Effects and role of macroprudential policy: Evidence from reserve requirements based on a narrative approach*

Pablo Federico
BlackRock

Carlos A. Vegh
University of Maryland and NBER

Guillermo Vuletin
Colby College

Preliminary and incomplete: November 17, 2012

Abstract

We analyze the macroeconomic effects of changes in legal reserve requirements and the relationship between reserve requirement policy and monetary policy in four Latin American countries (Argentina, Brazil, Colombia, and Uruguay). To correctly identify innovations in reserve requirements, we develop a narrative approach – based on contemporaneous reports from the IMF and Central Banks – that classifies changes in reserve requirements into endogenous or exogenous to the business cycle. We show that this distinction is critical in understanding the effects of reserve requirements. In particular, we show that output falls in response to exogenous changes in reserve requirements but would increase in response to all changes due to misidentification. We also show that, when properly identified, reserve requirement policy acts as a substitute for monetary policy rather than a complement. For instance, in bad times reserve requirements are lowered to stimulate output while interest rates need to increase to prevent the domestic currency from rapid depreciation.

JEL Classification: E31, E32, E52, E58, F31, F41.

Keywords: macroprudential, reserve requirement, monetary policy, narrative, output, capital flow, interest rate spread, credit, business cycle, VAR.

*This paper was written while the authors were visiting the World Bank's Office of the Chief Economist for Latin America and the Caribbean and Vegh was also visiting the Macroeconomics and Growth Division (DEC) at the World Bank, and is part of an ongoing project on macroprudential policy at the Office of the Chief Economist. The authors are very grateful for the hospitality and stimulating policy and research environment and would like to thank Tito Cordella, Augusto de la Torre, Alain Ize, and participants at several brainstorming sessions for many helpful comments and discussions. We would also like to thank Robert Dekle, Sebastian Edwards, Graciela Kaminsky, Hashem Pesaran, Alessandro Rebucci, and participants at the conference on "Global Crisis and Latin American Economies" at University of Southern California (November 16, 2012) for usefuls and constructive comments. Jorge Puig and Pedro Pablo Matinez provided excellent research assistance. We are also grateful to Inessa Love for sharing her code for Panel VAR estimation (pvar.ado). The views expressed in the paper are the authors' own and do not necessarily reflect those of the Office of the Chief Economist or the World Bank.

1 Introduction

The recent global financial crisis has triggered an intense debate on the pros and cons of using macroprudential policy, broadly defined as the use of prudential tools, such as reserve or capital requirements, for macroeconomic stabilization purposes. Although the discussion is certainly not novel – many emerging countries had resorted to macroprudential policy well before Lehman Brothers' demise on September 15, 2008 – it took an urgent undertone in light of the sudden realization of the severe contractionary forces that could be unleashed by the abrupt unwinding of financial imbalances and systemic risk. Perhaps one of best examples of the renewed debate on macroprudential policy is the resurgence of the so-called "Tobin tax" – a financial tax on short-term capital inflows – whose popularity had arguably reached a low point by the mid-2000's, after gaining some limited popularity in previous decades thanks to its use by Chile.[1] The mere fact that even the IMF – presumably a bulwark of macroeconomic orthodoxy – has come out in favor of using Tobin taxes under some circumstances is a dramatic illustration of the search for new policy tools in this much-changed post-Lehman world.

While there is a blossoming theoretical literature (e.g., Bianchi, 2012; Korinek, 2011), the empirical evidence on the effects of macroprudential policy is rather limited, mainly because of the absence of readily-available panel datasets on macroprudential tools. The empirical literature has generally focused on assessing the relative effectiveness of different macroprudential instruments as well as understanding the relationship between macroprudential and monetary policy.[2] Existing empirical studies, however, focus on a small set of countries (e.g., Vargas Herrara, Varela, Betancourt, Rodriguez, 2010; Izquierdo, Loo-Kung, and Rojas-Suarez, 2011) and/or a limited sample period (Gray 2011; Claessens and Ghosh, 2012). Moreover, most studies focus on the impact of macroprudential policy on domestic credit conditions (Montoro and Moreno, 2011; Terrier et al, 2011; Crowe, Dell'Ariccia, Igan, and Rabanal, 2011; Lim et al, 2011; Tovar, Garcia-Escribano, and Vera Martin, 2012). To out knowledge, only Glocker and Towbin (2012) study the effects on economic activity. As a result, the effectiveness of macroprudential policy and its relation to monetary policy is still very much an open

[1] See Edwards, De Gregorio, and Valdes (2000).

[2] See also Borio and Shim (2007), Vargas Herrara, Varela, Betancourt, and Rodriguez (2010), Calderon and Serven (2011), IMF (2011), Ma, Xiandong, and Xi (2011), Montoro and Moreno (2011), De la Torre, Ize, and Schmukler (2012), IDB (2012, Chapter 6), and Glocker and Towbin (2012).

question.

The purpose of this paper is to contribute to this incipient empirical literature on the macroeconomic effects of macroprudential policy and its interaction with monetary policy by focusing on legal reserve requirements. The focus on reserve requirements (RR) is only natural for two main reasons: (i) RR are arguably the most common macroprudential tool and (ii) collecting time series data on RR is, in principle, easier than collecting data on other prudential tools such as capital requirements. In fact, in this paper we rely on a novel quarterly database on legal RR rates originally collected as part of a World Bank regional study on macroprudential policy carried out by the Office of the Chief Economist for Latin America.[3] Our main focus, however, will be on four Latin American countries – Argentina, Brazil, Colombia, and Uruguay – for which we have developed a narrative about the nature of RR changes that will be critical for identification purposes.[4] In fact, we will argue that misidentification problems are at the core of some counterintuitive results in the existing literature (for instance, the finding that an increase in marginal RR increases private credit growth).[5] When shocks to RR are properly identified as exogenous to the business cycle by using a narrative analysis, we show that results change dramatically.

After describing the data in Section 2, we begin our formal analysis in Section 3 by using the traditional identification strategy used in the monetary policy literature of ordering the policy instrument last in the Cholesky decomposition (based on the idea that, with monthly data, it makes sense to assume that the policy rate can react contemporaneously to output and inflation but not viceversa). As a benchmark – and before turning to reserve requirement policy (RRP) – we illustrate the macroeconomic effects of monetary policy in our four countries and compare them to those in the United States. Not surprisingly, we find that monetary policy tightening (i.e., increase in policy interest rate) leads to a fall in output. We also find that the policy interest rate reacts positively to shocks to inflation. Contrary to findings in industrial countries, however, we find that the policy interest rate *falls* in reaction to higher

[3] The original database comprises data on legal RR for 52 countries, 15 industrial and 37 developing countries; see Federico, Vegh, and Vuletin (2012) for details. Notice that effective RR (calculated as the ratio of banks' reserves at the central bank to bank deposits) would be a poor proxy for policy changes due to the endogeneity of deposits, lending, and banks' voluntary reserves. This is the reason that we focus on the legal RR rate as the policy tool.

[4] The analysis covers the period 1995-2010 for Brazil and 1992-2011 for Argentina, Colombia, and Uruguay.

[5] See, for example, Figure 10 (bottom-right impulse response) in Tovar, Garcia-Escribano, and Vera Martin (2012).

output. We attribute this procyclical monetary response to what Vegh and Vuletin (2012) and Federico, Vegh, and Vuletin (2012) have called "fear of free falling" and "fear of capital inflows." "Fear of free falling" refers to the reluctance of emerging markets to lower interest rates in bad times to help the economy get out of the recession for fear of facing rapid currency depreciation, while "fear of capital inflows" captures the reluctance of policymakers to increase interest rates in good times for fear of attracting even more capital inflows.

When using the traditional identification strategy to evaluate the effects of RRP, we find a puzzling result: output *increases* in response to a positive RR innovation. Naturally, this finding is at odds with any standard macro model in which an increase in RR reduces output by increasing lending spreads and reducing bank credit. We also find that RRP seems to complement (i.e., reinforce) monetary policy (in the sense that, qualitatively speaking, RR respond to output and inflation in the same way as the policy interest rate). This evidence is at odds with arguments usually articulated in policy circles, which suggest that RRP tends to substitute for monetary policy in open economies. Considering the above discussion on the fear of free falling and fear of capital inflows it is perhaps not surprising to see developing countries resort to the use of RR in a countercyclical manner, as they provide the second instrument that may be needed to achieve the two targets just mentioned. In other words, during bad times a country may not be able to lower interest rates (as it would like, were it not for the fear of free falling), but may lower RR instead. Similarly, during good times a country may not be able to increase interest rates (as it would like, were it not for the fear of capital inflows), but may increase RR instead.[6]

Section 4 turns to our new identifying strategy, which relies on the use of Romer-Romer type narratives to identify truly exogenous (to the business cycle) shocks to RR.[7] To the best of our knowledge, this is the first instance in this literature in which such an approach has been followed. Using historical documents, including IMF and central banks reports, we classify changes in RR into (i) *endogenous* changes, which were mainly motivated by

[6] This was, for example, the position of the Turkish Central Bank as described in a Financial Times article on December 13th, 2010. The deputy governor argued that the way to deal with heavy capital inflows was to reduce interest rates (to reduce capital inflows and currency appreciation) while using other instruments (i.e., reserve requirements) to reduce credit growth.

[7] See, for example, Romer and Romer (2010), Riera-Crichton, Vegh, and Vuletin (2012), and Gunter, Riera-Crichton, Vegh, and Vuletin (2012) for a discussion on the use of narratives to evaluate the effect of taxation policy, and Romer and Romer (2004) and Coibion (2012) when assessing the impact of monetary policy.

current or projected output fluctuations (i.e., when output growth differs from normal) and (ii) *exogenous* changes, which were triggered by reasons exogenous to the business cycle, including microprudential factors and financial liberalization. When we then incorporate into our VAR the exogenous changes in RR, we find that, as expected, higher RR reduce output. Moreover, past output fluctuations are poor predictors of changes in exogenous RR changes, supporting our narrative categorization. Our analysis also confirms that endogenous changes in RR, in turn, respond positively and strongly to output shocks, which supports our misidentification arguments (RRP acts as a substitute for monetary policy rather than as a complement). Like Coibion (2012) on the monetary side, we find that when using truly exogenous RR series, the historical contribution of these policy shocks to explain output fluctuations is much higher than with the more traditional identification strategy. When using all changes in RR, these invonations explain less than 2 percent of variation in economic activity. On the contrary, when using exogenous RR series they explain about 6 percent of variation in ouput.

