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Inflation Targeting and Quantitative Tightening: Effects of Reserve Requirements in Peru

As a policy response to address the macroeconomic challenges brought about by financial dollarization and the resulting vulnerability of the financial system, the Central Bank of Peru adopted an inflation-targeting regime in 2002, becoming the first policy authority to implement this framework under a dual monetary system. The inflation-targeting regime in Peru has a particular design. The central bank actively intervenes in the foreign exchange market to smooth exchange rate fluctuations and to build international reserves as a self-insurance mechanism against negative external shocks. Moreover, reserve requirement policy is used as an active monetary control tool to tame the impact of capital flows on domestic credit conditions denominated in both domestic currency (the nuevo sol) and foreign currency (primarily U.S. dollars). The central bank has also set high reserve requirements on foreign currency liabilities as a prudential tool to mitigate liquidity and foreign currency credit risk. These additional policy tools have relaxed the trade-offs that the central bank faces when implementing standard monetary policy within an inflation-targeting regime that simultaneously takes into account financial stability considerations. Moreover, the ready use of reserve requirements in the Peruvian monetary policy framework has allowed the central bank to induce the necessary quantitative tightening required to face the domestic spillover effects of the unprecedented quantitative easing policies engaged in by developed countries.

Based on this experience, this paper evaluates the relevance of reserve requirements as a complementary instrument for monetary policy. To this end,

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we provide a detailed account of the rationality of its use in Peru, explore how changes in reserve requirements policy propagate and affect credit conditions, and make a quantitative assessment of its impact on monetary and credit conditions using a counterfactual policy analysis.

The paper is organized as follows: The next section provides an overview of the Peruvian monetary framework, including the standard interest rate setting. The paper then discusses the use of reserve requirements as a monetary policy tool, the transmission mechanism of reserve requirement changes, and the control of financial dollarization risks and liquidity risks. We present our empirical evaluation of reserve requirement policies, and the final section concludes.

The Monetary Policy Framework

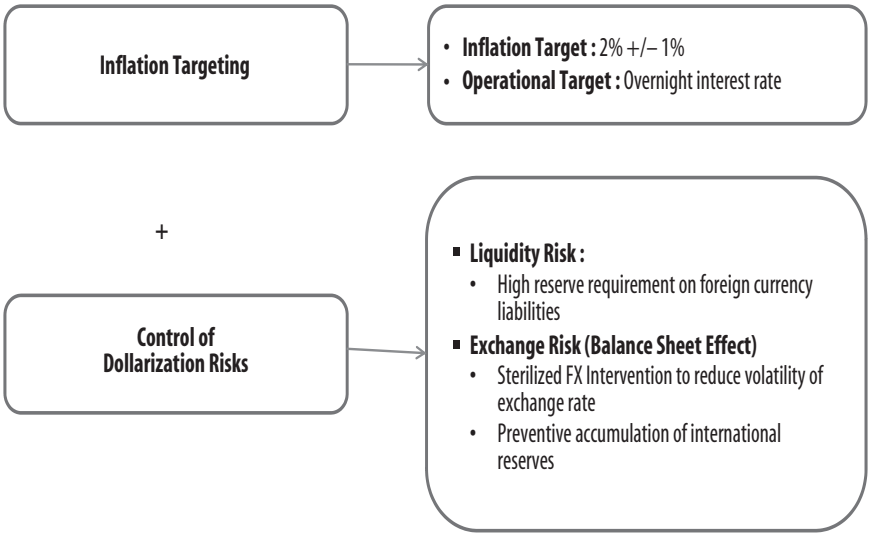
The current monetary policy framework in Peru has been in place since 2002. It is best characterized as a full-fledged inflation-targeting regime that takes explicit account of the risks brought about by financial dollarization. The target is a 2 percent annual increase in the consumer price index with a tolerance band that ranges from 1 to 3 percent. Before inflation targeting was adopted, monetary policy in Peru was implemented by a monetary target framework that used the annual money base growth rate as an intermediate target while also including instruments such as foreign exchange intervention and high reserve requirements for foreign currency deposits.[1]

When the central bank adopted inflation targeting, the aforementioned policy tools used to confront the risks of financial dollarization were still in place. Several papers assess the implementation of the inflation-targeting framework in a financially vulnerable economy as a combination of a standard interest rate rule and the active use of other instruments to control financial risks.[2] Figure 1 illustrates the inflation-targeting framework set up in Peru.

1. The bulk of foreign currency deposits are denominated in U.S. dollars, and around 40 percent of total deposits are denominated in foreign currency. Armas and others (2001) describe the evolution of the monetary policy framework in the 1990s and how the Central Bank of Peru was creating the preconditions to adopt an inflation-targeting scheme.

2. Webb and Armas (2003) provide the first account of the implementation of inflation targeting in a dollarized environment. In this environment, Morón and Winkelried (2005) study the optimal interest rate rule that a central bank should use, considering a framework in which balance sheet effects operate à la Céspedes, Chang, and Velasco (2004). Armas and Grippa (2005) describe the rationale for smoothing exchange rate volatility via sterilized foreign exchange interventions, reserve requirements on the foreign currency liabilities of commercial banks, and the accumulation of central bank foreign currency reserves.

FIGURE 1. Inflation Targeting plus Dollarization Risk Control Framework in Peru

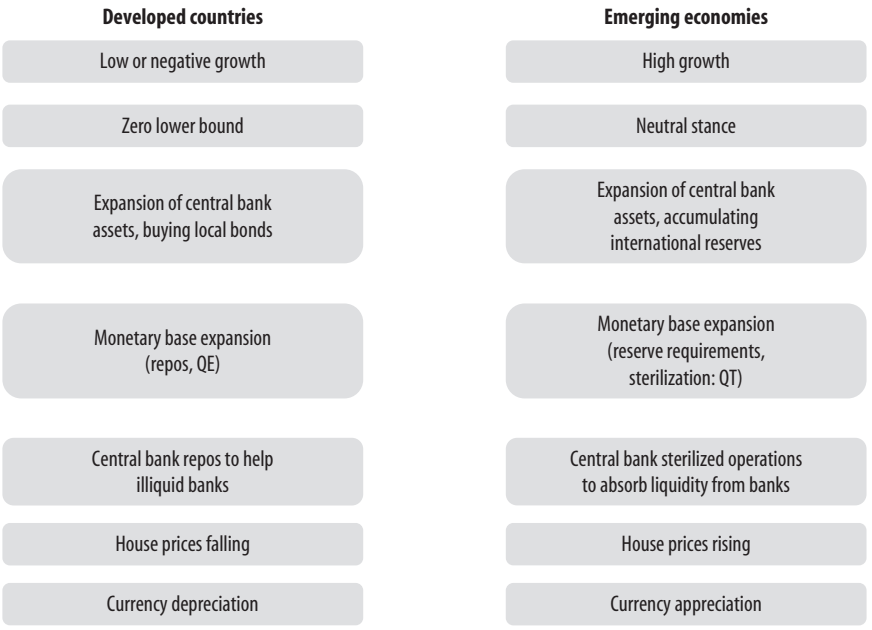


Source: Armas and Grippa (2005).

Since 2008, reserve requirements have been changed frequently to complement policy rate changes. The main reason for this new role for reserve requirements was the launching of the unprecedented expansionary monetary policies in developed economies, which triggered the zero lower bound for their policy interest rates and the implementation of quantitative easing. Emerging economy central banks had to respond with different actions to deal with the spillover effects of these ultra-easy policies, manifested in capital inflows and low international interest rates. Figure 2 summarizes the different economic cycles and policy responses of both developed and emerging economies during the quantitative easing period.

Starting in 2008, changes in the marginal and average reserve requirement rates have been used cyclically in tune with the new international environment. Reserve requirements have been raised in response to capital inflow episodes, such as those observed in the first quarter of 2008 and more recently since the second half of 2010, following the U.S. Federal Reserve's announcement of the second round of quantitative easing. This reserve requirement tightening was aimed at limiting the impact of capital inflows on credit, particularly those denominated in foreign currency. This also resulted in the

FIGURE 2. Quantitative Easing and Quantitative Tightening



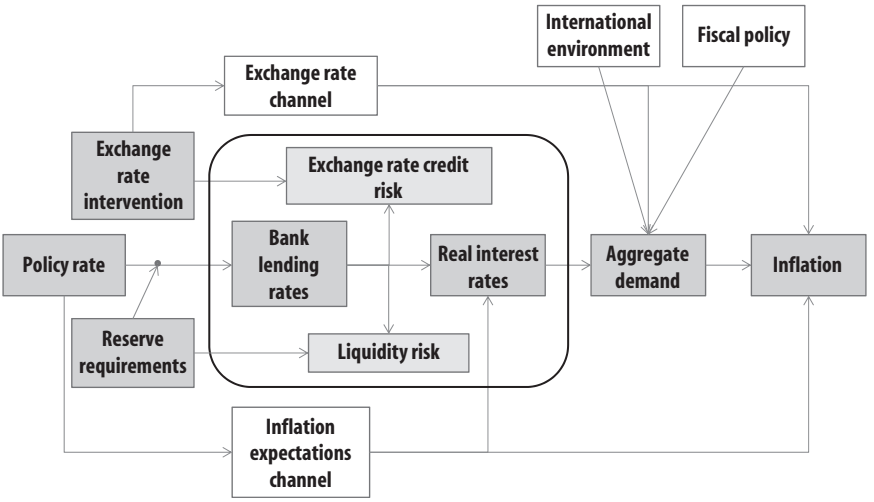
central bank's increased capacity to inject foreign currency liquidity in case of a sudden capital flight.

This policy framework has proved to be effective in dampening financial risks, despite the high degree of financial dollarization. In contrast to the Russian crisis, when a sudden stop in capital flows triggered a credit crunch, during the 2008 sudden-stop episode, the central bank was better prepared: high international reserves and higher reserve requirements allowed a massive injection of liquidity to the system and prevented another credit crunch.[3]

Figure 3 illustrates how the use of unconventional monetary policy tools complements the use of the short-term interest rate. Exchange rate market interventions aimed at dampening excess exchange rate volatility limit the probability of systemic risk associated with sharp exchange rate depreciations, whereas the use of high and cyclical reserve requirements in foreign

3. Castillo and Barco (2009) evaluate Peru's policy responses during the Russian crisis. See also León and Quispe (2010) for a detailed account of the central bank's response to the global financial crisis.

FIGURE 3. Peruvian Monetary Policy Framework



currency contributes to curbing systemic liquidity risks associated with financial dollarization.

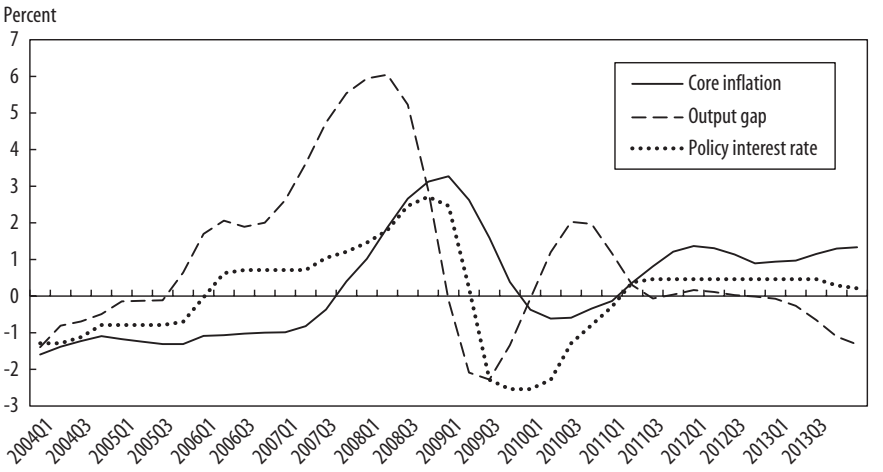
Standard Interest Rate Setting under Peruvian Inflation Targeting (2002–12)

The operational target of monetary policy is the short-term interest rate. This operational target is used by the central bank, as it is by any other inflation-targeting central bank, to communicate the stance of monetary policy to the market. During periods of high inflation or a large output gap, the central bank tends to increase its policy interest rate to fight inflationary pressures; conversely, when inflation is below the central bank target and the output gap is negative, the central bank tends to cut its policy rate.

However, in the case of a financially dollarized economy, interest rate setting also has to take into account how financial dollarization affects the transmission of monetary policy. The central bank addresses this issue by using a quarterly inflation forecasting model that explicitly takes into account the impact of dollarization on credit market conditions and on the dynamics of the exchange rate and inflation.[4] In this model, dollarization reduces the impact of monetary policy on inflation and the output gap, since a large

4. Winkelried (2013).

FIGURE 4. The Pace of the Monetary Policy Interest Rate[a]



a. All variables are demeaned.

depreciation not only generates a typical positive impact on exports, but also triggers a negative impact on the financial position of firms that have currency mismatches. Thus, with financial dollarization, the typical expansionary effect of the exchange rate channel of monetary policy after a policy easing is muted. Additionally, the inflation forecasting model takes into account the impact of both changes in reserve requirement and exchange rate market interventions on the dynamics of interest rates and the exchange rate.

