emergentes (Brasil, China, Hong Kong e India). Los resultados muestran que la conectividad entre los retornos de las bolsas internacionales se ha incrementado a través del tiempo. Este patrón se ve marcado especialmente desde mediados de los noventa, mostrando una tendencia alcista a largo plazo desde entonces. En particular, la conectividad entre retornos ha experimentado incrementos significativos durante dos episodios, la crisis del Este Asiático en octubre de 1997 y durante la quiebra de Lehman Brothers en septiembre del 2008. Luego de esto, debido a los movimientos de política monetaria adoptados por el Banco Central Europeo, que ayudaron a estabilizar los mercados en Europa, a mediados del 2012, el nivel de conectividad global empezó a decrecer. Sin embargo, las noticias acerca de la disminución de la expansión cuantitativa por parte de la Reserva Federal de los Estados Unidos (Fed) afectaron a los mercados de valores a nivel mundial, especialmente en las economías emergentes, y llevó a una leve reversión de la tendencia a la baja en junio del 2013.

El mercado de bonos es tan crucial como el mercado de valores. De hecho, en países industrializados los bonos representan la mayor fuente de financiamiento para los gobiernos locales, estatales y federales, y para las corporaciones. La crisis de la deuda soberana en la Eurozona y su impacto sobre los mercados financieros globales han mostrado que los mercados de bonos pueden estar altamente conectados a nivel internacional durante períodos de crisis. En este contexto resulta más relevante el análisis de las volatilidades que de los retornos, debido a que una mayor volatilidad en los bonos implica un préstamo con un mayor riesgo asociado, y la compensación que los prestamistas deben demandar en forma de tasa de interés tenderá a ser más alta. El análisis de conectividad entre la volatilidad de las tasas de interés de los bonos a largo plazo de 12 países (el G7, Australia, España, Grecia, Irlanda y Portugal) estuvo sujeta a una tendencia creciente entre los años 2000 y 2004. Dicha tendencia, sin embargo, experimentó ocasionales caídas durante períodos de alta incertidumbre, tales como el estallido

de la burbuja "punto com" a inicios del 2000, los ataques terroristas del 9/11, la guerra de Iraq a inicios del 2013, y durante los cambios en la orientación de la política monetaria de la Fed a mediados del 2004. Siguiendo dicho patrón, entre las primeras señales de la crisis *subprime* en marzo del 2007 y la crisis de liquidez de agosto del mismo año, la conectividad de la volatilidad se incrementó substancialmente, alcanzando su punto máximo durante el anuncio de la caída de Lehman Brothers. Sin embargo, durante la crisis global la situación para los mercados de bonos fue muy diferente a la situación de los mercados de valores. Como los bonos del gobierno de países industrializados, especialmente de Estados Unidos, eran vistos como activos totalmente seguros, muchos inversores se apresuraron a comprar bonos del gobierno, haciendo disminuir los rendimientos. Junto con los rendimientos, la volatilidad también disminuyó, y la conectividad de los bonos soberanos decreció drásticamente desde finales de septiembre del 2007 hasta agosto del 2009, fecha en la cual empezó nuevamente a incrementarse debido los problemas fiscales que experimentaba Grecia, y consecuentemente otros países de la Eurozona.

Un mercado financiero que se encuentra aun más ligado a un contexto global es el de divisas. En el 2010, 65% del volumen de negocios diario en el mercado de divisas estaba compuesto por transacciones transfronterizas. Además, con US$4 trillones diarios en volumen de negocios, el mercado de divisas es el mercado financiero más líquido. Motivado por estos hechos, el estudio de la conectividad entre la volatilidad de los tipos de cambio de las principales monedas (vis-à-vis el dólar estadounidense) resulta de alta importancia. En particular, se estudia la interdependencia entre el euro, la libra esterlina (GBP), el franco suizo (CHF), la corona noruega (NOK), la corona sueca (SEK), el yen japonés (JPY), el dólar australiano (AUD), el dólar neozelandés (NZD) y el dólar canadiense (CAD). Los resultados muestran que la conectividad entre los tipos de cambio AUD/USD y NZD/USD es mayor que entre las demás divisas. Una de las características más importantes del análisis es que el tipo de cambio EUR/USD es el más conectado con las demás monedas, y en particular, con el franco suizo, la corona noruega y la corona sueca. Además, cabe recalcar que el tipo de cambio EUR/USD incrementó su conectividad desde el estallido de la crisis financiera global, indicando un incremento en el papel que juega el euro en la propagación de la volatilidad, a través de los mercados de divisas globales. Finalmente, el tipo de cambio USD/JPY resulta ser el menos conectado con el resto de las divisas, en particular desde que el sistema bancario de Estados Unidos empezó a emerger de la crisis, en la primera mitad del 2009.