2 Reserve requirement data

Our starting point is a novel quarterly legal RR database originally collected as part of a World Bank regional study on macroprudential policy carried out by the Office of the Chief Economist for Latin America.[8,9] For this paper, we focus on four Latin American countries – Argentina, Brazil, Colombia, and Uruguay– since the early 1990s.[10] This dataset on RR comes from primary sources such as central banks' websites (Argentina) as well as research and policy papers (Brazil). For Colombia and Uruguay, however, we received invaluable help from staff and researchers at central banks.[11] Unlike countries such as Chile and Mexico that have rarely changed their legal RR, the four countries analyzed in this paper have frequently resorted to the use of RR for macroeconomic stabilization purposes, which makes them excellent candidates for a study on the macroeconomic effects of changes in RR.[12] As shown in Table

[8] As already mentioned, the original database comprises 52 countries, 15 industrial and 37 developing countries. See Federico, Vegh, and Vuletin (2012) for a detailed description of this dataset.

[9] As is the case when using cyclically-adjusted revenue measures to assess changes in tax policy (Riera-Crichton, Vegh, and Vuletin, 2012), effective RR series (calculated as the ratio of banks deposits at the central bank to bank deposits) are poor proxies for changes in policy instruments such as legal RR; see Federico, Vegh, and Vuletin (2012) for more details. Henceforth we use the term RR to refer to legal RR.

[10] The analysis covers the period 1995-2010 for Brazil and 1992-2011 for Argentina, Colombia, and Uruguay.

[11] See Appendix 8.1 for a detailed description of the data and sources.

[12] Chile and Mexico changed their RR only twice since 1975 and 1988, respectively.

1, we identify a total of 70 quarterly changes in RR. Specifically, Argentina, Brazil, Colombia, and Uruguay changed their RR on 33, 20, 7, and 10 occasions, respectively. In other words, on average, these countries changed their RR almost once a year. To set the stage, we begin by briefly discussing some broad features of the data; in particular the varieties of RR (Section 2.1), as well as long and short run properties (Section 2.2).[13]

2.1 Varieties of reserve requirements

Figure 1 illustrates the diversity of RR in our sample: (i) single RR; (ii) RR that vary according to maturity; and (iii) RR that vary according to both maturity and currency of denomination. The existence of RR based on currency of denomination in many developing countries should perhaps come as no surprise given the widespread phenomenon of "dollarization" or, more broadly, foreign currency deposits. As a general rule, short-term deposits (i.e., demand) as well as deposits in foreign currency are typically associated with higher RR than more long-term and local currency based deposits. For example, the historical average RR on demand deposits in Brazil has been 56 percent compared to about 15 percent for savings and term deposits. This differential RR structure has been aimed at discouraging short-term capital inflows and deposits. Regarding currency denomination, in Uruguay, for example, the average RR for deposits in local currency has been 8 percent compared to about 15 percent for foreign currency deposits. This differential reflects concerns with sudden reversals in foreign currency flows (Quizpe and Rossino, 2010) that may spell trouble for the banking sector due to currency mismatches in banks' balance sheets (Savastano, Reinhart, and Rogoff, 2003).

2.2 Long and short run properties

To get an idea of how RR have evolved over time, Figure 2 plots the means and standard deviations of RR for each country. With the exception of Uruguay which, compared to other developing countries, has been relatively open from a financial point of view, the other three countries show a declining trend in their average RR, reflecting financial liberalization and financial deepening. The average RR has decreased in Argentina, Brazil, and Colombia from

[13] Our study also uses other macroeconomic variables such as real GDP, inflation, and central bank interest rates, all of them at the quarterly frequency. Most of this data were gathered from Global Financial Data and IFS (IMF). See Appendix 8.1 for a description of data and its sources.

values close to 30, 50, and 40 percent in the early 1990s to 17, 26, and 11 percent in 2010, respectively. We can also see an increase in average RR in the period 2005-2010 reflecting the greater reliance on macroprudential policy in the period surrounding Lehman's fall on September 15, 2008. Another general feature – particularly in Argentina and Brazil – has been an important reduction in the dispersion of RR associated with different types of deposits. For example, while in 1995 RR in Brazil ranged from 90 percent on demand deposits to 27 percent on term ones, the range had narrowed to between 43 and 20 percent in 2010.

How about the relation between changes in different types of RR? Figure 3 shows the change in RR for each country. While the levels of RR tend to vary across different categories of deposits (Figure 1), their changes appear to be positively related (Figure 3). Indeed, in virtually all cases we cannot reject the null hypothesis that such correlations are positive and statistically significant (Table 2).[14] This finding offers a strong justification for focusing our analysis on the change in the *average* RR. Naturally, if all countries had a single RR, the analysis would be fairly straightforward since we would need to focus only on the change in the single RR. However, the presence of multiple RR that may vary according to maturity and/or currency could, in principle, present a formidable challenge to the analysis of RRP if changes in different RR were negatively correlated. This, however, is not the case as virtually all changes in RR appear to be strongly positively correlated.

3 Evidence from traditional identification strategy

This section assesses the macroeconomic effects of changes in legal RR using traditional identification methods; that is, methods inspired by the empirical monetary policy literature for the United States. As a helpful benchmark, we begin by replicating existing analysis of monetary policy for the United States and then comparing those results to those for our four Latin American countries.

[14] The statistically insignificance between changes in RR associated to deposits in local and foreign currency for Uruguay is due to the fact that there is only one change in RR for foreign currency and 9 changes in local currency. Interestingly enough, the correlation between the change in the *average* in RR and both local and foreign currency deposits is highly positive and statistically significant.

3.1 Monetary policy

We start by using the traditional closed economy identification strategy used in the monetary policy literature (Leeper, Sims, and Zha, 1996; Bernanke, Gertler, and Watson, 1997; Christiano, Eichenbaum, and Evans; 1999; Bernanke, Boivin, and Eliasz, 2005) which relies on the use of VAR together with an identification method based on a particular ordering of the relevant variables. In particular, this literature assumes that in the short-run (i.e., using monthly data) monetary policy innovations have no contemporaneous effects on macroeconomic variables such as output and prices. In other words, it is assumed that output and prices are the more exogenous or slow-moving variables (i.e., they are ordered first in the Cholesky ordering), while monetary policy is the more endogenous or fast-moving (i.e., it is ordered last in the Cholesky ordering). Using this timing assumption, these studies typically find that the output effect of monetary innovations in the United States is fairly small: a peak drop of approximately 0.2 to 0.7 percent in output in response to a one percentage-point increase in the Federal Funds Rate.[15]

As a benchmark for our own analysis, Figure 4 replicates this exercise using (as it will be the case of RR) quarterly data and three quarter lags.[16,17] We use the following ordering of the variables as capturing the most basic system in this literature: real GDP growth rate (seasonally adjusted), inflation (seasonally adjusted), and changes in the Federal Funds Rate.[18] We find that a one percentage-point increase in the Federal Funds Rate reduces output by 0.24 percent in the long-run (Figure 4, panel A).[19] Moreover, in line with findings regarding the Taylor rule (e.g., Taylor, 1993 and 1999; Clarida, Gali, and Gertler,2000), we

[15] See Coibion (2012) for an excellent review and a discussion of the limitations of this approach for the case of the United States.

[16] While the empirical monetary literature in the United States and other industrial countries have mostly relied on the use of monthly data (typically using industrial production as a proxy for economic activity), this is not the dominant approach when focusing on developing countries (e.g., Disyatat and Vongsinsirikul, 2003; Le, 2009). First, for many developing countries monthly industrial production is unavailable or available only very recently. For example, while Argentinean monthly industrial production is available at best since early 2000s, quarterly real GDP is available since 1970. Even when available, the quality of monthly data, in particular as a proxy for economic activity is seriously questioned. For example, while both quarterly and annual data indicates that Argentina grew 4.1 percent in 2008, monthly data suggest a drastic fall of -12.7 percent.

[17] AIC, FPE, and HQIC lag selections criteria consistently point to a lag specifications which includes 3 lags. Many papers in the literature also allow for a one year lag structure. Similar results are obtained if the structure of lags was moderately increased.

[18] Inflation is from Saint Louis Federal Reserve Economic Data. Real GDP and Federal Funds Rate is from Global Financial Data. See Appendix of data 8.1 for details.

[19] Changing the order of variables does not affect qualitatively our main (cumulative) results.

find that the Federal Fund Rate responds positively to output and inflation shocks (Figure 4, panels B and C).

What happens when we perform the same exercise using our four Latin American countries? Figure 5 shows the results using a panel VAR as described in Holtz, Eakin, Newey, and Rosen (1988).[20] In line with our findings for the United States, a contractionary monetary policy reduces output (Figure 5, panel A). Indeed, a one percentage-point increase in the central bank interest rate reduces output by 0.03 percent in the long-run (Figure 5, panel A). It is worth mentioning that since monetary shocks are about seven times higher in these four countries than in the United States, it makes more sense to compare a one standard-deviation shock, in which case the output effects are much more similar (output falls by 0.61 in the United States and 0.38 in our four Latin American countries). Figure 5, panel C also shows that, as is the case for the United States, the interest rate responds positively to an inflation innovation. Similar results are obtained if nominal exchange rate depreciation was used instead of (or in addition to) inflation.[21]

Interestingly, Figure 5, panel B shows that the policy interest rate increases in recessions and falls in booms; that is to say, monetary policy is procyclical. As discussed in Vegh and Vuletin (2012) and Federico, Vegh, and Vuletin (2012), this apparent puzzle can be explained by what we call the "fear of free falling" (in bad times) and "fear of capital inflows" (in good times). "Fear of free falling" refers to policymakers' reluctance in emerging markets to lower interest rates in bad times to help the economy get out of the recession for fear of facing rapid currency depreciation. While a typical industrial country can lower interest rates in bad times without the fear of a sharp depreciation of their currency, this is often not true of developing countries. In bad times, when capital is flowing out and credibility is at a low point, many developing countries see the value of their currency plummet. In those circumstances, the monetary authority may have no choice but to increase the interest rate to defend the currency (or at least not reduce it for fear of exacerbating the fall).[22] As a

[20] We use central bank interest rate data. Similar qualitative results are obtained if interbank lending data was used. See Appendix of data 8.1 for details.

[21] We will discuss the implications of moving to a more open economy set up later in Section 6.

[22] In fact, this has been part of the standard IMF policy advice to developing countries, most notably during the Asian crisis of 1997. To quote Stanley Fischer, at the time the IMF's First Deputy Managing Director, in a 1998 lecture delivered at UCLA, "[i]n weighing this question [are the IMF programs in Asia too tough?], it is important to recall that when they approached the IMF, the reserves of Thailand and Korea were perilously low, and the Indonesian rupiah was excessively depreciated. Thus, the first order of business was, and still

result, policymakers raise interest rates to avoid/delay the capital outflow. While "fear of free falling" offers a plausible story for bad times, an analogous story for good times is based on what we could refer as "fear of capital inflows." The idea would be that in periods of capital inflows (and ensuing output boom), the monetary authority is reluctant to raise interest rates because of the fear of attracting even more capital inflows (or fear of currency appreciation). As a result, they either keep interest rates unchanged or even lower them to attract less capital inflows.