Figure 4 shows the evolution of the policy rate, the output gap, and core inflation since 2004. As shown, the policy rate has actively responded to the evolution of both inflation and the output gap. This has been particularly true during episodes of important changes in indicators such as core inflation and inflation expectations.

Estimates of the policy rule for the period 2002–09 show that this rule not only satisfies the Taylor principle, but also indicates that the central bank gives greater weight to reducing inflation volatility than output gap volatility. Estimates show that the interest response to inflation is close to 1.9 and the response to output is close to 0.5.[5] To the extent that changes in reserve

5. Salas (2011). These values correspond to the mode of the posterior distribution of the parameters. The corresponding confidence intervals located these parameters between 1.23 and 2.40 for the interest rate response to core inflation and between 0.30 and 0.60 for the output gap.

requirements affect money and credit conditions, the setting of the short-term interest rate also takes into account the level of reserve requirements and the estimated impact of foreign exchange market interventions.[6]

Two episodes clearly highlight the active response of the central bank to changes in expected inflation and the output gap. The first began in July 2007, when the central bank raised interest rates in response to a persistent rise in inflation. During that period, the central bank increased its reference interest rate eight times, for a total increase of 200 basis points, from 4.5 to 6.5 percent. The second period followed the Lehman Brothers collapse, when the central bank cut the policy interest rate aggressively from 6.5 to 1.25 percent in six months. The interest rate cuts were effective not only in reducing interest rates in the money market, but also in decreasing interest rates in the rest of the financial system. For example, the average interest rate on loans up to 360 days fell from 15.5 to 11.1 percent from January to December 2009.

The Use of Reserve Requirements by the Central Bank

The central bank uses reserve requirements mainly for monetary control, the mitigation of dollarization risks, and the lengthening of the maturity of the banking system's external leverage. This section addresses each of these issues in turn and then briefly reviews the use of reserve requirements in other Latin American countries.

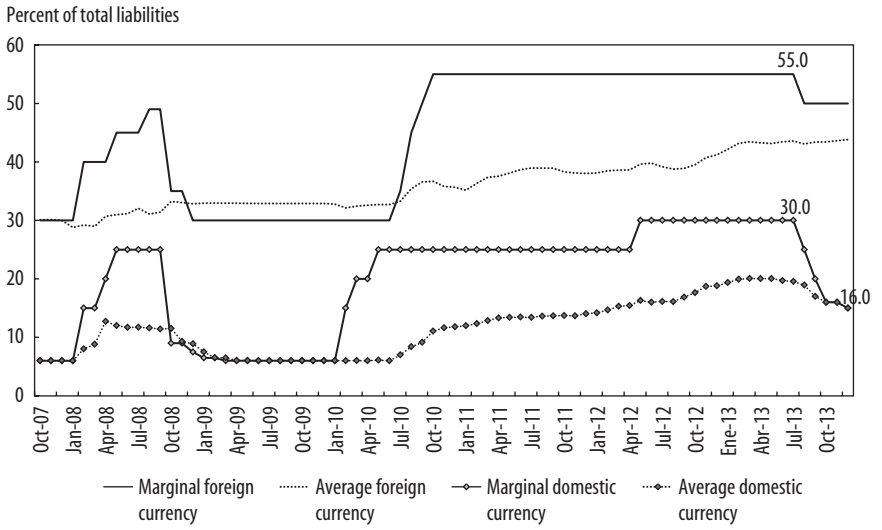
Monetary Control

Before the international crises, there was no major role for reserve requirements as a monetary tool in mainstream monetary policy and theory. As Bindseil describes, "Complex systems with an impressive number of differently treated reserve base categories were created, and in some years reserve ratios were changed at a high frequency. Today, these functions of reserve requirements are no longer taken for granted, like most other doctrines of the monetary control era. Instead, there is consensus that the main purpose of reserve requirements is the stabilization of short-term interest rates."[7] Unconventional instruments such as reserve requirements have been used in Peru since the 1990s to preserve the transmission channels of monetary policy and

6. Salas (2011) explains how the semi-structural quarterly inflation forecasting model incorporates foreign exchange intervention.

7. Bindseil (2003, p. 202).

FIGURE 5. Reserve Requirements in Domestic and Foreign Currency[a]



a. As a percent of total liabilities subject to reserve requirements.

prevent systemic risks associated mainly with exchange rate mismatches and liquidity risks created by financial dollarization.

The scope and use of reserve requirements have changed in recent years. Before the adoption of inflation targeting and in response to high financial dollarization, reserve requirements were higher for foreign currency obligations than for domestic currency obligations (see figure 5). Differential rates seek to encourage banks to internalize the risk of granting dollar-denominated loans to economic agents that do not generate dollar income and to create a foreign exchange liquidity buffer to reduce systemic liquidity risks, given that the central bank cannot act as a lender of last resort in foreign currency. During this period, reserve requirements were not used cyclically and only targeted domestic sources of bank funding.

In recent years, the central bank has used reserve requirements as a complementary tool to its short-term interest rate. As such, it has helped to break the trade-off between macroeconomic and financial stability. In particular, the reserve-requirement-induced quantitative tightening dampened the expansionary effects of capital inflows on domestic credit conditions and, through this channel, also reduced the output gap and inflationary pressures. This quantitative-tightening effect on the output gap implies that the policy

rate may not need to rise as much.[8] Therefore, the use of quantitative tightening under persistent capital inflows is analogous to a fiscal policy tightening that also allows a lower monetary policy rate and a less-appreciated domestic currency, and as such, it introduces a new dimension in the policy mix, one that also has to take into account the relationship between reserve requirements and policy rates.

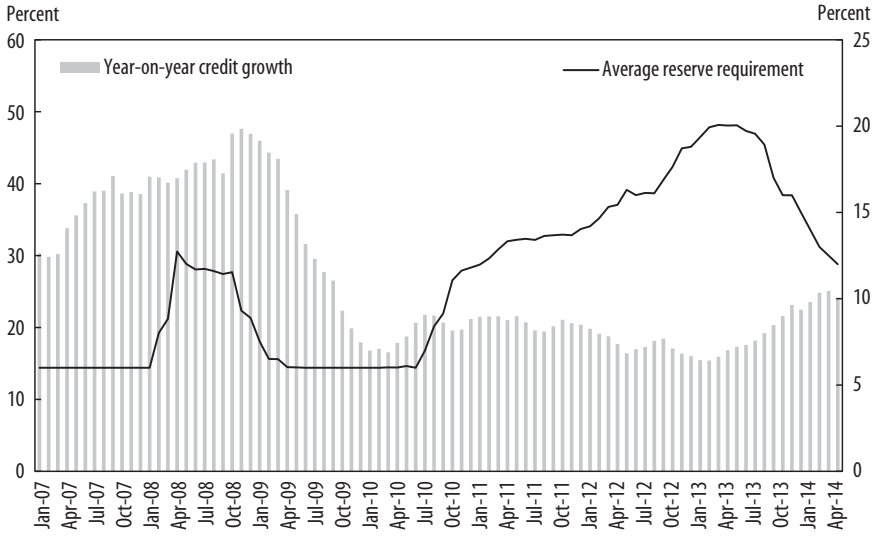
Additionally, under massive capital inflows or very low international interest rates, financial dollarization strengthens the spillover from expansionary international monetary conditions to the domestic financial system, which weakens domestic monetary policy. This is so because the demand for credit switches toward foreign currency credit. Under these conditions, higher reserve requirements on dollar liabilities contributes to tempering this spillover effect of international financial conditions on domestic markets and therefore strengthens the transmission of domestic interest rate policy.

The use of reserve requirements also contributes to monetary policy effectiveness. In credit market segments where the risk premium is high, lending interest rates are less sensitive to the policy rate, whereas changes in reserve requirements, which operate through changes in net interest margins, have a bigger impact on lending rates.

Countercyclical reserve requirements can help to offset credit expansion by reducing the amount of the bank's loanable funds as a share of total bank assets. When the industrialized world hit the zero lower bound for interest rates, it resorted to quantitative easing and Operation Twist in the United States and the massive injection of liquidity in Europe. The resulting massive capital inflows to emerging economies brought about new macroeconomic and financial stability challenges. This time, the preemptive use of unconventional tools by the Central Bank of Peru helped to bring about a smoother credit cycle compared to the 2007–08 episode (see figures 6 and 7). The use of unconventional policy instruments such as reserve requirements and foreign exchange market intervention not only helped mitigate the foreign-currency-induced credit risk and liquidity risk that financial dollarization creates, but also contributed to breaking the trade-off between reducing domestic demand pressures and attracting capital flows. The trade-off occurs when the policy rate is increased to face domestic demand pressures amid episodes of strong capital flows.

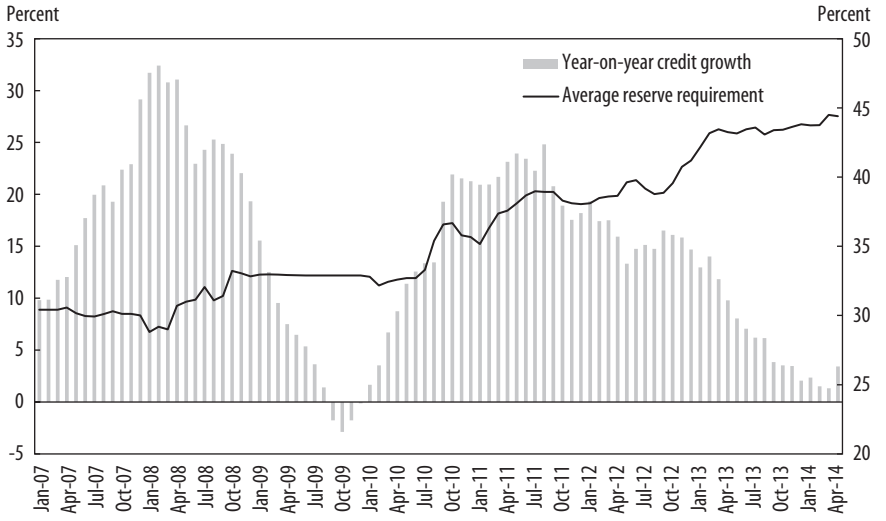
8. As Vargas and Cardozo (2012) note, the combination of interest rate and reserve requirement policy is part of an optimal policy framework. Furthermore, Glocker and Towbin (2012) show that when reserve requirements can achieve financial stability, the interest rate can more effectively address the inflation and output gap mix.

FIGURE 6. Banking System Credit in Domestic Currency to the Private Sector and Average Reserves[a]



a. Left axis measures credit growth; right axis measures reserve rate.

FIGURE 7. Banking System Credit in Foreign Currency to the Private Sector and Average Reserves[a]



a. Left axis measures credit growth; right axis measures reserve rate.

An increase in the reserve requirement rate implies that banks have to raise liquid assets to meet the new policy requirement. This tends to reduce the growth rate of credit, particularly when banks cannot substitute liabilities subject to reserve requirements for other sources of funding, like long-term foreign liabilities.[9] The largest impact is on small financial institutions with limited access to the international financial markets, like *cajas municipales* and *cajas rurales.*

Thus, by increasing reserve requirements during episodes of capital inflows and credit expansions, the central bank seeks to reduce the probability of liquidity stress scenarios in the financial system. Higher reserve requirements lead private banks to increase the availability of liquid assets, which also reduces their capacity to expand credit, particularly in foreign currency. Hence, reserve requirements generate buffer stocks of liquidity in both domestic and foreign currency.