Diebold y Yilmaz han hecho un trabajo convincente argumentando que la conectividad es una buena medida descriptiva de la dependencia entre series de tiempo que contienen información acerca de mercados financieros. A lo largo del texto, los autores dedican un minucioso esfuerzo por vincular las fluctuaciones de sus medidas de conectividad con los eventos contemporáneos de alta relevancia. De esta manera, *Financial and Macroeconomic Connectedness* proporciona una visión original para estudiar en detalle los acontecimientos financieros mundiales, analizando los orígenes y la propagación de choques que afectan de manera global a los sistemas económicos y financieros.

REVISIÓN DE PUBLICACIONES

DICIEMBRE 2015

Esta sección tiene por objetivo presentar las más recientes investigaciones publicadas sobre diversos tópicos de la economía chilena. La presentación se divide en dos partes: una primera sección de listado de títulos de investigaciones y una segunda de títulos y resúmenes de publicaciones. Las publicaciones están agrupadas por área temática, considerando la clasificación de publicaciones del *Journal of Economic Literature (JEL)*, y por orden alfabético de los autores.

CATASTRO DE PUBLICACIONES RECIENTES

Los resúmenes de los artículos indicados con (*) se presentan en la siguiente sección.

Código JEL: E / MACROECONOMÍA Y ECONOMÍA MONETARIA

Agostini, C. y J. Jiménez (2015). "The Distributional Incidence of the Gasoline Tax in Chile". *Energy Policy* 85: 243 – 52 .

*Ceballos, L. y D. Romero (2015). "The Yield Curve Information under Unconventional Monetary Policies". *Revista de Análisis Económico* 30(2): 3–18.

Chen, K. y A. Irarrázaval (2015). "The Role of Allocative Efficiency in a Decade of Recovery". *Review of Economic Dynamics* 18(3): 523–50.

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Pedersen, M. (2015). "What Affects the Predictions of Private Forecasters? The Role of Central Bank Forecasts in Chile". *International Journal of Forecasting* 31(4): 1043–55.

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*Hales, A. (2015). "Liquidity and Price Discovery in Latin America: Evidence from American Depositary Receipts". *Journal of Economics and Finance* 39(4): 661–78.

Código JEL: G / ECONOMÍA FINANCIERA

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Castro, R. y A. Fortunato (2015). "¿Se Comporta el Alfabetismo Financiero como un Bien Económico?" *CEPAL Review* 116: 147–62.

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Agostini, C., D. Inostroza y M. Willington (2015). "Price Effects of Airlines' Frequent Flyer Programs: The Case of the Dominant Firm in Chile". Transportation Research: Part A: Policy and Practice 78: 283–97.

Berdegue, J., F. Carriazo, B. Jara, F. Modrego y I. Soloaga (2015). "Cities, Territories, and Inclusive Growth: Unraveling Urban-Rural Linkages in Chile, Colombia, and Mexico". *World Development* 73: 56–71.

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Figueroa, E. y R. Pasten (2015). "The Economic Value of Forests in Supplying Local Climate Regulation". *Australian Journal of Agricultural and Resource Economics* 59(3): 446–57.

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Jara, M., D. Paolini y J.D.D. Tena (2015). "Management Efficiency in Football: An Empirical Analysis of Two Extreme Cases". *Managerial and Decision Economics* 36(5): 286–98.

Mullins, J. y P. Bharadwaj (2015). "Effects of Short-Term Measures to Curb Air Pollution: Evidence from Santiago, Chile". *American Journal of Agricultural Economics* 97(4): 1107–34.

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Ospina, P., A. Bebbington, P. Hollenstein, I. Nussbaum y E. Ramirez (2015). "Extraterritorial Investments, Environmental Crisis, and Collective Action in Latin America". *World Development* 73: 32–43.

*Ramirez, E. y R. Ruben (2015). "Gender Systems and Women's Labor Force Participation in the Salmon Industry in Chiloe, Chile". *World Development* 73: 96–104.

Santoleri, P. (2015). "Diversity and Intensity of Information and Communication Technologies Use and Product Innovation: Evidence from Chilean Micro-data". *Economics of Innovation and New Technology* 24(5-6): 550–68.

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*Bustos-Salvagno, J. (2015). "Bidding Behavior in the Chilean Electricity Market". Energy Economics 51: 288–99.

Bravo, F. y J. L. Ruiz (2015). "Herding Behavior and Default in Funded Pension Schemes: The Chilean Case". *Emerging Markets Finance & Trade* 51(6): 1230–43.

Carranza, R. y D. Hojman (2015), "Inequality of Opportunity in Health and Cognitive Abilities: The Case of Chile". Documento de Trabajo N°410, Departamento de Economía, Universidad de Chile.

Fernandez, R., A. Valencia y S. Seriani (2015). "On Passenger Saturation Flow in Public Transport Doors". Transportation Research: Part A: Policy and Practice 78: 102–12.