This implies that developing countries may be caught in the common policy dilemma of too few instruments (the policy interest rate) relative to the number of targets (output and nominal exchange rate). Viewed in this light, it is perhaps not surprising to see developing countries resort to the use of RR in a countercyclical manner, as they provide the second instrument that may be needed to achieve the two targets just mentioned. In other words, during bad times a country may not be able to lower interest rates (as it would like to do, were it not for the fear of free falling), but may lower RR instead. Similarly, during good times a country may not be able to increase interest rates (as it would like to do, were it not for the fear of capital inflows), but may increase RR instead. In other words, RR policy may be able to act as a substitute for monetary policy. This was, for example, the position of the Turkish Central Bank as described in a Financial Times article on December 13th, 2010. The Deputy Governor argued that the way to deal with heavy capital inflows was to reduce interest rates (to reduce capital inflows and currency appreciation) while using other instruments (i.e., RR) to reduce credit growth.

We now use the traditional identification strategy discussed above to evaluate the effect and determinants of RR shocks. For this purpose we use quarterly data, a panel VAR with three quarter lags, and the following ordering: real GDP growth rate (seasonally adjusted), inflation (seasonally adjusted), and change in the average RR. Changing the order of variables, for example, ordering change in the average RR first does not affect qualitatively our main (cumulative) results.[23] Our findings are puzzling and run counter to what we would expect. First, Figure 6, panel A shows that increases in RR increase output, as opposed to reduce it.

is, to restore confidence in the currency. To achieve this, countries have to make it more attractive to hold domestic currency, which, in turn, requires increasing interest rates temporarily, even if higher interest costs complicate the situation of weak banks and corporations."

[23] Including changes in central bank interest rate does not affect qualitatively our main (cumulative) results.

Moreover, these invonations explain less than 2 percent of variation in economic activity at different time horizons.[24]

Also, Figure 6, panel B shows that the average RR seems to decrease (increase) in response to an increase (decrease) in output, and that it also increases (decreases) in response to an increase (decrease) in inflation (see panel C). In other words, qualitatively speaking, panels B and C in Figure 6 are very much similar to those of Figure 5. This would imply that RRP acts as a complement (i.e., reinforce), rather than as a substitute for monetary policy. The complementarity between monetary and RRP has also been suggested by other studies (Vargas Herrara, Varela, Betancourt, and Rodriguez, 2010; Ma, Xiandong, and Xi, 2011; Tovar, Garcia-Escribano, and Vera Martin, 2012).

4 Evidence from the narrative analysis

This section develops an alternative approach to identify RR innovations that do not respond to business cycle considerations. Subsection 4.1 presents the narrative analysis in which we identify the motivation for each RR change. After categorizing these changes into endogenous and exogenous, subsection 4.3 evaluates the effect of exogenous RR changes on output as well as the determinants of endogenous changes.

4.1 Sources and identifying motivation

The sources of the narrative analysis are primary documents produced by policymakers both at international and country institutions at the time. Our key sources are IMF reports including Staff Reports and Recent Economic Developments, as well as central banks' documents including working papers and monetary and financial stability reports, among others. We differentiate changes in RR into those that were mainly motivated by current or projected fluctuations in output, which we will call endogenous, from those that were triggered by other reasons, which we will call exogenous.[25] In the rest of the section we present our categorization strategy and also provide, as examples, shorter versions of some of the narratives which

[24] This finding is similar to that obtained by Glocker and Towbin (2012). They find that for Brazil (1997-2010) RR shocks explain about 2 percent of the variation in unemployment.

[25] Naturally, as in Romer and Romer (2010), we do not use the term "exogenous" in a strictly econometric sense or to mean that the changes have no economic causes. An equally terminology would be "valid" and "invalid."

are fully developed in Appendix ??.

Endogenous changes in reserve requirements are ones typically taken to offset developments that would cause output growth to differ from trend. This includes macroprudential cases where policymakers were intentionally responding to current or projected economic activity, including those events related to fluctuations in capital flows. What follows is a brief description of 3 consecutive changes in RR (1 increase and 2 decreases) that are categorized as endogenous. They took place in Colombia before and after the global crisis of 2008:

In the second quarter of 2007 RR increased from 13 percent to 27 percent. Before the 2008 global crisis, Colombia was experiencing a very strong economic performance as a result of sound macroeconomic policies and favorable external conditions. The economy grew on average more than 7 percent in 2006 and 2007, the strongest expansion since the late 1970s and above average for Latin America. The rapid growth in domestic demand as well as rises in food and fuel prices was increasing inflationary pressures. Motivated by this scenario, and aiming at slowing domestic demand growth, the Central Bank of Colombia increased in the second quarter of 2007 the RR from 13 percent to 27 percent.

In the second quarter of 2008 RR decreased from 27 percent to 12 percent and, subsequently, in the last quarter of 2008 RR decreased from 12 percent to 11 percent. Economic growth slowed in 2008 as a result of less buoyant domestic demand conditions and the effects of the global crisis on commodity prices and world economic activity. GDP growth declined from 7 percent in the second half of 2007 to 4 percent in the first half of 2008. Since mid-year, the real effective exchange rate had weakened by an estimated 20 percent, reflecting the decline of commodity prices and turbulence in international financial markets. The authorities acted swiftly to bolster confidence and ensure that the private sector retains access to credit in the wake of the global crisis. As a preventive measure, the Central Bank of Colombia reduced RR twice in the year.

Exogenous changes in reserve requirements are those not taken to offset factors pushing growth away from normal. We group these changes under 3 categories: financial liberalization, microprudential purposes, and liquidity regulation. The quintessential exogenous change might be because of financial liberalization arguments; a reduction in RR motivated by a belief that lower RR will increase private credit and output in the long run. Such an action is completely different from stabilization measures discussed above because the goal is to raise

normal growth, not to offset shocks acting to reduce growth relative to normal. For example, in early 1990s, Argentina gradually reduced their RR from 79 percent in 1992 to about 40 percent in early 1993. In those years, the authorities continued their efforts to bring about a transformation of the structures and institutions of the economy, moving away from decades of overregulation and state intervention and toward a flexible, dynamic, and open economy based on private initiative.

On other occasions central banks change RR for microprudential regulation purposes including measures aiming at improving financial intermediation as well as guarantying the solvency of the financial system. For example, while the financial markets in Uruguay are closely linked to international markets, the financial system continued in early 1991 to be characterized by a wide spread between lending and deposit rates in domestic currency. In the third quarter of 1991, the Central Bank of Uruguay reduced the RR on local currency demand and savings deposits by 2 percentage-points to narrow this spread and improved financial intermediation.

Another reason not associated to actions aiming at stabilizing output is related to the use of RR for liquidity regulation purposes. In these occasions, central banks change RR to affect market's liquidity needs in an effort to ease pressure on inflation, exchange rate, and interest rate. For example, in March of 1999, the Central Bank of Brazil increased the RR on term deposits from 20 percent to 30 percent. The international confidence crisis of 1997 and 1998 as a consequence of the financial problems faced by Russia and Asia, jointly with an increased concern about debt sustainability led to strong capital outflows in Brazil, culminating in the floating of the exchange rate in January 1999, which was a year of stagnant output growth and flat or contracting domestic demand. At that time, a new policy framework was then envisaged to keep inflation under control without further compromising the fiscal accounts. To attain this objective the authorities disposed during the first quarter of 1999 different measures of monetary policy which included changes in RR. In particular RR on term deposits was raised from 20 percent to 26.5 percent starting on March 5th 1999, and to 30 percent beginning on March 12th 1999.

4.2 The new measure of shock to reserve requirements

Out of the total 69 quarterly RR changes, our narrative analysis identifies 44 exogenous and 25 endogenous RR changes, respectively (Table 1). More than half of exogenous changes (23 out of 44) are associated with microprudential arguments. The remaining 21 exogenous cases are virtually equally splitted between financial liberalization (11) and liquidity regulation (10).

Figure 7 shows endogenous and exogenous changes for each country, as well as the composition of endogenous changes into those associated to measures aiming at offsetting output fluctuations in good and bad times. Macroprudential use of RRP has been common across the board in our four Latin American economies in the period surrounding the 2008 global crisis. Interestingly, yet not surprisingly, the use of RR for macroprudential (i.e., output stabilization) purposes has been, by no means, a recent phenomenon as some of the recent papers in the literature seem to suggest. Changes in RR have been frequently used for countercyclical purposes in past. For example, central banks of Argentina and Brazil actively used them before and after the financial crisis of 1995. Colombia also resorted to their use in 1998 to mitigate the effects of the 1997 Asian crisis. Argentina also reduced the RR on several occasions in 2001 in an attempt to stimulate economic activity after several quarters of negative output growth rates.

4.3 Empirical implications of the narrative analysis

We now use our new measure of RR shocks to examine the effects of RR changes on economic activity. For this purpose, we estimate similar panel VAR using the following ordering of the variables: exogenous average RR changes, real GDP growth rate (seasonally adjusted), and inflation (seasonally adjusted). We order exogenous average RR changes first because (i) our narrative analysis has established that these changes are not driven by cyclical output fluctuations, and (ii) it seems reasonably to allow changes in RR to affect output in the same quarter.[26]

Figure 8 shows the findings of our new exogenous RR series. Panel A shows that a one percentage-point increase in RR reduces output on impact by -0.17 percent and by about -0.15

[26] Similar results are obtained if changes in endogenous RR and/or changes in central bank interest rate were included in the system.

percent in the long-run.[27] These findings differ substantially from those obtained in Section 3 when using the timing identification strategy and all RR changes (Figure 6, panel A). In that case, independently of the ordering of the RR series, an increase in RR triggered an increase in economic activity. This striking difference shows in a very clear way the practical relevance regarding the strategy used to identifying policy innovations that are free of endogenous movements.

Using Brazilian monthly data for the period 1997-2010, Glocker and Towbin (2012) also find that economic activity decreases as a response to a positive shock in RR. Interestingly, for this period almost 80 percent (11 out of 14) of changes in RR are clasified as exogenous (see Figure 7, panel C). Indeed, if we replicated the excersice just performed using their sample coverage, a one percentage-point increase in exogenous RR reduces output by about -0.21 percent in the long-run. This finding is almost identical to the one we obtain when using our whole sample of countries. If, on the contrary, we did not distinguished between exogenous and endogenous changes such contractionary effect would be -0.03; negative, yet much smaller than the one obtained when focusing on exgoneous RR changes. These findings suggest that Glocker and Towbin's (2012) results are strongly driven by a sample heavily dominated by exogenous changes, yet even when only 20 percent of RR changes are endogenous (3 out of 14), the contractionary effect on output obtained is quite dramatic when using all RR changes (-0.03) versus when focusing on exogenous RR changes (-0.21). These findings strongly reinforces the importance of our narrative based identification strategy.