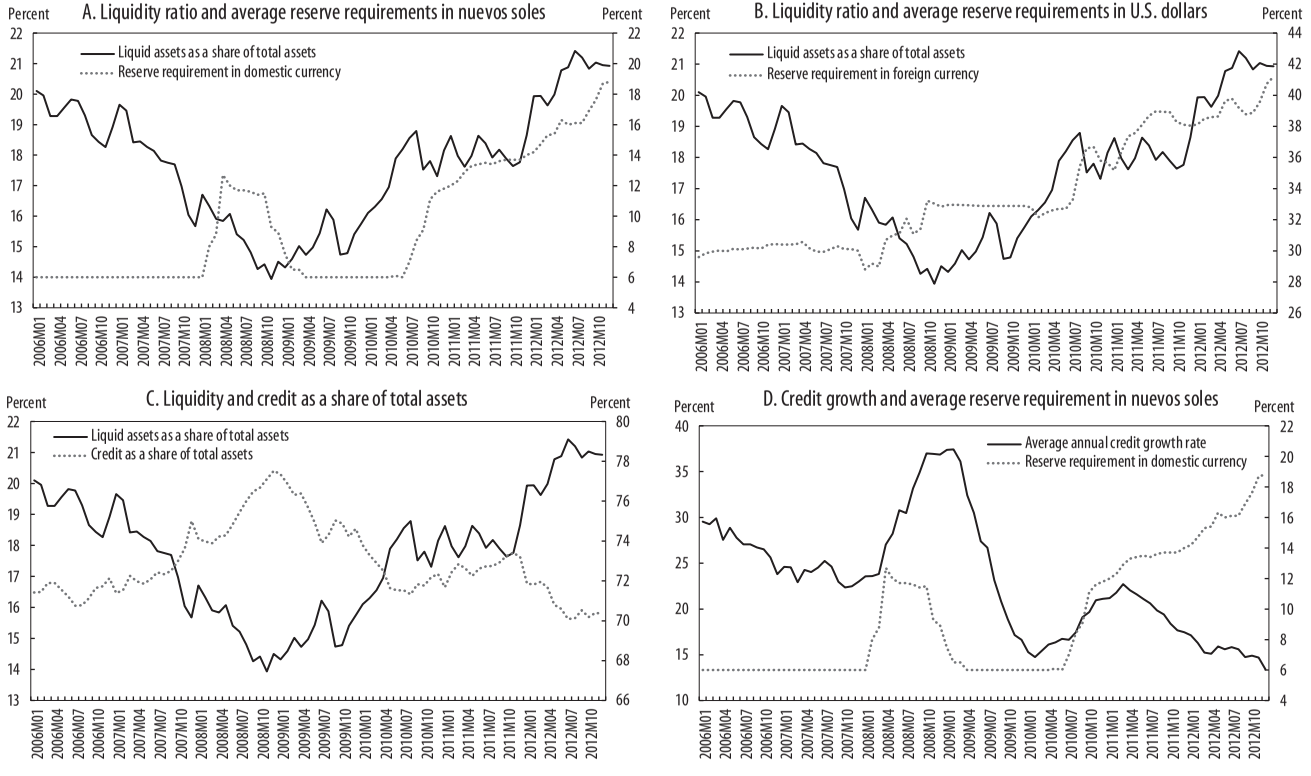
As figure 8 shows, the *cajas municipales* responded to the increase in reserve requirements between December 2009 and December 2012 by increasing their liquid assets and reducing the ratio of credit to total assets as well as credit growth. During this period, the central bank increased both marginal and average reserve requirements. The marginal rate for domestic currency deposits was raised from 6 to 25 percent, while the marginal rate for foreign currency deposits was increased from 30 to 55 percent. Average reserve requirement rates for domestic currency deposits were raised seven times, for a total increase of 3.25 percentage points. As a consequence, the credit growth rate in *cajas municipales* fell from 22 to 9 percent during this period. This episode illustrates the main mechanism whereby reserve requirement policy impinges on credit. The reserve requirement rate for foreign currency deposits was increased ten times (for a total of 3.75 percentage points).

The quantitative effect of this mechanism depends on the duration and the intensity of increases in reserve requirements and the way the policy is implemented. Figure 8 also shows a different behavior of credit and liquid assets in 2007 and 2008, when credit growth accelerated and liquid assets decreased despite the increase in reserve requirements. During this period, the increase in reserve requirements was much milder and short-lived than the rises observed since 2010, which reduced the effectiveness of reserve requirements.[10] Moreover, the increase in reserve requirements was implemented only through increases in marginal rates and not through increases in the average rate. This distinction is important because an increase in the average reserve

9. In Peru, long-term foreign liabilities are not subject to reserve requirements up to a limit of 2.2 times the bank's net worth.

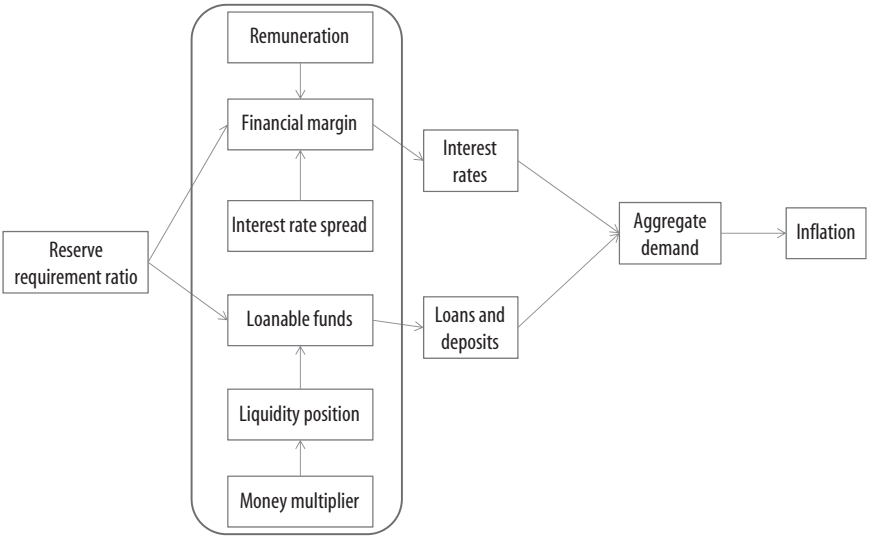
10. See also Céspedes, Chang, and Velasco (2012) for an account of this specific episode.

FIGURE 8. Credit, Liquid Assets, and Reserve Requirements at *Cajas Municipales*[a]



a. Information corresponds to the simple average of the thirteen *cajas municipales* for each variable. Credit and liquid assets were obtained from the balance sheet statements published by the Superintendency of Banks and Insurance (SBS).

FIGURE 9. The Transmission Mechanism of Changes in Reserve Requirement Ratios



requirements has a stronger impact on bank credit supply than an increase in the marginal rate because the former is not contingent on the growth of bank deposits, as are marginal reserve requirements.[11] This implies that when the central bank increases average reserve requirements, banks have to increase their levels of liquid assets even when deposits are not increasing.

THE TRANSMISSION MECHANISM. Reserve requirements affect money and credit conditions through a number of channels. Here we describe a simple mechanism.[12] As figure 9 shows, reserve requirements first aim at reducing financial entities' primary loanable funds. Lower loanable funds imply lower liquidity and credit, which in turn has an impact on aggregate expenditure and inflation. This mechanism is more effective when the balance of liquid assets held by financial entities is low. Second, higher reserve requirements reduce banks' financial margins, which banks will seek to preserve by widening the spread between lending and deposit rates.[13] They can achieve this by raising

11. Tovar, García-Escribano, and Vera Martin (2012) provide empirical evidence of the effectiveness of average over marginal reserve requirements.

12. More structural models are laid out in Glocker and Towbin (2012) and Carrera and Vega (2012). These two papers study reserve requirements in the presence of financial frictions and how these requirements interact with standard monetary policy management.

13. León and Quispe (2010); Montoro and Moreno (2011).

lending rates, reducing deposit rates, or both.[14] Higher market interest rates cause economic agents to cut back their expenditures, thereby attenuating inflationary pressures.

Regarding empirical evidence, there is virtually no reference to Peru before 2008, since reserve requirements were not an active monetary policy tool. When the central bank started to use reserve requirements actively, the initial approach was to calibrate the impact of reserve requirements through an accounting procedure that operated through banks' financial margins.[15] The prior was that the demand for credit was relatively inelastic to changes in the interest rate, mainly for small and medium-size firms. Additionally, it was clear that the effectiveness of the reserve requirement tool would depend on the degree of substitute liquid assets or external funding from foreign financial institutions. Data for 2008–12 show that this prior was not far from actual figures. The inflation-forecasting model assumes that changes in this instrument increase bank lending rates. The estimated impact of a 1.0 percent rise in the average reserve requirement rate is about 0.3 percent on average lending rates denominated in domestic currency and 0.1 percent on lending rates denominated in foreign currency. The low pass-through from reserve requirements to foreign currency lending rates is explained by the larger set of alternative sources of funding available to corporate firms in foreign currency.

In practice, the implementation of monetary policy within a dual currency economy requires not only forecasting inflation conditional on the policy rate instrument, but also making continuous assessments of the risks and vulnerabilities associated with financial dollarization under the baseline scenario. Unconventional policy instruments are then set to curb those risks. For instance, if the baseline scenario assumes a period of capital inflows and persistent low international interest rates, then the two resulting risks are a rapid expansion of dollar loans and more intensive use by local banks of short-term liabilities with foreign banks. In this case, a rise in reserve requirements on foreign currency liabilities is also considered a policy option in the baseline scenario.

Mitigation of Dollarization Risks

The international financial crisis intensified the discussion on the importance of unconventional policies as tools to prevent systemic risks and preserve financial stability. In developed economies, financial asset prices, such as

14. Reinhart and Reinhart (1999); Terrier and others (2011).
15. León and Quispe (2010).

stocks and bonds, are an element in the policy transmission mechanism. In contrast, emerging economies' shallow capital markets limit the role of financial asset prices in monetary policy transmission. In this group of economies, the most important asset price is the exchange rate. This is particularly the case in financially dollarized economies such as Peru.

Financial dollarization generates systemic risk on at least two crucial dimensions: first, because it reduces the capacity of the central bank to act as a lender of last resort, financial dollarization increases the likelihood of a liquidity shortage in the financial system; and second, since banks lend in foreign currency to nontradable firms, financial dollarization also creates currency mismatches, which amplify foreign-currency-induced credit risk. A common feature of these two additional sources of financial vulnerability is that both generate negative externalities that justify policy intervention. They can also trigger potential nonlinear dynamics with undesirable consequences for financial stability, which support the use of precautionary policy actions.

Reserve requirement policy is one such key preventive action. One way to rationalize reserve requirement policy is to consider it as a financial intermediation tax. This line of reasoning dates back as far as Keynes, who describes reserve requirements as a tax-type tool and sympathized with it:

> The custom of requiring banks to hold larger reserves than they strictly require for till money and for clearing purposes is a means of making them contribute to the expenses which the central bank incurs for the maintenance of the currency. . . . For we ought to be able to assume that the central bank will be at least as intelligent as a member bank and more to be relied on to act in the general interest. I conclude, therefore, that the American system of regulating by law the amount of the member bank reserves is preferable to the English system of depending on an ill-defined and somewhat precarious convention.[16]

Similar to the optimal taxation approach, the appropriate design and calibration of reserve requirements must identify the externalities and distortions produced by financial intermediation and specify how these externalities and distortions can be reduced with the use of this policy instrument.

LIQUIDITY RISK AND LENDER OF LAST RESORT IN FOREIGN CURRENCY. The key externality at play with financial dollarization is a nonpecuniary one that was common before the creation of central banks on the continent. When banks intermediate in foreign currency, they do not take into account the fact that they are operating under a system without a lender of last

16. Keynes (1930, p. 70).

resort in that currency. Banks assume that when they need foreign currency liquidity, they will be able to obtain it from the interbank market (local or international) at the market interest rate, which is related to the policy rate of the central bank that issues the foreign currency. This may not be possible, however, particularly if all banks experience the same type of liquidity shortage.

This was the case in Peru during the 1998 Russian crisis. This shock triggered a sudden stop of capital flows and quickly damaged banks' foreign currency positions, particularly for banks that had heavily borrowed short-term funds from the international financial system. During this episode, banks were not able to obtain foreign currency liquidity even at very high short-term interest rates. Consequently, several banks suddenly had to curtail credit. The average local interbank rate in dollars was 8.0 percent in July 1998 (240 basis points over the one-month LIBOR) and soared to 12.9 percent in October (760 basis points over the one-month LIBOR). Reserve requirements on foreign currency deposits can help take the edge off sudden stops. During the financial crises in the late 1990s, contingent monetary policy that emphasized providing international liquidity to the financial system to ease financial distress was fundamental in diminishing the impact of the sudden stop.[17]

Thus, under financial dollarization, preventive policy is necessary because private banks hold too little foreign currency liquidity. Higher reserve requirements on foreign currency liabilities, together with the accumulation of international foreign reserves, contribute to reducing the adverse impact of this externality.

Historically, financial systems operated without a lender of last resort in the nineteenth and early twentieth centuries, when bank runs were frequent around the world. In the United States, the National Bank Act of 1863 required banks to keep a 25 percent reserve against deposits, but the role of reserve requirements decreased after the creation of the U.S. Federal Reserve in 1913.[18]

Reserve requirements on foreign currency liabilities fulfill three functions that help deal with financial distortions. First, reserve requirements signal financial intermediaries that foreign currency liabilities are riskier than their domestic currency counterparts, thereby fostering the internalization of dollarization risks. By setting higher reserve requirement rates on foreign currency liabilities, the central bank increases the cost of providing foreign

17. Castillo and Barco (2009).
18. Goodfriend and Hargraves (1983).

currency loans, which reduces banks' incentives to intermediate in foreign currency, particularly in credit market segments where borrowers have few alternative sources of funding.