Figueroa, E. y R. López (2015), "The Nexus Between Fiscal Policy and Sustainable Development: Insights for Developing Countries from the Case of Chile". Documento de Trabajo N°411, Departamento de Economía, Universidad de Chile.

Rojas, C. (2015). "The Welfare Effects of Banning Off-Net/On-Net Price Differentials in the Mobile Sector". *Telecommunications Policy* 39(7): 590–607.

Söderholm, P. y N. Svahn (2015). "Mining, Regional Development and Benefit-Sharing in Developed Countries". *Resources Policy* 45: 78–91.

RESÚMENES DE ARTÍCULOS SELECCIONADOS

Los textos presentados a continuación son transcripciones literales del original.

Código JEL: E / MACROECONOMÍA Y ECONOMÍA MONETARIA

*Ceballos, L. y D. Romero (2015). "The Yield Curve Information under Unconventional Monetary Policies". *Revista de Análisis Económico* 30(2): 3–18.

This paper attempts to address the question of how unconventional monetary policies affected the market expectations regards the expected path of the monetary policy rate and economic growth in countries where some kind of unconventional monetary policies were applied. The approach used is to compare the implicit expectations in the yield curve with market surveys (for the expected path pf monetary policy rate) and econometric models (for economic growth) and evaluate the accuracy of each forecast at different horizons. We conclude that in the period where unconventional monetary policies were applied, the yield curve provided relevant additional information to forecast the monetary policy rate and economic growth, especially in developed economies.

Código JEL: F / ECONOMÍA INTERNACIONAL

*Hales, A. (2015). "Liquidity and Price Discovery in Latin America: Evidence from American Depositary Receipts". *Journal of Economics and Finance* 39(4): 661–78.

This study provides a comprehensive examination of price discovery for American Depositary Receipts (ADRs) originating in Latin America. Using data on 87 ADR issues from Latin America, the empirical approach allows for an endogenous role of exchange rate fluctuations in the price discovery process. The results indicate that while exchange rates are not primarily determined by stock market prices, there is significant flow of information from the stock market to currency markets particularly in Brazil and Mexico. In addition, the results reveal a mix of price discovery locations across Latin America. The conventional finding that the home market matters most for price discovery holds only for Chile. For ADRs from Brazil, the home and U.S. markets contribute equally to price discovery while the U.S. market dominates in price discovery for ADRs from Argentina and Mexico. Results from a cross-sectional analysis indicate that higher levels of illiquidity at home are consistent with higher contributions to price discovery from the U.S. market.

Código JEL: G / ECONOMÍA FINANCIERA

*Kristjanpoller, W. y J.E. Olson (2015). "The Effect of Financial Knowledge and Demographic Variables on Passive and Active Investment in Chile's Pension Plan". *Journal of Pension Economics and Finance* 14(3): 293–314.

This paper contributes to research on defined contribution (DC) retirement plans by examining how financial knowledge and demographic factors influenced Chile's pension holders' choice between a default life-cycle retirement plan

and active management. About one third of Chileans held default funds in 2009; younger people, men, people with lower incomes, and people with low financial knowledge were more likely to choose the default. For active investors, we examined what variables influenced their choice. Nearly three quarters of active investors chose more risky funds that the defaults for their age group. However, risk taking tended to decrease with age and to increase with income, financial knowledge, and risk tolerance.

Código JEL: O / DESARROLLO ECONÓMICO, CAMBIO TECNOLÓGICO Y CRECIMIENTO

*Ramirez, E. y R. Ruben (2015). "Gender Systems and Women's Labor Force Participation in the Salmon Industry in Chiloe, Chile". *World Development* 73: 96–104.

This paper, which follows the emergence of the salmon industry in the 1990s in Chiloe, Chile, demonstrates that factors restricting women's participation in labor force and wage differences between women and men are related to the gender systems operating in Chiloe. Results indicate that these systems reflect the territory's demographic and agrarian history and that local gender systems have a positive influence on women's participation in the labor market, though this is not accompanied by decreased salary discrimination in the salmon industry. The implication is that territory-specific and gender factors must be considered in national employment policies.

Código JEL: Y / NO CLASIFICADOS

*Bustos-Salvagno, J. (2015). "Bidding Behavior in the Chilean Electricity Market". Energy Economics 51: 288–99.

Contracts in power markets are usually obscure. From recently public auctions of long-term supply contracts we can obtain information on how contract prices are determined. To understand generators' bidding behavior, this paper examines the Chilean experience from 2006 to 2011. Using a divisible good auction model we provide a theoretical framework that explains bidding behavior in terms of expected spot prices and contracting positions. Empirical estimations indicate heterogeneity in the cost of over-contracting depending on incumbency, bringing evidence of significant barriers to entry.

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