Like Coibion (2012) on the monetary side, we find that when using truly exogenous RR series, the historical contribution of these policy shocks to explain output fluctuations is much higher than with the more traditional identification strategy. When using all changes in RR in Section 3, these invonations explain less than 2 percent of variation in economic activity. On the contrary, when using exogenous RR series they explain about 6 percent of variation in ouput. Panels B and C show the response of these exogenous RR changes to output

[27] Some concern might exist to the extent that some category/categories of RR change currently classified as exogenous could be less exogenous than others (for example, changes in RR associated with liquidity regulation motives). Similar qualitative results are obtained both on impact as well as cumulatively if panel VAR regressions are estimated excluding one-at-a-time each exogenous category (liquidity regulation, financial liberalization, and microprudential). Results are not shown for brevity. For example, if liquidity regulation changes were excluded, a one percentage-point increase in exogenous RR reduces output on impact by -0.21 percent and by about -0.16 percent in the long-run.

and inflation shocks. Exogenous changes in RR respond weakly (i.e., the response is mostly statistically insignificant) to past movements in output and inflation, supporting our narrative categorization.

We now turn our attention to the endogenous changes in RR. We estimate similar panel VAR using the following ordering of the variables: real GDP growth rate (seasonally adjusted), inflation (seasonally adjusted), and endogenous average RR changes. We order endogenous RR changes last because these changes are, indeed, driven by policy actions aiming at offsetting developments that would cause output growth to differ from normal. Therefore, we would like to allow them to contemporaneously (within the quarter) respond to developments in economic activity. Having said that, alternative specifications where endogenous RR changes are ordered first do not affect qualitatively our main (cumulative) results. This supports the robustness of our results to ordering considerations.[28]

Figure 9, panels B and C show the response of these endogenous RR changes to output and inflation shocks. In contrast to using all RR changes (Figure 6, panel B), Figure 9, panel B shows that endogenous RR changes respond strongly and positively to movements in output. Indeed, a one percent increase in real GDP increases RR by 0.27 percentage-points. In other words, when correctly identified, RRP seems to substitute rather than complement monetary policy. We will understand in more detail the underlying arguments behind this policy substitution later, in section 6. One the other hand, Figure 9, panel C shows that macroprudential policies do not respond to inflation shocks.

Analyzing the effect of endogenous RR changes on output proves to be an incorrect strategy, precisely because these changes in RR are, by construction, contaminated with endogeneity considerations. Figure 9, panel A suggest that, as in Figure 6, panel A an increase in RR increases output. This finding reinforces our arguments that the mere use of timing assumptions to identify innovations in RRP proves to be a poor identification strategy.

To complete our analysis of the macroeconomic implications of RRP, we explore in more detail the effects of exogenous RR changes on interest rate spreads (defined as lending minus deposit interest rates) as well as on private credit. Figure 10, panel A shows that a one percentage-point increase in exogenous RR increases the interest rate spread on impact by

[28] Including changes in central bank interest rate does not affect qualitatively our main (cumulative) results.

0.39 percentage-points and about 0.14 percentage-points in the long-run.[29,30] The effect on private credit is weaker in statistical terms, yet it has the expected sign (10, panel B). A one percentage-point increase in exogenous RR decreases private credit on impact by 0.04 percent and about 0.52 percent in the long-run.

5 Relative effectiveness of reserve requirement versus monetary policy

This section compares the relative effectiveness of RRP and monetary policy on real GDP, interest rate spread, and private credit.[31,32,33] To make more meaningful comparisons across these two policy tools, we analyze the effect of one standard-deviation innovations as opposed to one percentage-point shocks.

Figure 11, panels A and B show the effect of exogenous RR and central bank interest rate changes, respectively.[34] An increase in exogenous RR decreases output on impact by 0.39 percent and 0.33 percent in the long run. Monetary policy shocks have marginally lower effect on impact; an increase in the policy rate decreases output on impact by 0.21. However, the long run effect is almost 3 times higher than for a RR shock; an increase in the policy interest rate decreases output by 0.89 in the long run. This may occur because the monetary policy

[29] The five variables in panel VAR in Figure 10, panel A are exogenous RR changes, real GDP growth rate, inflation growth rate, interest rate spread, and changes in central bank interest rate; in that order. Interest rate spread is defined as lending minus deposit interest rates. In Panel B, private credit growth rate is used instead of interest rate spread. Similar results are obtained if changes in endogenous RR and/or changes in central bank interest rate are included in the system.

[30] This finding coincides qualitatively with Gelos (2009). For a different sample, he finds that a reduction in RR on demand deposits by 10 percentage points would reduce net interest margins by an average of 0.4-0.7 percentage points. Based on our findings, a similar shock decreases the interest rate spread by a larger margin (3.9 percentage points).

[31] For this purpose we abstract from critiques regarding the extent to which the central bank interest rate series is subject to endogenous movements (Romer and Romer, 2004). If anything – and based on evidence from the United States – controling for this should reinforce our main empirical findings regarding the effects of monetary policy as opposed to weaken them.

[32] For symmetry purposes, in order to allow both RR changes as well as monetary policy to have contemporaneous effects on macroeconomic variables, we order changes in central bank interest rate before real GDP growth rate and inflation growth rate. As for Figures 4 and 5, changing the order of changes in central bank interest rate does not affect qualitatively our main (cumulative) results.

[33] All panel VAR in this section include both RR as well as monetary policy simulteneously in the system. Similar results are obtained if the analysis was performed separating RR and monetary policies using separate panel VAR systems.

[34] Panels A and B use a four-variable panel VAR. The four variables are exogenous changes in RR, changes in central bank interest rate, real GDP growth rate, and inflation growth rate; in that order.

effect on interest rate spread is almost 6 times higher as that of a RR shock (Figure 11, panels C and D).[35] In particular, an increase in exogenous RR increases the interest rate spread on impact by 0.90 percentage-points and 0.32 percentage-points in the long run. On the other hand, an increase in the policy interest rate increases the interest rate spread on impact by 1.62 percentage-points and 1.98 percentage-points in the long run. As discussed in Section 4.3, the response of private credit to a RR innovation is negative but weak. In contrast, the response of private credit to a policy interest rate innovation is positive.[36,37]

6 Substitutability between reserve requirement and monetary policies

In section 3, we evaluated the relationship between RR and monetary policy using all changes in RR. As in other studies, we find that RRP policy seems to act as a complement (i.e., reinforce), rather than as a substitute for monetary policy (Vargas Herrara, Varela, Betancourt, and Rodriguez, 2010; Ma, Xiandong, and Xi, 2011; Tovar, Garcia-Escribano, and Vera Martin, 2012;). We argued that this finding was at odds with anecdotal policy evidence which suggested that macroprudential policy (i.e., use of RRP for stabilization purposes) has acted as a substitute for monetary policy. Using our new endogenous RR series we showed that RRP actually acts as a substitute for monetary policy (section 4.3).

This section analyzes the substitutability between RR and monetary policies in a more open economy framework by including exchange rate fluctuations in the panel VAR system. Doing so turns out to be critical to understand in more detail the phenomenons of fear of free falling (currency depreciation) and fear of capital inflows (currency appreciation). As discussed in Kim and Roubini (2000), Corbo (2000), and Moron and Winkelried (2005), while it might be fairly reasonable to view exchange rate changes as more endogenous than changes

[35] Panels C and D use a five-variable panel VAR. The five variables are exogenous changes in RR, changes in central bank interest rate, real GDP growth rate, inflation growth rate, and interest rate spread; in that order.

[36] Panels E and F use a five-variable panel VAR. The five variables are exogenous changes in RR, changes in central bank interest rate, real GDP growth rate, inflation growth rate, and private credit growth rate; in that order.

[37] This result could reflect the response of both credit demand and credit supply to policy interest rates actions (Kashyap and Stein, 2000). An increase in policy interest rates could, through an increase in interest rate spread (Figure 11, panel D), reduce credit demand. However, it could also increase the banks' incentives to relax other non-price credit conditions. This later channel could, in principle, be more prevalent in economies such as the once analyzed in this study with underdeveloped and small credit markets.

in the policy interest rate in relatively closed economies, this ordering is not particularly sensible in more financially vulnerable and open developing countries where monetary policy and economic activity are very responsive to exchange rate developments. Therefore, we estimate a panel VAR using the following ordering: nominal exchange rate depreciation, real GDP growth rate, inflation rate, changes in central bank interest rate, and endogenous changes in RR.[38] Figure 12 shows the effect of a nominal depreciation shock on output (panel A), inflation (panel B), and monetary policy (panel C). The response of inflation (panel B) is as expected: a nominal devaluation triggers an increase in domestic prices. In constrast, the finding in Panel A is at odds with traditional (tranquil times) trade theory according to which exchange rate depreciations may stimulate economic growth through an increase in exports (due to gain in external competitiveness). In fact, panel A shows that a one standard-deviation depreciation reduces output by 0.43 percent on impact and about 0.78 percent in the long-run. This occurs because many exchange rate depreciations episodes, especially in Latin America and other financially vulnerable countries, are associated with currency and banking crisis as well as capital outflows which disrupt economic activity. This is indeed the reason why central banks usually attempt to defend the currency by increasing policy interest rate (panel C).

Figure 13 confirms previous findings that reductions in real GDP increases the policy interest rate (panel B) and decreases RR (panel A). The response of policies to a shock in private credit are statistically weak, yet positive for policy interest rates (panels C and D). Panels E and F show that while RRP does not respond to nominal exchange rate depreciations, central banks increase (decrease) the policy interest rate in response to nominal exchange rate depreciations (appreciations). This evidence is fully consistent with our notion of fear of free falling and fear of capital inflows.

7 Conclusions

to be written

[38] Changing the order of the nominal exchange rate depreciation does not qualitatively affect our main (cumulative) results.

8 Appendices

to be written

8.1 Data

to be written

References

[1] Coibion, O., 2012. "Are the effects of monetary policy shocks big or small?," *American Economic Journal: Macroeconomics*, Vol. 4, pp. 1-32.

[2] Federico, P., C. Vegh, and G. Vuletin, 2012. "Reserve requirement policy over the business cycle," mimeo.

[3] Holtz Eakin, D., W. Newey, and H. Rosen (1988). "Estimating Vector Autoregression with Panel Data," Econometrica, 56, 1371-1395.

[4] Taylor, John B., \Discretion Versus Policy Rules in Practice," Carnegie-Rochester Conference Series on Public Policy 39: 195-214 (1993).