Second, reserve requirements reduce the likelihood of bank runs because economic agents realize that the banking system has a large pool of foreign-currency-denominated liquid assets. Reserve requirements on foreign currency deposits amount to about 20 percent of total international reserves, 50 percent of total foreign currency credit, and 44 percent of overall liabilities subject to reserve requirements.

Finally, reserve requirements increase the amount of international liquidity in the financial system when necessary. This level of liquidity allows the central bank to act as lender of last resort in foreign currency by providing it whenever it is needed. By cutting reserve requirements, a central bank can inject liquidity into the financial system and reduce the pressure on the interest rate.

CREDIT RISK FROM CURRENCY MISMATCH. The existence of a currency mismatch on the balance sheet of domestic agents generates an externality to the financial system because agents either do not properly internalize the foreign-currency-induced risk or engage in moral hazard behavior. Even nontradable firms that set prices in foreign currency do not realize that the nature of the mismatch is real. In other words, a negative shock to the economy that depreciates the real exchange rate increases the real debt of the nontradable firm (by reducing the net present value of cash in dollars).

Another externality operates through the payment system. By taking dollar-denominated loans, an individual firm increases its default risk. However, it also increases the default risk of other firms that are linked to the first firm through the payment system. Banks do not properly internalize the complex linkages among firms and therefore do not charge the proper risk premium when granting dollar-denominated loans to firms in the nontradable sector. In this case, a sharp and unexpected depreciation of the exchange rate can trigger negative balance-sheet effects that spill over across the payment system to a large set of firms, unduly affecting the credit quality of bank assets.

In a financially dollarized economy, systemic risk is generated not only by a sharp depreciation of the domestic currency, but also by a persistent appreciation. A persistent appreciation of the domestic currency reduces the real value of firms' debt, and it may also generate expectations of further appreciation. Firms may then perceive that borrowing in foreign currency is cheaper, leading them to increase their currency mismatches and, through this channel, the cost of a sudden exchange rate reversal.

Therefore, policy actions such as additional provisioning for dollar-denominated loans, higher reserve requirements for foreign currency liabilities, and foreign exchange intervention to smooth exchange rate fluctuations contribute to dampening this type of credit risk.

Lengthening the Maturity of Banks' External Leverage

Higher reserve requirements on both external short-term foreign currency liabilities and foreign currency deposits not only increase the cost of dollar-denominated loans, but also cause banks to lengthen the maturity of their external liabilities and to increase the availability of international liquidity. In 2007, the central bank extended the use of reserve requirements to banks' short-term foreign liabilities.[19] As a result, banks had the incentive to lengthen the maturity of their foreign currency liabilities, which reduced their vulnerability to sudden stops of capital inflows. Currently, a 50 percent special reserve requirement is in place for local banks' obligations to foreign banks with maturities of less than two years. Moreover, banks increased the average maturity of their foreign liabilities from two years in 2007 to four years in 2009. This special reserve requirement has also been used cyclically. The central bank raises its level in periods of abundant capital inflows and reduces it in response to capital outflows.

Crucially, after the collapse of Lehman Brothers, the limited exposure to sudden stops of capital inflows allowed local banks to maintain their supply of credit, which limited the impact of this shock on the local financial system. More recently, short-term capital inflows and firms' and banks' foreign liabilities, particularly bonds, have gained share in the capital account as a result of greater international financial integration and historically low world interest rates.[20] To limit overborrowing, the central bank set an additional reserve requirement on long-term foreign liabilities and bonds (i) when the stock of these liabilities exceeds 2.2 times a bank's net worth and (ii) when credit growth in foreign currency exceeds a particular limit established by the central bank. Finally, in 2013, the central bank set additional reserve requirements for financial institutions that grant foreign currency loans above specified prudential limits, with the aim of reinforcing credit dedollarization.

19. In 2004, the central bank extended the use of reserve requirements to banks' foreign liabilities.

20. Short-term capital inflows include nondeliverable forward operations with nonresident investors and purchases of public debt instruments denominated in domestic currency.

A Brief Comparison with Other Latin American Countries

In addition to the Central Bank of Peru, other inflation targeters in Latin America, such as Colombia and Brazil, have been very active in using reserve requirements as a prudential tool. The common reasons for using reserve requirements are to smooth credit growth, particularly during periods of persistent capital inflows, or to sterilize part of the monetary expansion resulting from international reserve accumulation. For instance, Colombia adopted changes in reserve requirements before the global financial crisis in order to limit credit growth and reinforce the transmission mechanism of changes in the interest rate.[21] Changes in reserve requirements involved increasing marginal and average rates for checking accounts, demand deposits, savings accounts, certificates of deposit (CDs), and bonds with a maturity of less than eighteen months. Reserve requirement remuneration rates were also reduced during this period. Thus, average reserve requirements for deposits were increased from 8.3 percent in June 2007 to 11.5 percent in June 2008, whereas reserve requirements for CDs and bonds with a maturity of less than eighteen months were increased from 2.5 to 6.0 percent in the same period. The marginal reserve requirement for savings accounts was raised from 12.5 percent to 27.0 percent in June 2007. Subsequently, reserve requirements were reduced in 2008 to boost bank liquidity and to limit the impact of the global financial crisis in the Colombian financial system. The Central Bank of Colombia has not actively used reserve requirements since 2010.

The Central Bank of Brazil has used reserve requirements not only to tame credit cycles, but also to stimulate the distribution of liquidity from large banks to smaller institutions, by partially exempting large banks from reserve requirements if they purchase assets from smaller banks. The Brazilian Central Bank has also used reserve requirements to reallocate credit among economic sectors, by making it compulsory for financial institutions that benefit from reductions in reserve requirements to extend rural credit. Since 2010, the central bank has tightened average reserve requirements in conjunction with other macroprudential tools, and in December 2011, it decreased the remuneration on time deposits and encouraged large banks to purchase small bank assets using the reserves associated with time deposits.

Brazil, Colombia, and Peru have all used reserve requirements as a complementary tool for the short-term interest rate, either to curtail a rapid credit

21. Vargas and others (2010).

expansion in scenarios of persistent capital inflows or to provide liquidity during periods of capital outflows, such as during the recent global financial crisis. Each country has used reserve requirements more actively in market segments where short-term interest rates are less effective. For example, Colombia increased reserve requirements in 2007 to strengthen the transmission mechanism of the short-term interest rate, during a period of rapid credit expansion. Peru has used reserve requirements to encourage banks to internalize the risk of financial dollarization and to reduce banks' incentives to take foreign short-term debt, whereas in Brazil, the objective was to redistribute liquidity from large to small banks in flight-to-safety scenarios in the money market. By reducing the risk of financial distress, reserve requirements have contributed to preserving the transmission mechanism of monetary policy and heightening effectiveness of the policy response of the central banks that have actively used this instrument in recent years.

Measuring the Effects of Reserve Requirements

In this section, we evaluate specific reserve requirement policy moves in terms of the direct outcomes outlined in the previous section. Especially, we aim to find the effect on interest rates and credit levels of reserve requirement policy applied to both domestic and foreign currency bank liabilities.

The Counterfactual Approach

Our counterfactual approach hinges on finding a policy effectiveness statistic based on a counterfactual policy evaluation.[22] A policy move generates an observed outcome that is compared to an unobserved counterfactual representing a policy-off scenario. For the approach to work, we need a period in which the policy has been off and a period in which the policy has been on. We identify specific policy episodes where this has actually been the case. The key assumption is that the policy change is due to an ad hoc change in the level of the policy instrument and not the result of a structural change in the policy parameters.

The counterfactual values after the policy change can be obtained from a conditional forecast generated by a reduced-form equation. The key point demonstrated by Pesaran and Smith is that we need only find impact effects

22. Our approach follows Pesaran and Smith (2012).

to perform the forecast, and those impact effects can be obtained by running a reduced-form regression that links outcomes to policy only and controls invariant to policy.[23] Pesaran and Smith's key insight is the demonstration that controls that are affected by policy do not need to be included.

Following Pesaran and Smith, the reduced-form equation can have the following form:[24]

$$y_t = \pi_1 x_t + \pi_2' \mathbf{W}_t + \upsilon_{yt}, \tag{1}$$

where y_t is an outcome variable, x_t is the policy instrument, and $\mathbf{W}_t$ is a vector of control variables that are invariant to ad hoc policy changes. The parameter π_1 will measure the total effect, which comprises both the direct and indirect impact effects.[25]

Outcomes and Policy Variables

In our policy evaluation exercise, the outcomes are the levels of outstanding credit denominated in domestic and foreign currency, lending, deposit interest rates denominated in both currencies, and the ratio of short- to long-term external bank debt. In terms of the instruments, we need a period in which reserve requirements have been off and then on for a reasonable amount of time. We identify three such episodes: the increase in the marginal reserve requirements for domestic currency deposits from 6 to 25 percent since July 2010; the increase in the marginal reserve requirements for foreign currency deposits from 30 to 55 percent since July 2010; and the increase in the reserve requirements on banks' short-term external debt from 30 to 60 percent since July 2010.[26]

To complete the specification of equation 1, candidates for control variables include first a set of external variables like the federal funds rate, the VIX, the trade-weighted U.S. dollar index, the ten-year U.S. Treasury bond yield, and the slope of the U.S. yield curve. A second set of control variables comprises variables affected mostly by external conditions (the terms of trade, the Emerging Market Bond Index, and domestic primary output)

23. Pesaran and Smith (2012, 2014).

24. Pesaran and Smith (2012).

25. As shown in Pesaran and Smith (2014), the indirect effects are related to the effect of a change in x_t on other regressors.

26. There was an earlier tightening episode from February to May 2008. However, this tightening was quickly reversed after the Lehman collapse, and thus it cannot be used in this exercise.

or by the financial development trend (number of employees and number of branches). The key assumption is that these sets of control variables are invariant to policy changes. To find out more about the invariance of these controls to the relevant policy measures, we performed Granger causality tests using the procedure outlined in Toda and Yamamoto (see tables A-1 to A-3 in appendix A).[27] The tests suggest that only the branches and the number of employees at banks are caused by the policy variables. The rest of the variables are statistically invariant to policy changes in the Granger sense.

The outcome variables are depicted in figures A-1 to A-4 (appendix A). In the equations, credit levels are in logs (figure A-1) and bank lending and deposit rates have two forms. The interest rates can be calculated in terms of the outstanding stock of loans/deposits or can reflect the rates of new loans/deposits granted or received during the month. The latter shows a less persistent pattern than the rates applied to stocks, as depicted in figure A-2. The estimations presented here are based on the interest rates on newly created loans and deposits at banks. Log credit levels at small financial institutions (*cajas municipales*) are shown in figure A-3, specified by type. All credit at *cajas* is denominated in domestic currency. The corresponding interest rates at *cajas* are described in figure A-4.

The policy variables are shown in figure A-5, where the shaded area indicates the period in which the policy variables were changed. Both panels A and B feature the marginal reserve requirement (the policy variable) together with average reserves. There are two important increments in the marginal reserve ratio: the first started in early 2008, but was quickly reverted due to the financial crisis; the second rise started in 2010 and is marked by the shaded area in the graph. We evaluate the second episode because it provides a sufficiently long period in which the marginal reserve requirements were set at a new high level. The three policy variables under evaluation are reserve requirements for nuevo-sol-denominated deposits, reserve requirements for dollar-denominated deposits, and reserve requirements on banks' short-term foreign liabilities.

In the case of reserve requirements for nuevo-sol-denominated deposits, the policy instrument is the marginal reserve requirement and the corresponding outcome variables are the interest rates for nuevo-sol-denominated loans and deposits and credit granted in nuevos soles. For U.S. dollar-denominated deposits, an augmented reserve requirement ratio has to be constructed to account for the fact that banks can more easily substitute this source of

27. Toda and Yamamoto (1995).

funding via external liabilities or bond issues. Hence, an augmented effective reserve ratio is constructed by dividing the amount of U.S. dollar reserves by the sum of augmented U.S. dollar liabilities. Augmented U.S. dollar liabilities include dollar deposits, external debt, and bond issues. Panel B of figure A-5 shows the evolution of this augmented ratio. While the standard reserve requirement measure started to increase in July 2010, this augmented ratio did not change by much in the period under analysis, showing that banks were active in managing their liability portfolio.

Finally, for the case of foreign liabilities, the policy is defined as the level of the reserve requirement to short-term foreign liabilities (see figure A-6).

Estimates of the Policy Impact Effects

Each of these variables is modeled according to equation 1, and given that the outcomes and control variables follow unit root processes, the corresponding equations are estimated via dynamic ordinary least squares (OLS) for cointegrating regressions.[28] Tables B-1 and B-2 in appendix B show the best regression results for each outcome variable. Cointegration tests were run to validate the cointegration equations. In all cases, cointegration cannot be rejected using the Hansen parameter instability test, while the Engle-Granger and the Phillips-Ouliaris tests delivered mixed results. The sample period in all these regressions is January 2003 to December 2012.