[5] Taylor, John B., \A Historical Analysis of Monetary Policy Rules," in J.B. Taylor,ed., Monetary Policy Rules, Chicago: U. of Chicago Press, 1999.

[6] Clarida, Richard, Jordi Galí and Mark Gertler (2000), "Monetary Policy Rule and Macroeconomic Stability: Evidence and Some Theory," Quarterly Journal of Economics.

[7] Camilo E. Tovar, Mercedes Garcia-Escribano, and Mercedes Vera Martin/2012/Credit Growth and the Effectiveness of Reserve Requirements and Other Macroprudential Instruments in Latin America*IMF Working Paper WP/12/142

[8] Le, V., 2009, "A Vector Autoregression (VAR) analysis of the monetary transmission mechanism in Vietnam," mimeo (National Graduate Institute for Policy Studies, GRIPS).

[9] Disyatat, P., & Vongsinsirikul, P. (2003). Monetary policy and the transmission mechanism in Thailand. The Journal of Asian Economics, 14 (2003), 389–418.

[10] Gelos, G. R. (2009) \Banking Spreads in Latin America", Economic Inquiry 47(4),796-814.

[11] Christian Glocker, Pascal Towbin, 2012, The Macroeconomic Effects of Reserve Requirements, WIFO Working Papers, No. 420

[12] Montoro, C. and R. Moreno (2011) \Los requerimientos de encaje como instrumento de política en Am erica Latina", Informe Trimestral del BPI, March.

[13] Terrier, G., R. Valés, C. Tovar, J. Chan-Lau, C. Fernández-Valdovinos, M. García-Escribano, C. Medeiros, M. Tang, M. Martin and C. Walker (2011) \Policy Instruments to Lean against the Wind in Latin America", IMF Working Paper No. 11/159.

[14] Vargas Herrara, H., C. Varela, Y. R. Betancourt and N. Rodriguez (2010) \E ects of Reserve Requirements in an In ation Targeting Regime: The Case of Colombia", Banco de la Republica Colombia Working Paper No. 587.

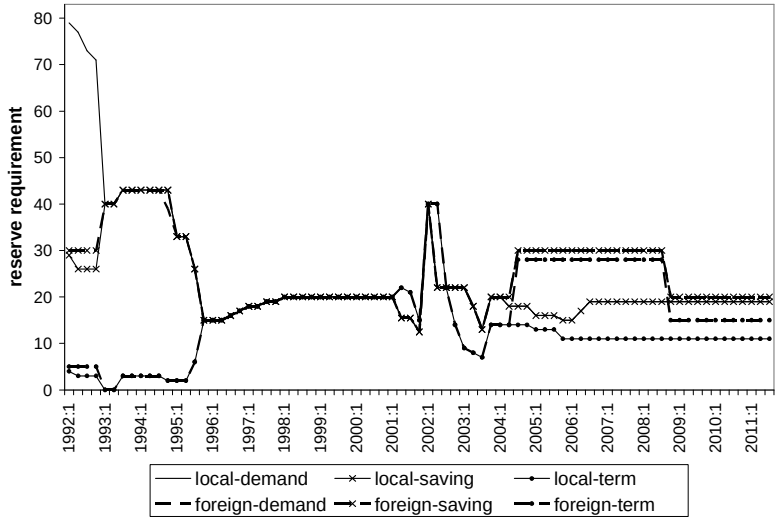
[15] Ma, G., Y. Xiandong, and L. Xi, 2011, China's evolving reserve requirements, BIS working paper No360.

[16] Crowe, Christopher, Dell'Ariccia, Giovanni, Igan, Deniz and Rabanal, Pau, How to Deal with Real Estate Booms: Lessons from Country Experiences (April 2011). IMF Working Papers, Vol. , pp. 1-58, 2011.

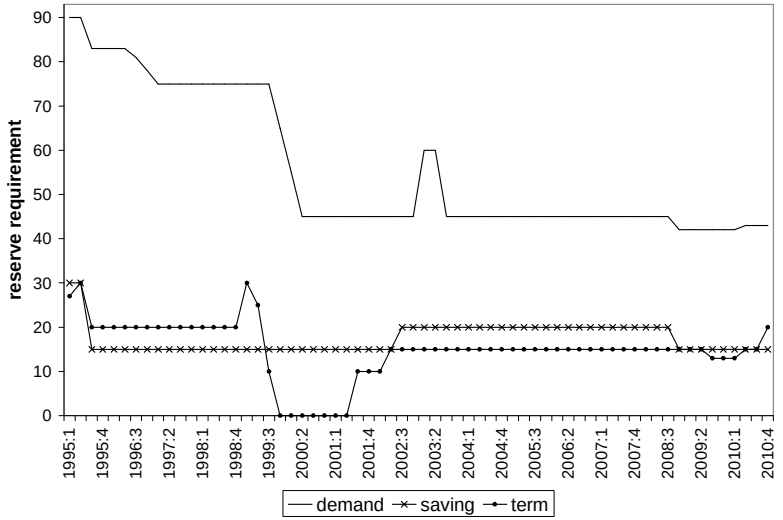
[17] Lim, C., F. Columba, A. Costa, P. Kongsamut, A. Otani, M. Saiyid, T. Wezel, and X. Wu, 2011, "Macroprudential policy: What instruments and how to use them?" IMF working paper 11/238

Figure 1. Level of reserve requirements.

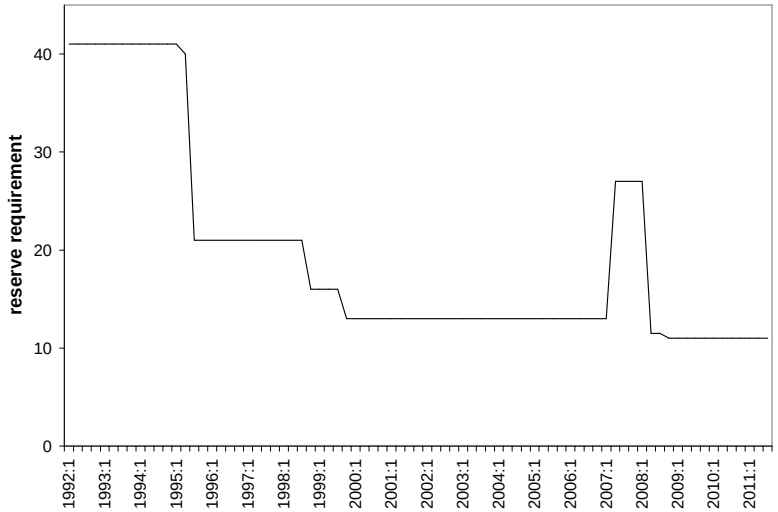
Panel A. Argentina: 1992-2011.



Panel B. Brazil: 1995-2010.



Panel C. Colombia: 1992-2011.



Panel D. Uruguay: 1992-2011

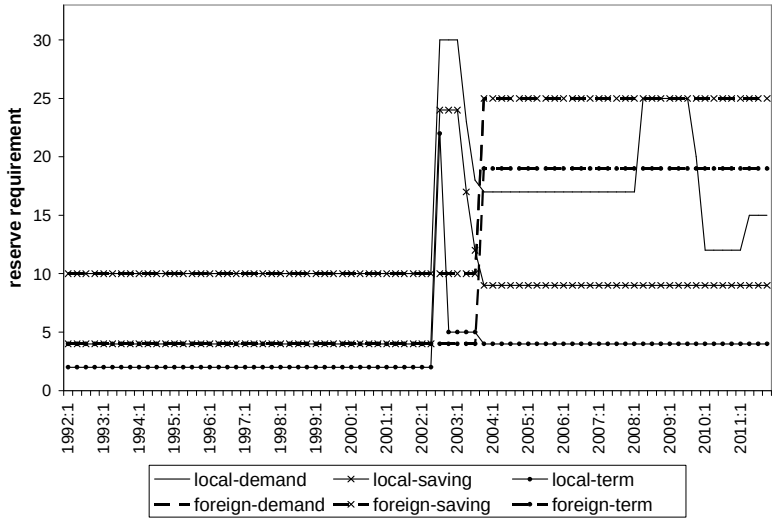
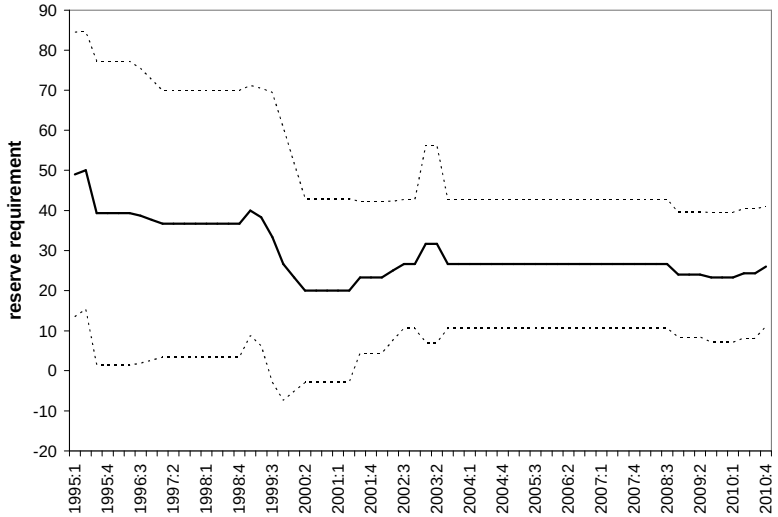


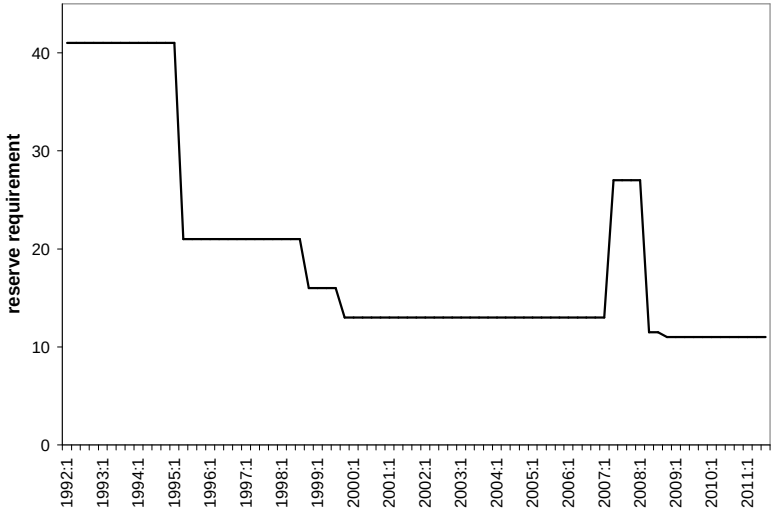
Figure 2. Mean and standard deviation of reserve requirements.