The key purpose of these regressions is to estimate the coefficients associated with the total impact effects ($\hat{\pi}_1$, the estimator of π_1 in equation 1). By no means should $\hat{\pi}_1$ be interpreted as the parameter that describes the isolated sensitivity of outcomes to policy when all else is held constant.[29] As described before, $\hat{\pi}_1$ comprises the total impact effect, namely, the direct and the indirect effects from the policy changes affecting other excluded regressors (and thereby affecting the outcome).

In terms of the sign of the estimated impact effects, table B-1 shows that the impact of reserve requirement changes is positive for loan rates but negative for deposit rates and credit levels. These results are expected in terms of the views outlined earlier in the paper. To make inferences about the total impact

28. The unit root tests applied were the augmented Dickey-Fuller, the detrended Dickey-Fuller using generalized least squares (GLS) (Elliott-Rothenberg-Stock), and the Phillips-Perron. All the tests rejected the null hypothesis for the FTIPM variable, so this is the only variable that is modeled in first-difference form. Results of the unit root tests are available on request.

29. To estimate a sensitivity parameter given all variables (the ceteris paribus case), we would need a standard design incorporating key control variables, irrespective of whether they are invariant to policy.

effect, we cannot rely on the *t* ratio reported by the regression, but rather need to make an adjustment along the lines of Pesaran and Smith.[30] We do not pursue inference on the impact effect here, but on the counterfactual evaluation.

In table B-2, the estimated impact effects do not all coincide with our expectations. A rise in required reserves should increase lending rates, decrease deposit rates, and reduce lending activity, but in two cases we obtain opposite total impact effects: long-term deposit interest rates at *cajas municipales* increase when the reserve requirement increases, and the short-term interest rate for consumer credit at *cajas municipales* falls when the reserve requirement increases.

Counterfactual Forecasts

The next step in the methodology is to run forecasts conditional on the policy change not being applied (the counterfactual). The forecast runs from July 2010, which is when the reserve requirement increases took place, to December 2012. In this exercise, the marginal reserve requirement for domestic currency deposits is kept at 6 percent, the rate for dollar deposits is kept at 30 percent, and the reserve requirement on banks' short-term external debt is kept at 30 percent.

Figures C-1 and C-2 in appendix C present the comparison of these counterfactual forecasts and the realized outcomes for large banks and small *cajas municipales,* respectively. For example, in figure C-1, the counterfactual forecast outcome is mostly below the realized outcome. This means that the rise in reserve requirements affected loan interest rates in domestic currency upward in large banks, as expected. But how far apart should the counterfactual and realized outcomes be to have a better understanding of the statistical significance of the policy change? We address this question using the inference tool outlined in Pesaran and Smith.[31]

RESULTS OF THE COUNTERFACTUAL POLICY EVALUATION. The simple question we aim to answer is what would have happened to credit levels and interest rates if the reserve requirement increases had not occurred. To find the answer, we only need to take the difference between the realized outcomes and the counterfactual forecasts. Analytically, the mean difference boils down to

$$\hat{d}_H = \hat{\pi}_1 \left[\frac{1}{H} \sum_{h=1}^{H} \left(x_{T+h} - x_{T+h}^0 \right) \right], \tag{2}$$

30. Pesaran and Smith (2014).
31. Pesaran and Smith (2012).

where $\hat{\pi}_1$ is the estimated policy impact effect, H is the number of periods the specific level of policy tightening has been effective, x_{T+h} represents the observed policy trajectory from period T on, and x^0_{T+h} is the counterfactual policy trajectory from period T on. The number of periods the policy stance lasted is $H = 22$ months.[32]

Next, Pesaran and Smith propose a policy-effectiveness test statistic given by[33]

$$P_H = \frac{\hat{d}_H}{\hat{\sigma}_{v_y}} \sim^a N(0,1) \tag{3}$$

where $\hat{\sigma}_{v_y}$ is the standard error of the policy reduced-form regression. Namely, if the mean effect $\hat{d}_H$ is relatively large compared with the standard error of the forecasting equation, then it is likely that the policy effect is significant.

Our objective is to make inference about policy effectiveness, for which we rely on estimating the total impact effect of three types of reserve requirement changes over sixteen outcome values (interest rates and lending levels). All the estimated mean effects according to equation 2, together with their policy effectiveness statistic and p values, are depicted in table 1. This table contains the main empirical results of the paper.

The effect of the reserve requirement changes in 2010 in general increased lending interest rates and reduced deposit rates. The effect on bank interest rates implies that an increase in reserve requirements causes banks' interest rate spreads to widen, as described earlier and consistent with the general effects expected in the literature.[34]

Furthermore, there is evidence that the effect on credit works as expected, though it is statistically less significant. For banks, only lending denominated in nuevos soles was strongly affected. In the case of *cajas,* only mortgage credit seems to have been statistically different from its counterfactual. These results on the effects on credit levels are also compatible with Dancourt, who performs panel regressions with credit levels at banks and *cajas* using interest rate policy and reserve requirements in addition to standard control variables.[35]

32. On May 2012, the central bank engaged in another round of reserve requirement measures.

33. Pesaran and Smith (2012).

34. For example, Reinhart and Reinhart (1999); Montoro and Moreno (2011); Terrier and others (2011).

35. Dancourt (2012).

TABLE 1. Policy Effectiveness Statistics

Outcome	*Mean effect*[a] ($\hat{d}_H$)	*Policy-effectiveness statistic* (P_H)	*p value*	*Expected sign*
Bank lending rates in domestic currency	0.1	6.47	0.00	yes
d(Bank deposit rates in domestic currency)	−0.0	−0.02	0.49	yes
Bank lending rates in U.S. dollars	0.6	1.57	0.06	yes
Bank deposit rates in U.S. dollars	−0.4	−0.65	0.26	yes
Bank lending in nuevos soles	−19.0	−3.79	0.00	yes
Bank lending in U.S. dollars	−0.8	−0.49	0.31	yes
Banks' short-term external debt over total external debt	−30.0	3.20	0.00	yes
Cajas short-term interest rate to microenterprises	2.8	2.85	0.00	yes
Cajas long-term interest rate to microenterprises	1.3	1.24	0.11	yes
Cajas short-term interest rate for consumer credit	−0.6	−0.41	0.34	no
Cajas long-term interest rate for consumer credit	3.7	5.14	0.00	yes
Cajas short-term interest rate for deposits	−0.2	−0.65	0.26	yes
Cajas long-term interest rate for deposits	1.1	2.98	0.00	no
Cajas consumer credit	0.9	0.97	0.17	no
Cajas credit to small firms	−0.9	−0.30	0.38	yes
Cajas mortgage credit	−44.2	−12.28	0.00	yes

Source: Authors' calculations, following Pesaran and Smith (2012).
a. Mean effects are in percentage points.

In terms of bank rates, the effect is stronger on bank lending rates than on bank deposit rates. The effect on interest rates at *cajas* is mixed. Lending interest rates to microenterprises were more affected by the policy change, while other interest rates at *cajas* have the correct sign but are statistically weak or have the opposite sign.

The last empirical result presented here relates to the increase in required reserves for banks' short-term external liabilities. The evidence indicates that this policy action produced a shift in banks' external debt toward long-term maturities and away from short-term debt.

Conclusions

Unconventional policy tools, such as reserve requirements, are being used actively by many central banks in emerging market economies. The evidence provided by the Peruvian experience shows that this policy instrument is an effective tool to reduce the trade-offs that expansionary monetary policies in developed economies are creating in emerging market financial systems. In particular, reserve requirements can dampen the credit cycles in periods of capital inflows and reduce their expansionary effects on domestic aggregate

demand. Additionally, when reserve requirements are applied to foreign currency bank liabilities, they can contribute to increasing the availability of international liquidity in the financial system and thus help to reduce the impact of capital outflows on the domestic financial system.

The paper performs counterfactual exercises following Pesaran and Smith to quantify the effect of a marginal reserve requirement tightening that spanned the period from July 2010 to April 2012.[36] The effects are measured in interest rates and credit levels.

As with any other form of tax, reserve requirements generate efficiency costs, which can affect the degree of financial system development. However, when financial frictions pervade, these costs are of second-order magnitude compared with the benefits of an active use of reserve requirements that reduces the probability of a financial crisis. In that sense, the calibration of reserve requirements needs to take into account these costs to define both the magnitude and the duration of these types of unconventional policy instruments.

In economies like Peru, where domestic capital markets are not well developed, reserve requirements can also speed up the development of these markets by increasing the cost of financial intermediation through the banking system. However, they could also increase the incentives for firms to use more external funding.

These costs can be reduced by spreading the burden of prudential regulation among a larger set of instruments, such as cyclical capital requirements, dynamic provisioning, and, in the case of financially dollarized economies, additional capital requirements for loans in dollars. The central bank has to continuously assess the efficacy of reserve requirements as prudential instruments and reverse them when necessary. For instance, reserve requirements on short-term bank liabilities were reduced in 2012 for those liabilities oriented to finance trade operations to avoid the substitution of banking credit by off-shore credit lines.

The Peruvian experience also shows that central banks need to monitor closely the impact of these types of instruments in order to minimize the potential costs. Close coordination with the regulatory authority is also necessary to complement reserve requirements with the use of other instruments aimed at reducing systemic risk, such as countercyclical provisioning and capital requirements and higher capital requirements for foreign loans.

36. Pesaran and Smith (2012).

Appendix A: Data Sources

Outcome variables for banks and *cajas municipales* are obtained from the Central Bank of Peru (www.bcrp.gob.pe/), as are variables like the Emerging Market Bond Index (EMBI) and the terms of trade. Outcome variables at small financial institutions (*cajas municipales*) and control variables such as the number of branches and the number of employees are extracted from the Superintendency of Banks and Insurance (SBS) (www.sbs.gob.pe/). The federal funds rate, the trade-weighted U.S. dollar index, and the ten-year U.S. Treasury bond yield are obtained from the Federal Reserve Economic Data (FRED) database maintained by the Federal Reserve Bank of St. Louis (research.stlouisfed.org/fred2/), while the VIX volatility index is obtained from the Chicago Board Options Exchange (CBOE) (www.cboe.com/micro/vix/).

TABLE A-1. List of Model Variables

Outcome variables at banks	
ftamn	Lending interest rates (30-day moving average) in domestic currency
ftipmn	Deposit interest rates (30-day moving average) in domestic currency
ftamex	Lending interest rates (30-day moving average) in foreign currency
ftipmex	Deposit interest rates (30-day moving average) in foreign currency
llnd_bcos_mn	Banking credit in nuevos soles to the private sector (millions of soles) (logs)
llnd_bcos_me	Banking credit in U.S. dollars to the private sector (millions of U.S. dollars) (logs)
ade_rat	Banks' short-term external debt to total external debt
Outcome variables at cajas municipales	
iac_cp	Short-term interest rate for consumer credit
iac_lp	Long-term interest rate for consumer credit
iam_cp	Short-term interest rate to microenterprises
iam_lp	Long-term interest rate to microenterprises
ip_cp	Short-term interest rate for deposits
ip_lp	Long-term interest rate for deposits
llnd_cs_cajas	Consumer credit (logs)
llnd_fms_cajas	Credit to microenterprises (logs)
llnd_mtg	Mortgage credit (logs)
Control variables	
lbranches	Number of branches systemwide at *cajas municipales* (logs)
lnemply	Number of employees systemwide at *cajas municipales* (logs)
lbranches_b	Number of branches systemwide at banks (logs)
lnemply_b	Number of employees systemwide at banks (logs)
ffed	Federal funds rate
lti	Terms of trade (logs)
ltwdindex	Trade-weighted U.S. dollar index: major currencies (logs)
vix	Implied volatility of S&P 500 options index
embi	EMBI spread
tby10	Ten-year U.S. Treasury bond yield

(*continued*)

TABLE A-1. List of Model Variables (*Continued*)

Policy variables	
rrmn_mg	Marginal reserve requirement in nuevos soles
rrme_mg	Marginal reserve requirement in U.S. dollars
rrmn_exg	Reserve requirement in nuevos soles
rrme_exg	Reserve requirement in U.S. dollars
rrmn_eff	Effective reserved rate in nuevos soles
rrme_eff	Effective reserved rate in U.S. dollars
rrme_amp	Reserve requirement in U.S. dollars (augmented)
frme_fl	Reserve requirement for short-term foreign liabilities

TABLE A-2. Granger Causality Test: Control Variables and Reserve Requirements in Domestic Currency[a]

	Null hypothesis	*Probability*	*Result*
(1)	lbranches does not Granger cause rrmn_mg	0.99	Do not reject
	rrmn_mg does not Granger cause lbranches	0.40	Do not reject
(2)	lbranches_b does not Granger cause rrmn_mg	0.12	Do not reject
	rrmn_mg does not Granger cause lbranches_b	0.02	Reject
(3)	lnemply does not Granger cause rrmn_mg	0.48	Do not reject
	rrmn_mg does not Granger cause lnemply	0.88	Do not reject
(4)	lnemply_b does not Granger cause rrmn_mg	0.49	Do not reject
	rrmn_mg does not Granger cause lnemply_b	0.02	Reject
(5)	ffed does not Granger cause rrmn_mg	0.02	Reject
	rrmn_mg does not Granger cause ffed	0.57	Do not reject
(6)	lti does not Granger cause rrmn_mg	0.49	Do not reject
	rrmn_mg does not Granger cause lti	0.76	Do not reject
(7)	ltwdindex does not Granger cause rrmn_mg	0.59	Do not reject
	rrmn_mg does not Granger cause ltwdindex	0.49	Do not reject
(8)	vix does not Granger cause rrmn_mg	0.01	Reject
	rrmn_mg does not Granger cause vix	0.42	Do not reject
(9)	embi does not Granger cause rrmn_mg	0.60	Do not reject
	rrmn_mg does not Granger cause embi	0.22	Do not reject

Source: Authors' calculations.

a. The tests use the procedure outlined in Toda and Yamamoto (1995).