Panel A. Argentina: 1992-2011.

Panel B. Brazil: 1995-2010.



Panel C. Colombia: 1992-2011.



Panel D. Uruguay: 1992-2011

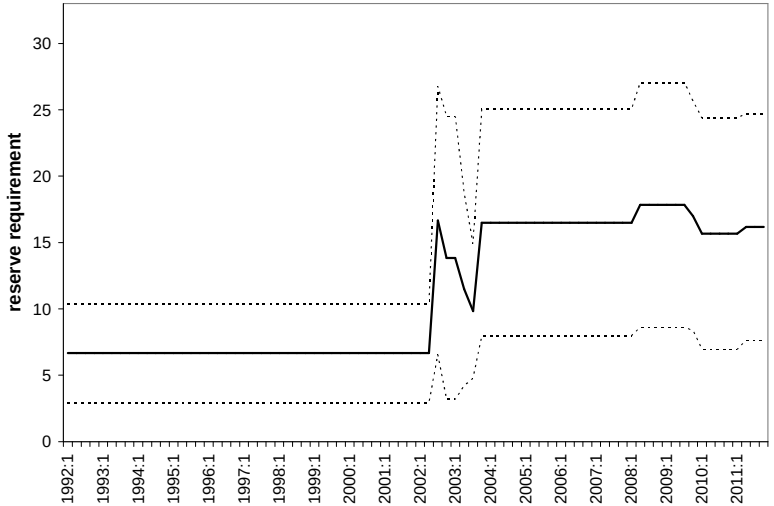
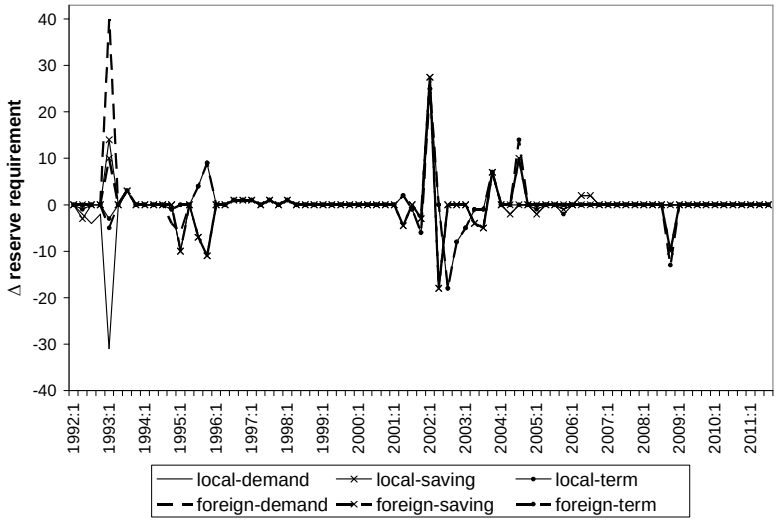
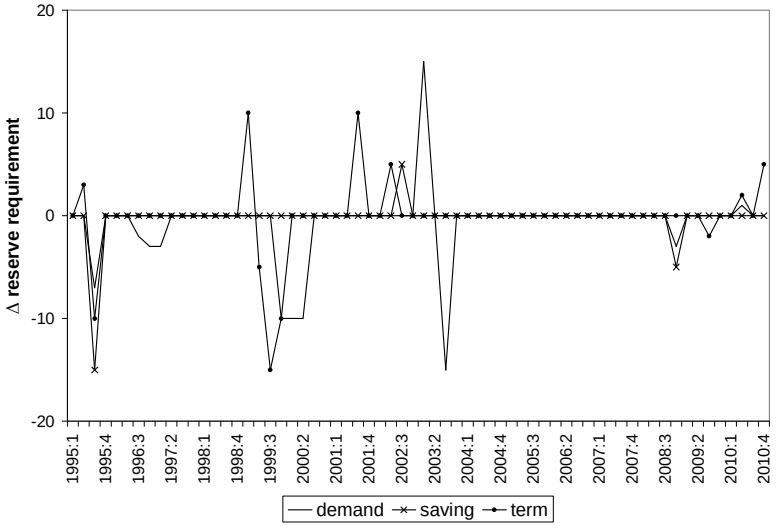


Figure 3. Change in reserve requirements.

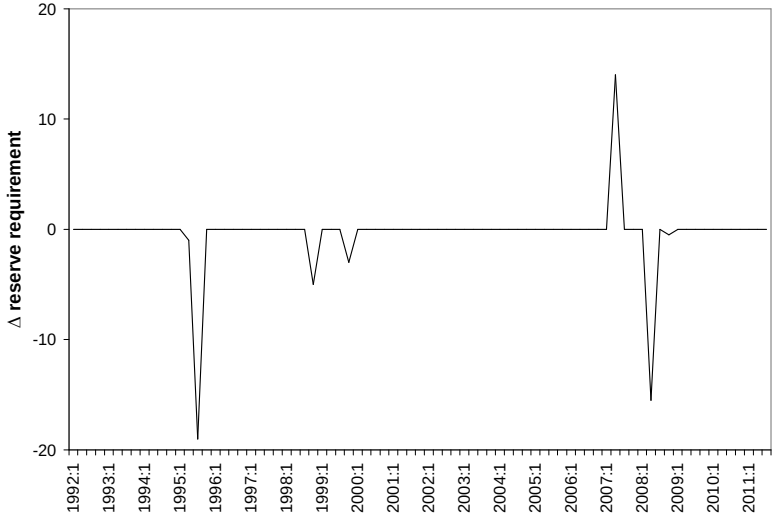
Panel A. Argentina: 1992-2011.



Panel B. Brazil: 1995-2010.



Panel C. Colombia: 1992-2011.



Panel D. Uruguay: 1992-2011

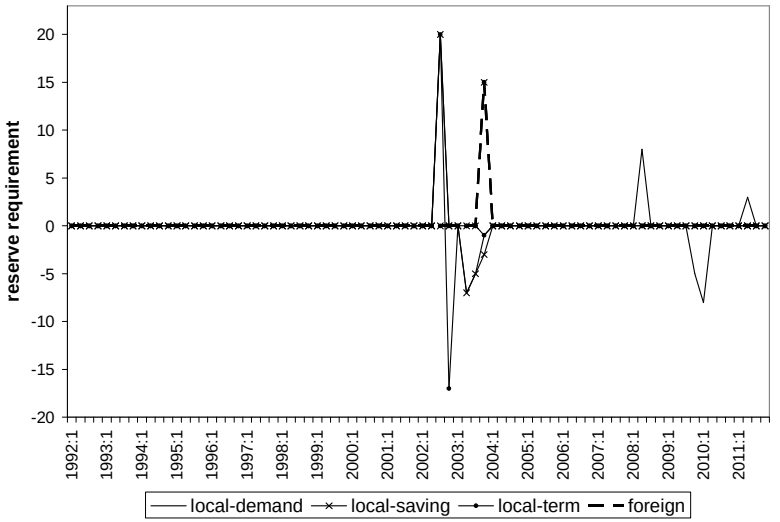
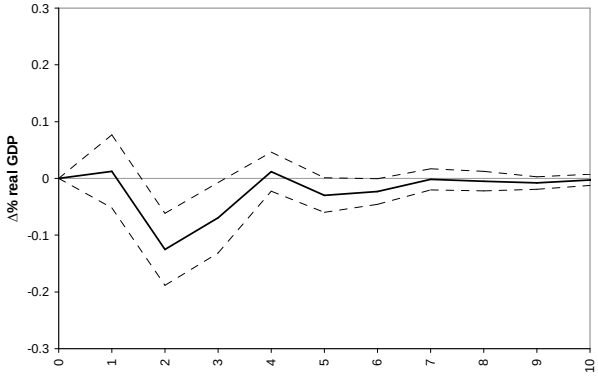
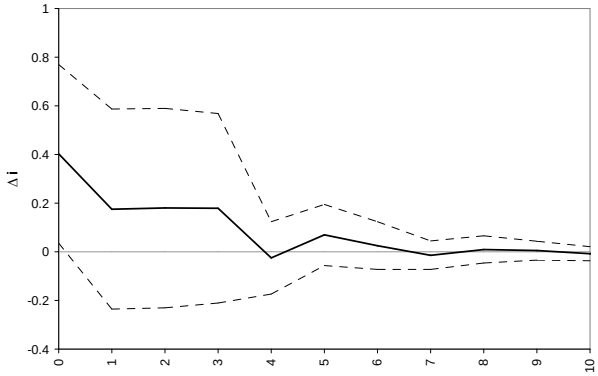


Figure 4. Monetary policy in United States (1970-2011). Three-variable VAR: real GDP growth, inflation, and change in Federal Funds Rate (i). One percentage shocks.

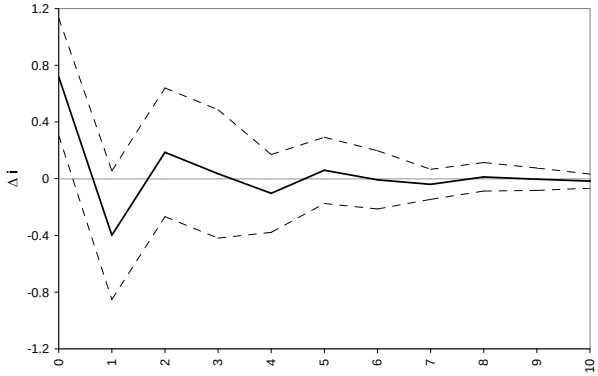
Panel A. Effect of monetary policy on real GDP.



Panel B. Effect of real GDP shock on i.



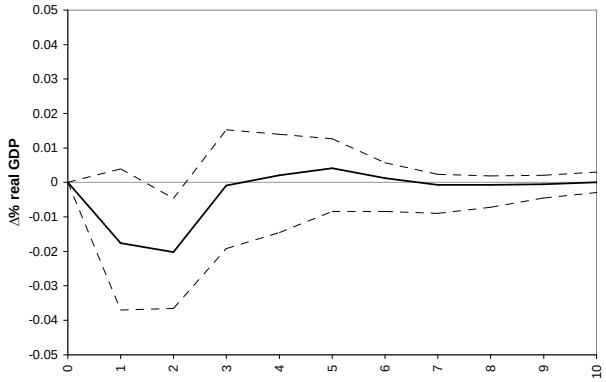
Panel C. Effect of inflation shock on i.