TABLE A-3. Granger Causality Tests: Control Variables and Reserve Requirements in Foreign Currency[a]

	Null hypothesis	*Probability*	*Result*
(10)	tby10 does not Granger cause rrme_amp	0.76	Do not reject
	rrme_amp does not Granger cause tby10	0.50	Do not reject
(11)	embi does not Granger cause rrme_amp	0.15	Do not reject
	rrme_amp does not Granger cause embi	0.88	Do not reject
(12)	ffed does not Granger cause rrme_amp	0.95	Do not reject
	rrme_amp does not Granger cause ffed	0.83	Do not reject
(13)	lti does not Granger cause rrme_amp	0.77	Do not reject
	rrme_amp does not Granger cause lti	0.78	Do not reject
(14)	lbranches_b does not Granger cause rrme_amp	0.85	Do not reject
	rrme_amp does not Granger cause lbranches_b	0.00	Reject

Source: Authors' calculations.

a. The tests use the procedure outlined in Toda and Yamamoto (1995).

FIGURE A-1. Levels of Bank Credit

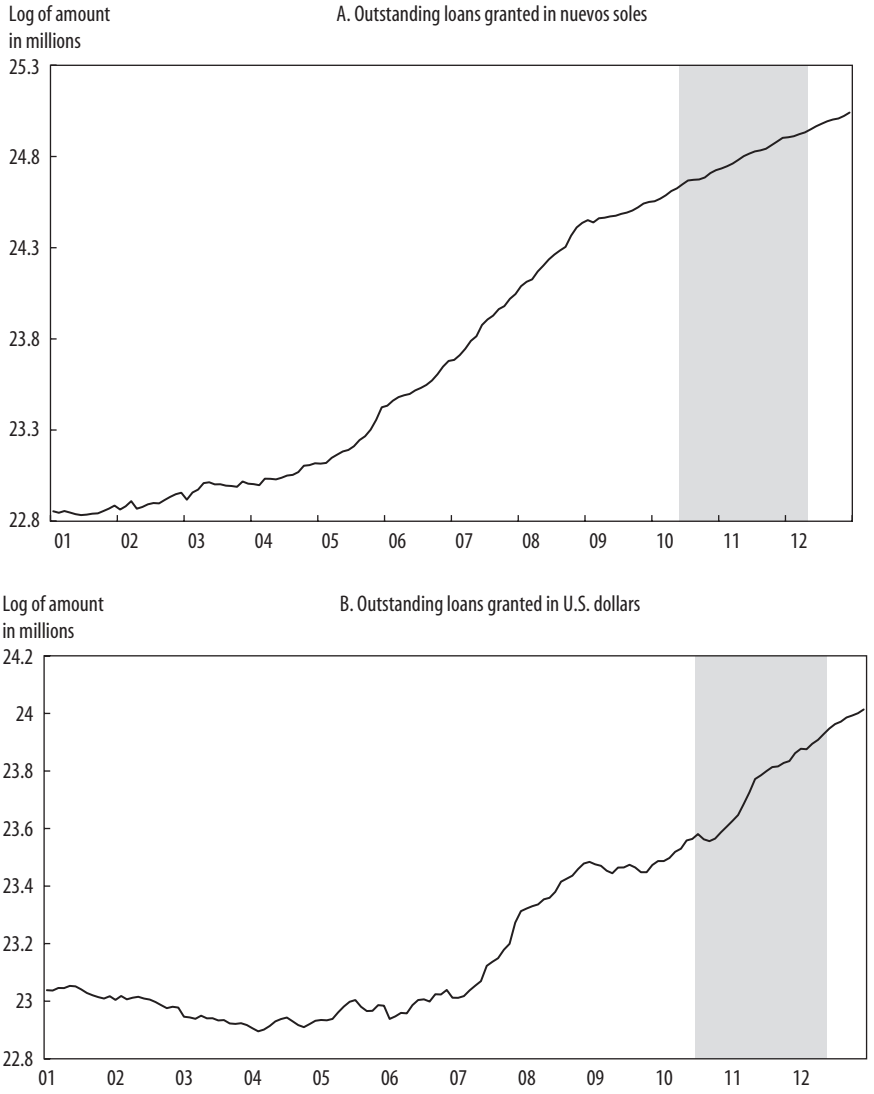
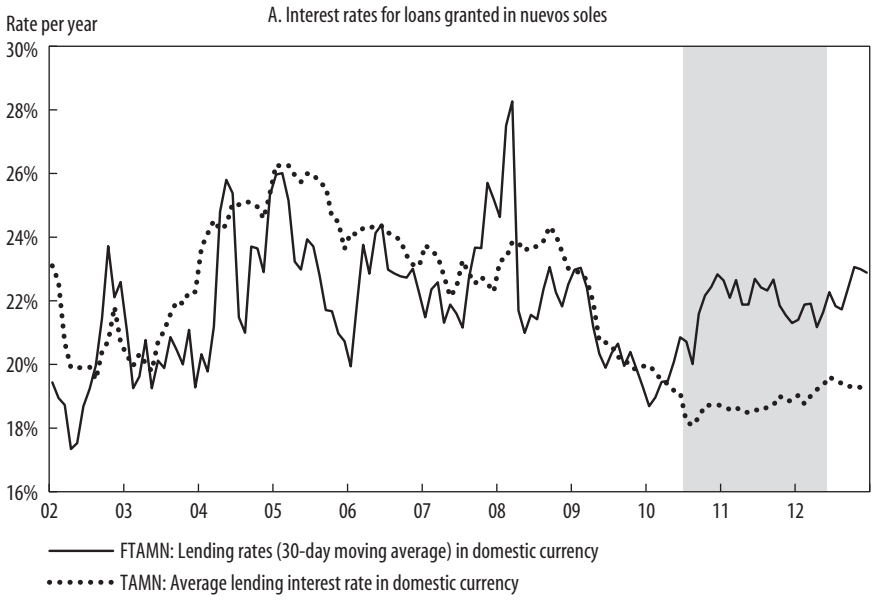
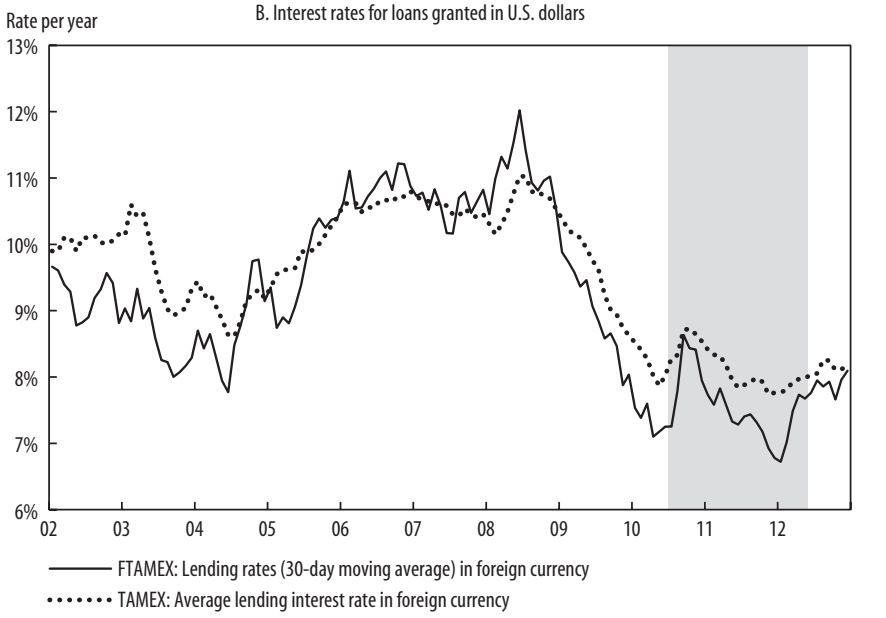


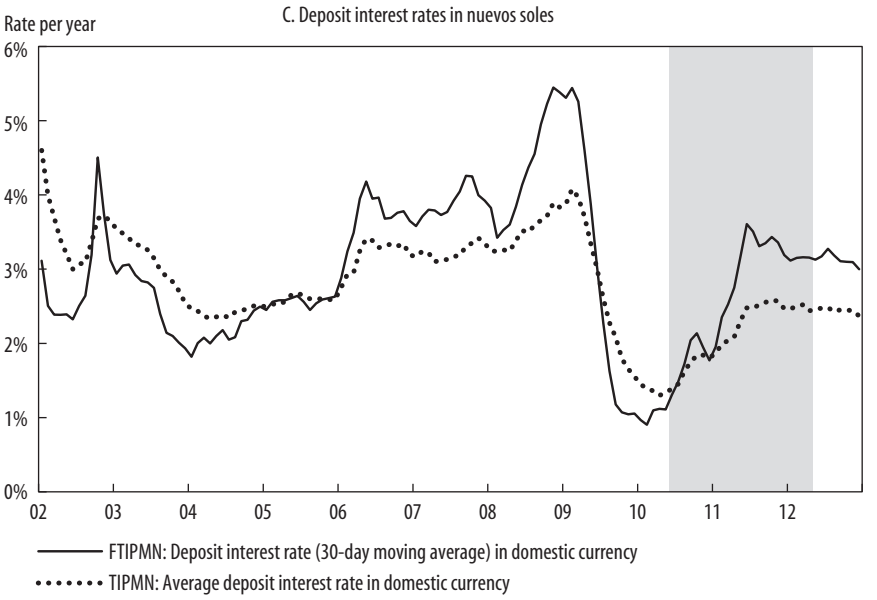
FIGURE A-2. Interest Rates in the Banking System





(*continued*)

FIGURE A-2. Interest Rates in the Banking System (*Continued*)



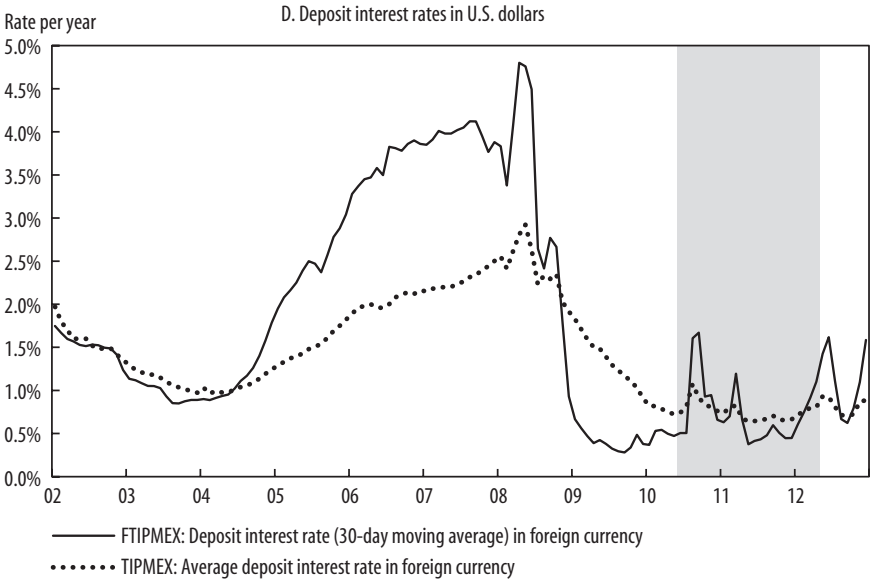
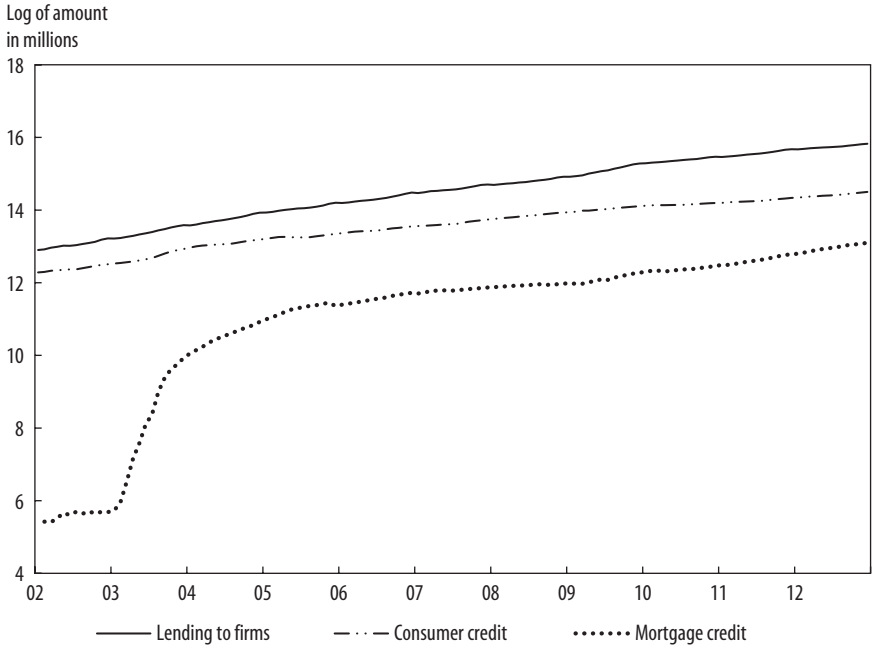


FIGURE A-3. Levels of Credit at *Cajas Municipales*[a]



a. Domestic currency only.

FIGURE A-4. Interest Rates Set by *Cajas Municipales*

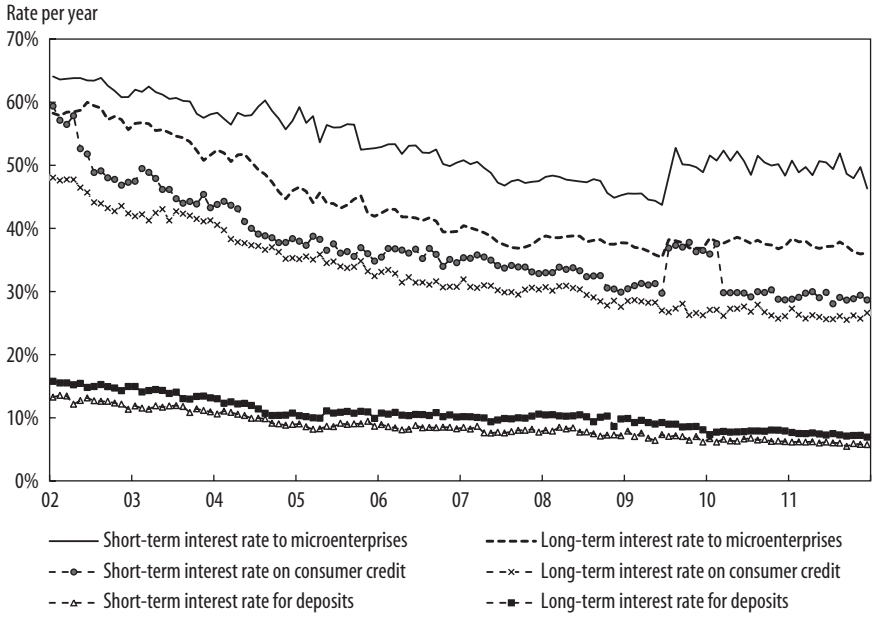


FIGURE A-5. Path of Policy Variables

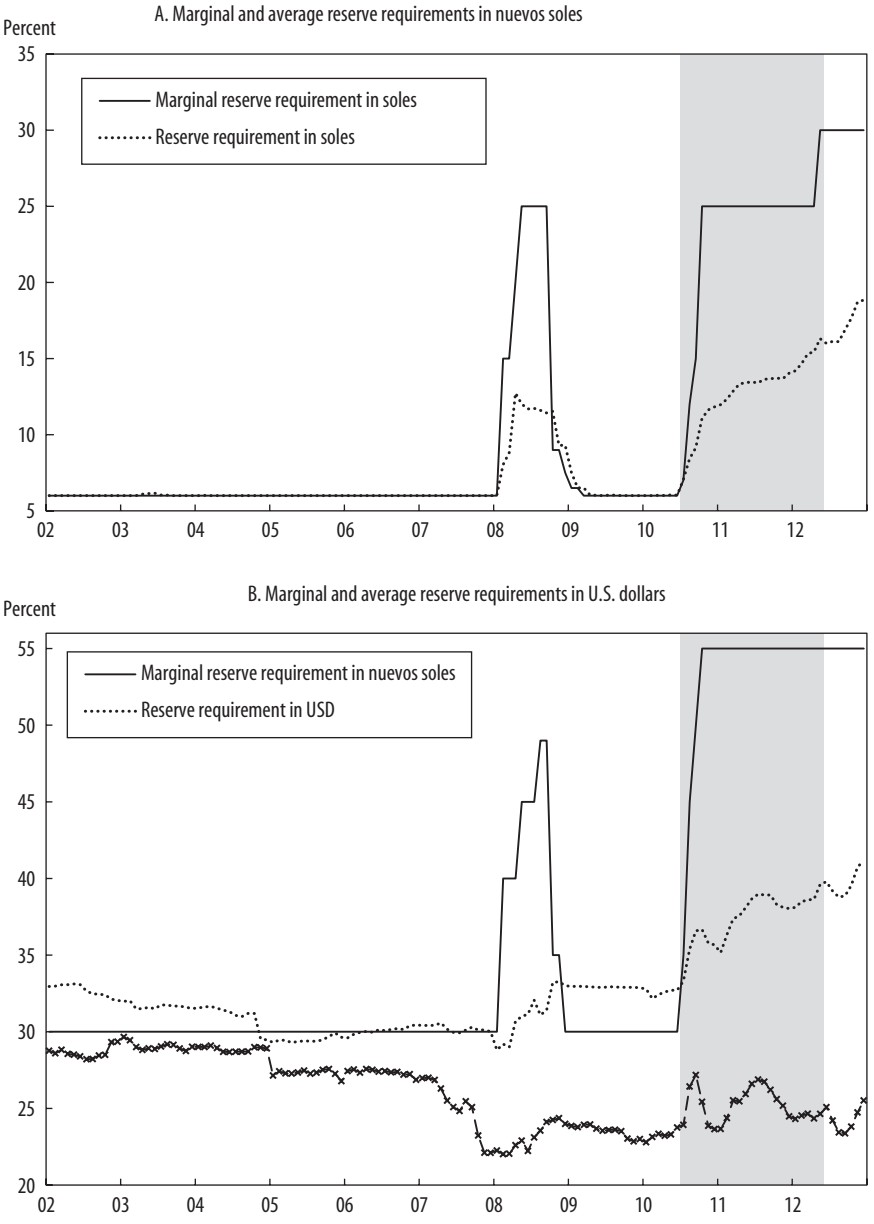
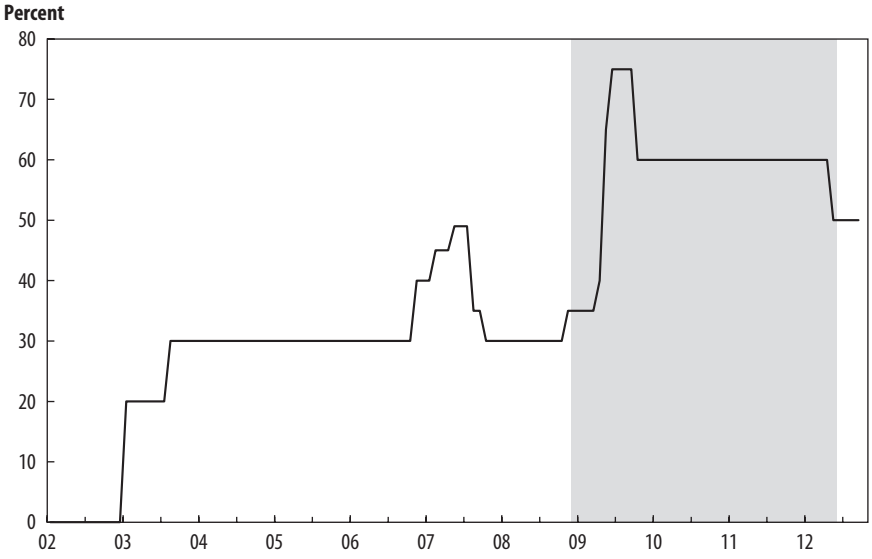


FIGURE A-6. Reserve Requirement on Banks' Short-Term Foreign Liabilities



Appendix B: Regression Results

TABLE B-1. Regression of Outcome Variables against Policy and Control Variables: Banks

Explanatory variable	*FTAMN*	*D(FTIPM)*	*FTAMEX*	*FTIPMEX*	*Log (bank lending soles)*	*Log (bank lending USD)*	*Bank's short-term to total external debt*
d(Marginal reserve requirement in soles)	0.101						
	[2.556]*						
Marginal reserve requirement in soles		–0.004			–1.107		
		[0.476]			[–7.364]		
Augmented reserve requirement in U.S. dollars			0.390	–0.252		–0.536	
			[3.028]**	[–3.854]**		[–0.353]	
Reserve requirement on short-term foreign liabilities							–0.74
							[–3.17]**
FTAMN(–1)	0.887						
	[19.615]**						
D_LTWDINDEX	0.093	0.011					
	[2.036]*	[1.283]					
D_FFED	–1.846						
	[–3.327]**						

(*continued*)

TABLE B-1. Regression of Outcome Variables against Policy and Control Variables: Banks (*Continued*)

Explanatory variable	*FTAMN*	*D(FTIPM)*	*FTAMEX*	*FTIPMEX*	*Log (bank lending soles)*	*Log (bank lending USD)*	*Bank's short-term to total external debt*
VIX	−0.021	−0.003					
	[−1.910]	[−1.521]					
Federal funds rate			0.915			2.900	
			[10.018]**			[3.090]**	
Ten-year Peruvian Treasury bond yield							0.09 [3.36]**
EMBI			0.576	−0.818	15.288	19.965	−0.14
			[2.024]*	[−5.102]**	[9.723]**	[13.291]**	[−7.29]**
Log terms of trade			−0.062	0.060			
			[−2.540]*	[3.811]**			
Constant	0.029	0.001	0.163	−0.130	21.690	21.843	0.49
	[2.754]**	[1.486]	[1.591]	[−1.709]	[357.962]**	[37.740]**	[2.10]*
D(FTIPM) (−1)		0.675					
		[10.046]**					
@TREND			0.002	−0.001	0.025	0.010	
			[6.737]**	[−10.639]**	[57.636]**	[2.309]*	
@TREND^2			−0.000			0.000	
			[−5.552]**			[1.107]	

Note: *t*-statistics are shown in brackets, *indicates significance at the 5% level, **indicates significance at the 1% level.

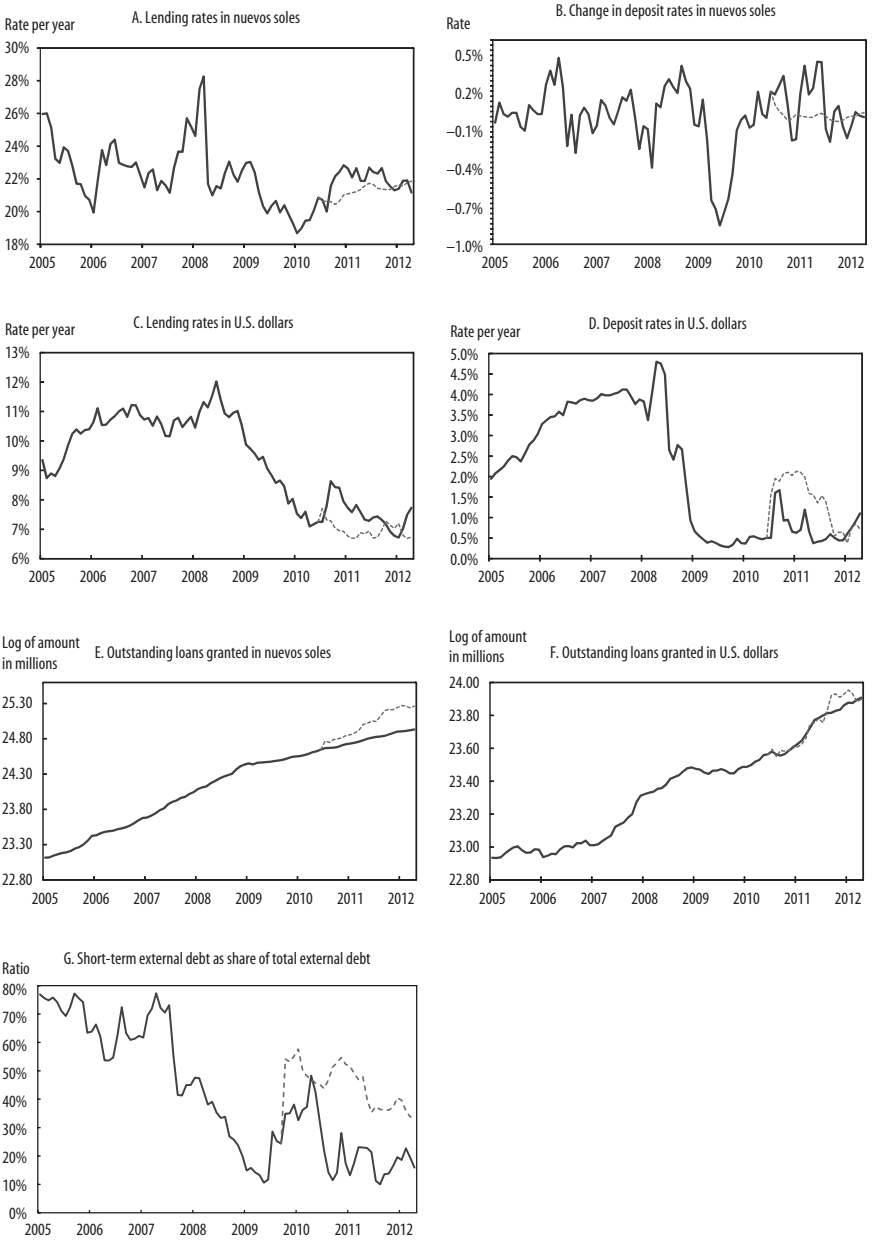
TABLE B-2. Regression of Outcome Variables against Policy and Control Variables: *Cajas Municipales*