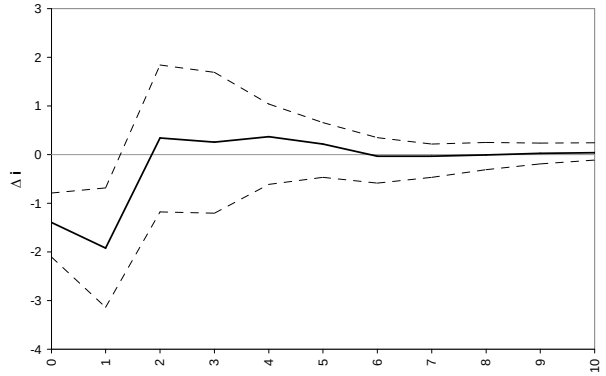
Note: The three variables in VAR are real GDP growth rate, inflation, and changes in Federal Fund Rate; in that order. Changing the order of variables does not affect qualitatively our main (cumulative) results. Results are now shown for brevity. Dashed lines refer to 95 percent confidence intervals.

Figure 5. Monetary policy. Three-variable panel VAR: real GDP growth, inflation, and change in central bank interest rate (i). One percentage shocks.

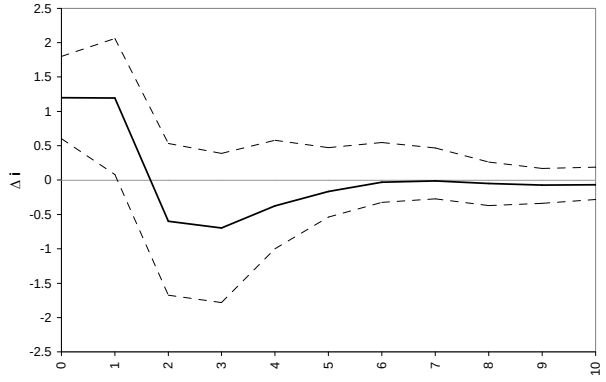
Panel A. Effect of monetary policy on real GDP.



Panel B. Effect of real GDP shock on i.



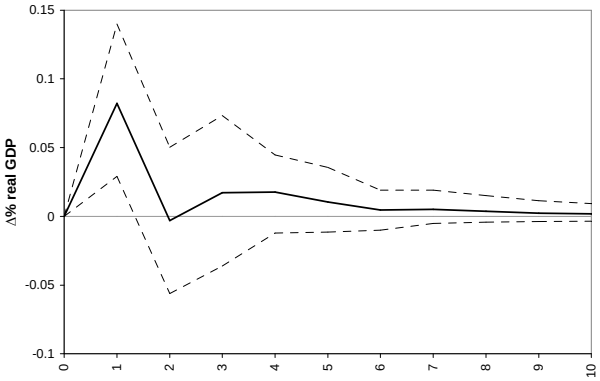
Panel C. Effect of inflation shock on i.



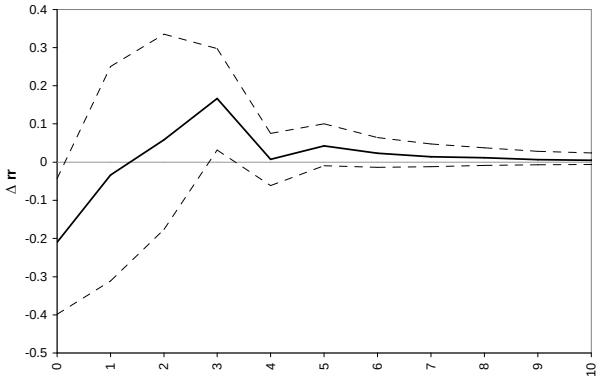
Note: The three variables in panel VAR are real GDP growth rate, inflation, and changes in central bank interest rate; in that order. Changing the order of variables does not affect qualitatively our main (cumulative) results. Results are now shown for brevity. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 6. Reserve requirement policy. Three-variable panel VAR: real GDP growth, inflation, and all changes in reserve requirement (rr). One percentage shocks.

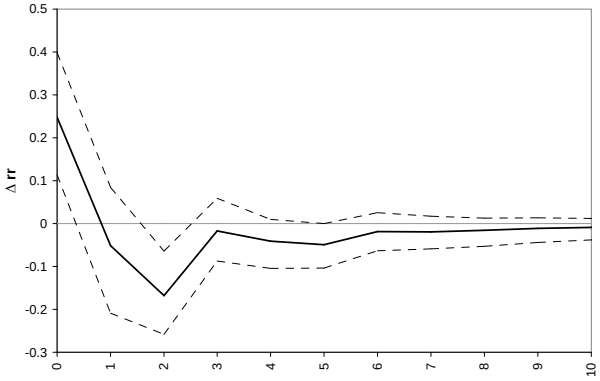
Panel A. Effect of rr policy (all changes) on real GDP.



Panel B. Effect of real GDP shock on rr.



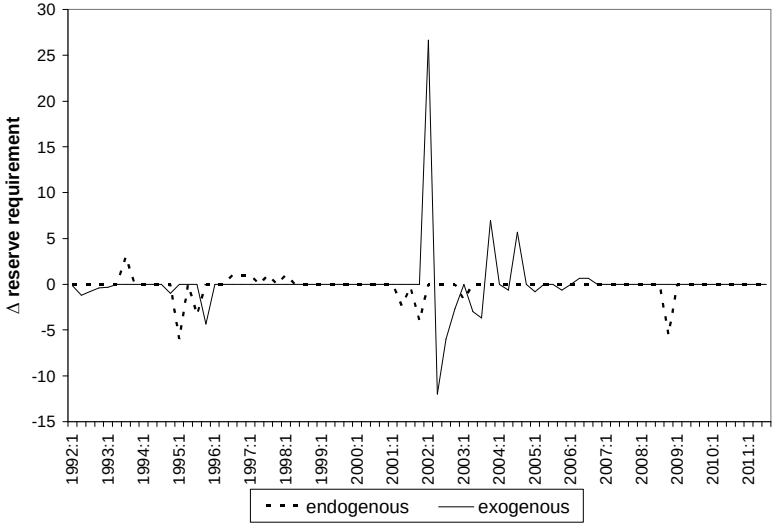
Panel C. Effect of inflation shock on rr.



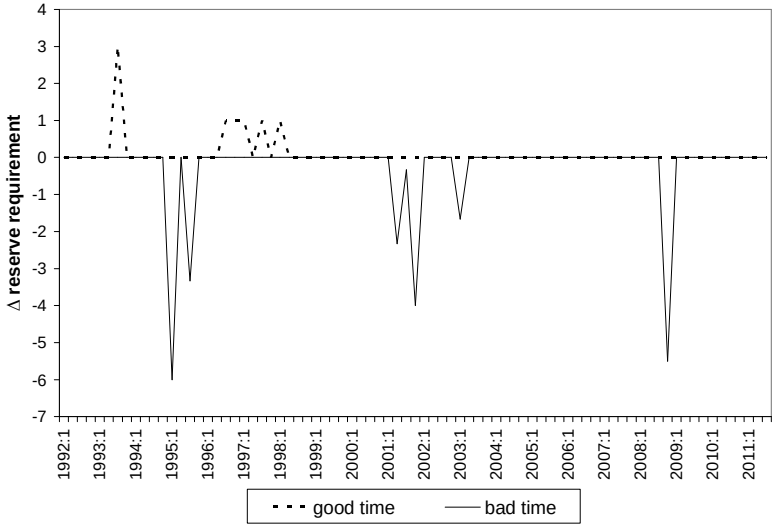
Note: The three variables in panel VAR are real GDP growth rate, inflation, and all changes in reserve requirement; in that order. Including changes in central bank interest rate or changing the order of variables does not affect qualitatively our main (cumulative) results. Results are now shown for brevity. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 7. Change in average reserve requirements.

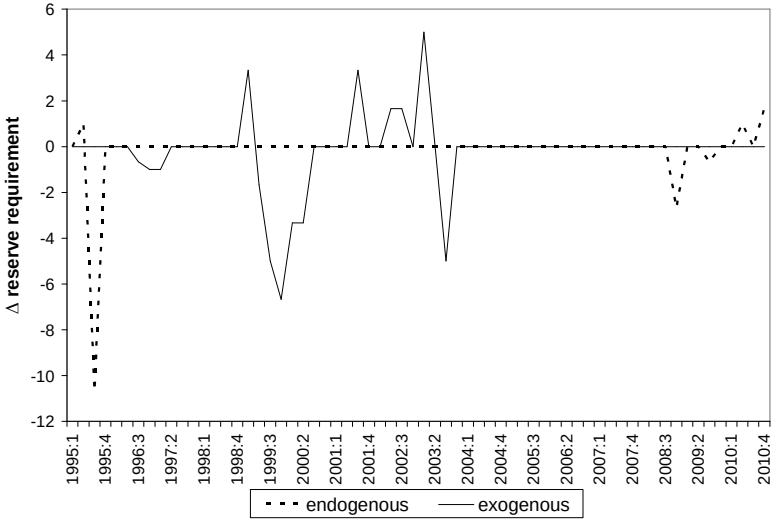
Panel A. Argentina: 1992-2011. Endogenous and exogenous.



Panel B. Argentina: 1992-2011. Endogenous: good and bad times.



Panel C. Brazil: 1995-2010. Endogenous and exogenous.



Panel D. Brazil: 1995-2010. Endogenous: good and bad times.