Explanatory variable	*Short-term interest rate to microenterprises*	*Long-term interest rate to microenterprises*	*Short-term interest rate for consumer credit*	*Long-term interest rate for consumer credit*	*Short-term interest rate for deposits*	*Long-term interest rate for deposits*	*Consumer credit*	*Credit to small firms*	*Mortgage credit*
Marginal reserve requirement in soles	0.162 [2.180]*	0.075 [1.751]	–0.032 [–0.567]	0.216 [11.510]**	–0.013 [–1.625]	0.065 [2.257]**		–0.050 [–0.698]	–2.578 [–7.313]**
Reserve requirement in soles							–0.043 [–0.286]		
Log (trade-weighted dollar index)	0.190 [5.511]**		0.668 [8.871]**	0.205 [3.727]**			–0.561 [–8.412]**		–5.030 [–16.792]**
Federal funds rate	1.120 [5.016]**		2.842 [4.542]**	–0.445 [–3.741]**			4.095 [8.356]**		–14.197 [–8.946]**
Log (number of branches at *cajas*)	0.320 [5.583]**	0.543 [13.620]**	0.665 [6.138]**		0.021 [5.992]**	0.088 [5.459]**		–1.148 [–9.647]**	–2.410 [–11.709]**
Log (number of employees at *cajas*)	–0.588 [–5.039]**	–1.015 [–11.122]**	–0.506 [–6.192]**	–0.102 [–11.801]**				3.042 [10.218]**	
Log (terms of trade)							–0.260 [–3.243]**		
Constant	2.606 [3.691]**	5.571 [11.063]**	–2.126 [–4.425]**	0.265 [0.832]	0.064 [3.970]**	–0.233 [–2.994]**	16.276 [42.184]**	–3.712 [–2.230]*	44.640 [23.975]**
@TREND	0.004 [2.855]**	0.007 [6.688]**			–0.002 [–21.278]**	–0.002 [–12.061]**	0.014 [29.939]**	–0.013 [–3.934]**	0.046 [16.183]**

Note: *t*-statistics are shown in brackets, *indicates significance at the 5% level, **indicates significance at the 1% level.

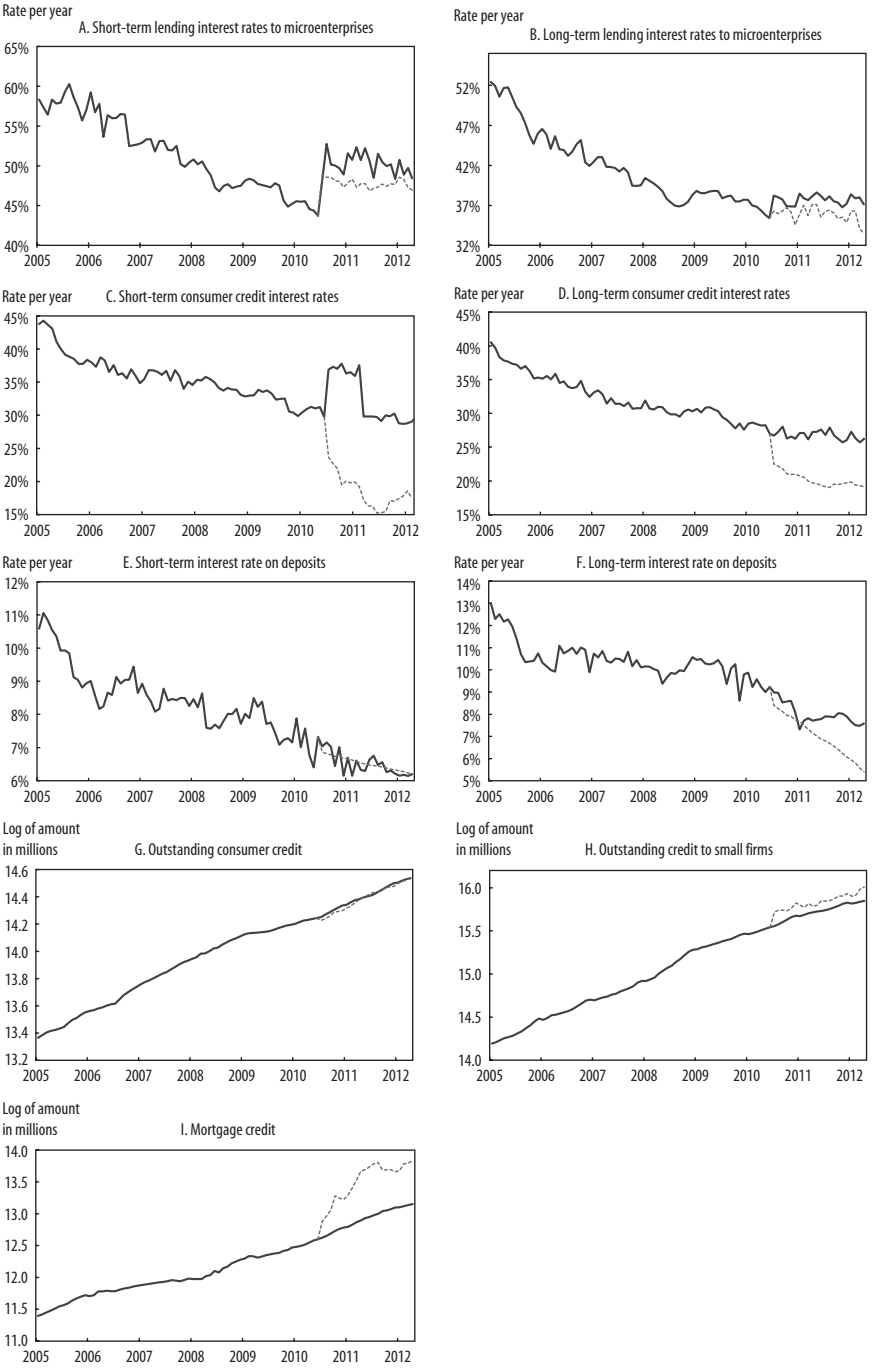
Appendix C: Figures with Counterfactual Forecasts

FIGURE C-1. Path of Observed and Counterfactual Outcomes at Banks[a]



a. The solid lines are realized outcomes; the dotted lines are the counterfactuals (no policy tightening).

FIGURE C-2. Path of Observed and Counterfactual Outcomes at *Cajas Municipales*[a]



a. The solid lines are realized outcomes; the dotted lines are the counterfactuals (no policy tightening).

References

Armas, Adrián, and Francisco Grippa. 2005. "Targeting Inflation in a Dollarized Economy: The Peruvian Experience." RES Working Paper 4423. Washington: Inter-American Development Bank.

Armas, Adrián, and others. 2001. "De metas monetarias a metas de inflación en una economía con dolarización parcial: El caso Peruano." *Revista de Estudios Económicos* 17.

Bindseil, Ulrich. 2003. *Monetary Policy Implementation: Theory, Past and Present.* Oxford: Oxford University Press.

Carrera, César, and Hugo Vega. 2012. "Interbank Market and Macroprudential Tools in a DSGE Model." Working Paper 2012-014. Lima: Central Bank of Peru.

Castillo, Paul, and Daniel Barco. 2009. "Peru: A Successful History of Reserve Management." In *Dealing with an International Credit Crunch: Policy Responses to Sudden Stops in Latin America,* edited by Eduardo Cavallo and Alejandro Izquierdo. Washington: Inter-American Development Bank.

Céspedes, Luis F., Roberto Chang, and Andrés Velasco. 2004. "Balance Sheets and Exchange Rate Policy." *American Economic Review* 94(4): 1183–93.

———. 2012. "Is Inflation Targeting Still on Target?" Working Paper 18570. Cambridge, Mass.: National Bureau of Economic Research.

Dancourt, Oscar. 2012. "Banking Credit, Policy Interest Rate, and Reserve Requirements in Peru." *Ensayos Económicos* 1(65–66): 41–60.

Glocker, Christian, and Pascal Towbin. 2012. "Reserve Requirements for Price and Financial Stability: When Are They Effective?" *International Journal of Central Banking* 8(1): 65–114.

Goodfriend, Marvin, and Monica Hargraves. 1983. "A Historical Assessment of the Rationales and Functions of Reserve Requirements." In *Monetary Policy in Practice,* edited by Marvin Goodfriend. Richmond, Va.: Federal Reserve Bank of Richmond.

Keynes, John M. 1930. "A Treatise on Money: The Applied Theory of Money." In *The Collected Works of John Maynard Keynes.* London: Macmillan/Cambridge University Press.

León, David, and Zenón Quispe. 2010. "El encaje como instrumento no convencional de política monetaria." *Revista Moneda* 143. Lima: Central Bank of Peru.

Montoro, Carlos, and Ramón Moreno. 2011. "The Use of Reserve Requirements as a Policy Instrument in Latin America." *BIS Quarterly Review* (March).

Morón, Eduardo, and Diego Winkelried. 2005. "Monetary Policy Rules for Financially Vulnerable Economies." *Journal of Development Economics* 76(1): 23–51.

Pesaran, M. Hashem, and Ron Smith. 2012. "Counterfactual Analysis in Macroeconometrics: An Empirical Investigation into the Effects of Quantitative Easing." Cambridge University.

———. 2014. "Signs of Impact Effects in Time Series Regression Models." *Economics Letters* 122(2): 150–153.

Reinhart, Carmen, and Vincent Reinhart. 1999. "On the Use of Reserve Requirements in Dealing with Capital Flow Problems." *International Journal of Finance and Economics* 4(1): 27–54.

Salas, Jorge. 2011. "Estimación Bayesiana de un modelo macroeconómico simple para una economía pequeña, abierta y parcialmente dolarizada." *Revista de Estudios Económicos* 22: 41–62.

Terrier, Gilbert, and others. 2011. "Policy Instruments to Lean against the Wind in Latin America." Working Paper 159. Washington: International Monetary Fund.

Toda, Hiro, and Taku Yamamoto. 1995. "Statistical Inference in Vector Autoregressions with Possibly Integrated Processes." *Journal of Econometrics* 66(1): 225–50.

Tovar, Camilo E., Mercedes García-Escribano, and Mercedes Vera Martin. 2012. "El crecimiento del crédito y la efectividad de los requerimientos de encaje y otros instrumentos macroprudenciales en América Latina." *Revista Estudios Económicos* 24: 45–64.

Vargas, Hernando, and Pamela Cardozo. 2012. "The Use of Reserve Requirements in an Optimal Monetary Policy Framework." *Borradores de Economía* 716. Bogotá: Banco de la República (Central Bank of Colombia).

Vargas, Hernando, and others. 2010. "Effects of Reserve Requirements in an Inflation Targeting Regime: The Case of Colombia." Borradores de Economía 587. Bogotá: Banco de la República (Central Bank of Colombia).

Webb, Richard, and Adrián Armas. 2003. "Monetary Policy in a Highly Dollarized Economy: The Case of Peru." In *Challenges to Central Banking from Globalized Financial Systems,* edited by Piero Ugolini, Andrea Schaechter, and Mark Stone. Washington: International Monetary Fund.

Winkelried, Diego. 2013. "Modelo de proyección trimestral: Actualización y novedades." *Revista de Estudios Económicos* 26: 9–60.