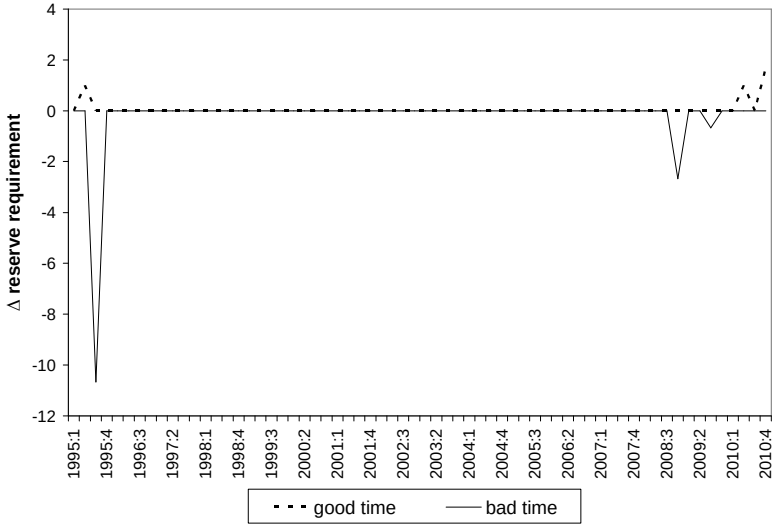
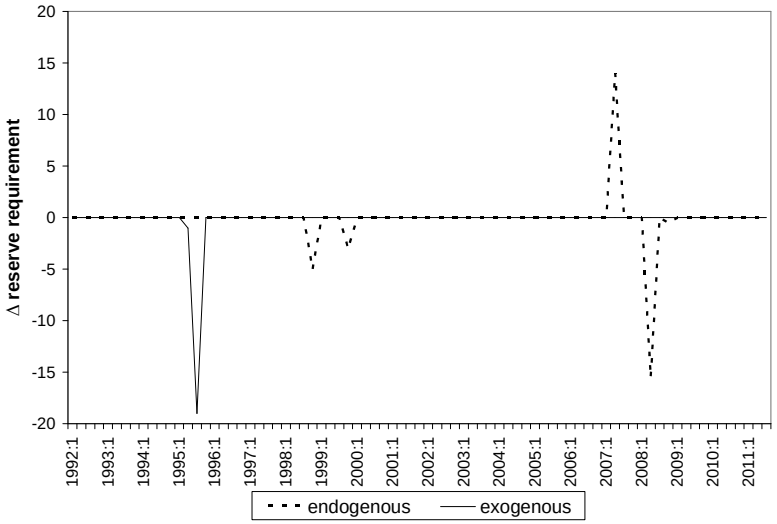
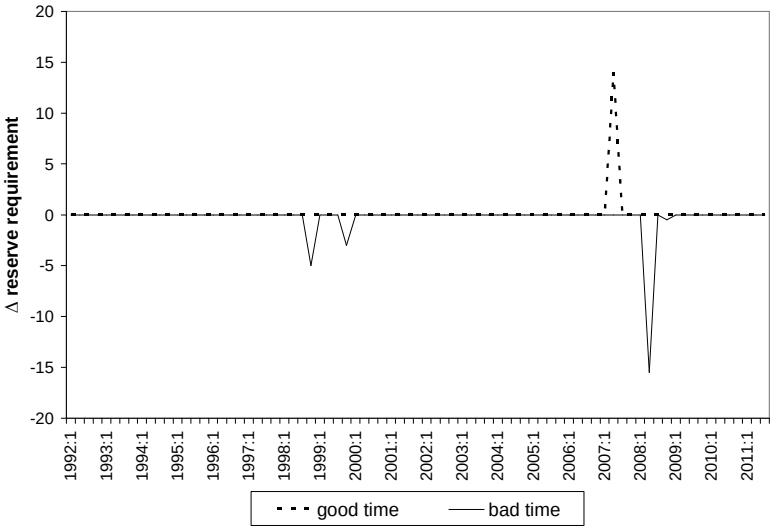


Figure 7 cont. Change in reserve requirements.

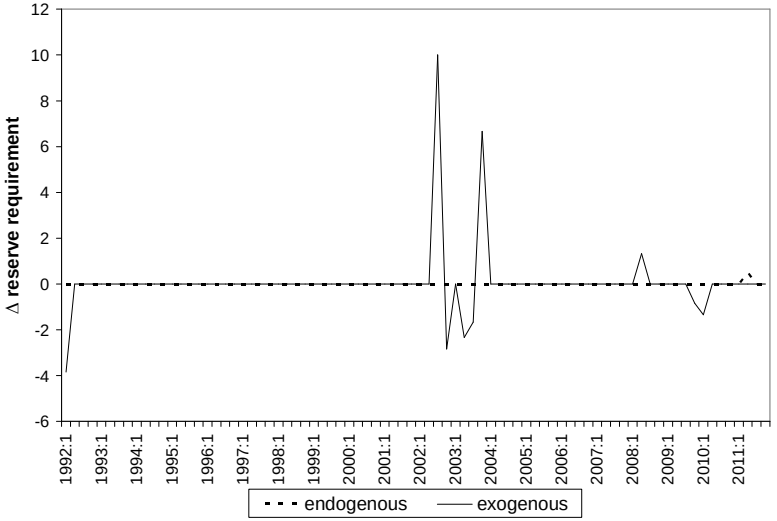
Panel E. Colombia: 1992-2011. Endogenous and exogenous.



Panel F. Colombia: 1992-2011. Endogenous: good and bad times.



Panel G. Uruguay: 1992-2011. Endogenous and exogenous.



Panel H. Uruguay: 1992-2011. Endogenous: good and bad times.

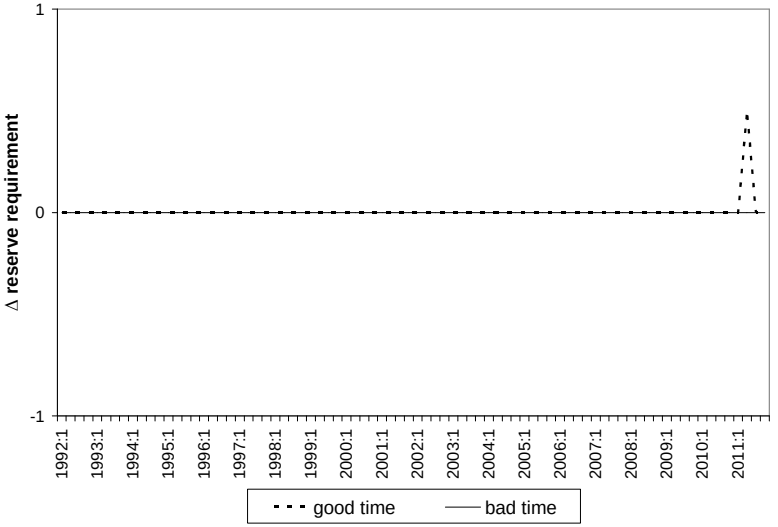
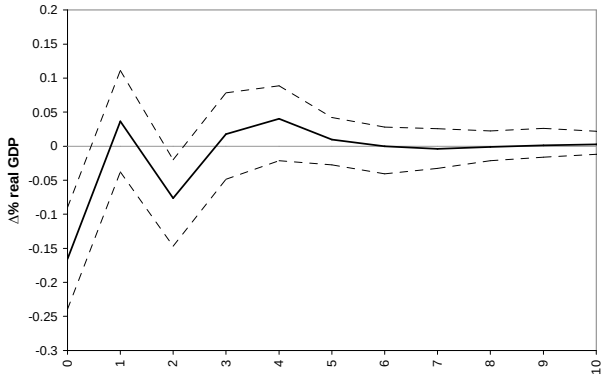
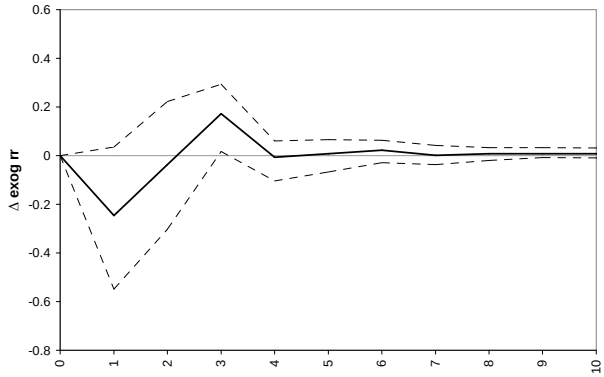


Figure 8. Reserve requirement policy. Three-variable panel VAR: exogenous changes in reserve requirement (exog rr), real GDP growth, and inflation. One percentage shocks.

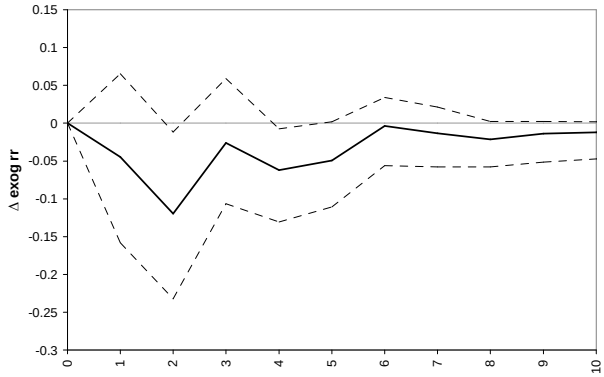
Panel A. Effect of rr policy (exog changes) on real GDP.



Panel B. Effect of real GDP shock on exog rr.



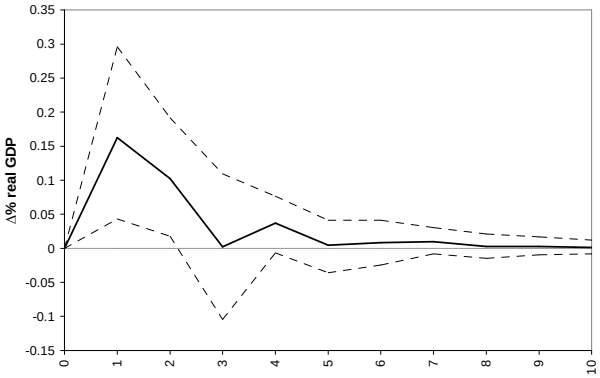
Panel C. Effect of inflation shock on exog rr.



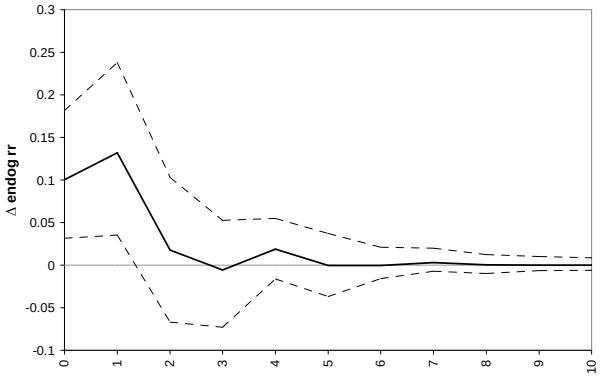
Note: The three variables in panel VAR are exogenous changes in reserve requirement (exog rr), real GDP growth rate, and inflation; in that order. Similar results are obtained if changes in endogenous reserve requirement and/or changes in central bank interest rate are included in the system. Results are now shown for brevity. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 9. Reserve requirement policy. Three-variable panel VAR: real GDP growth, inflation, and endogenous changes in reserve requirement (endog rr). One percentage shocks.

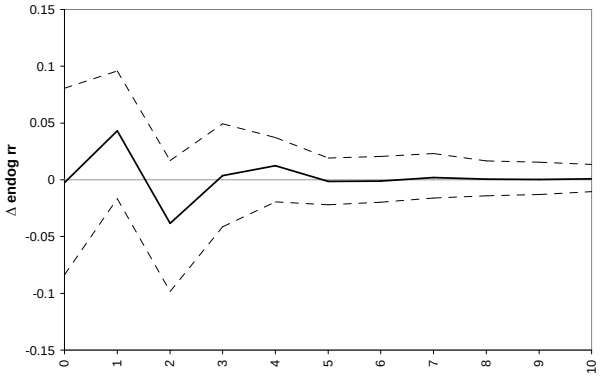
Panel A. Effect of rr policy (endog changes) on real GDP.



Panel B. Effect of real GDP shock on endog rr.



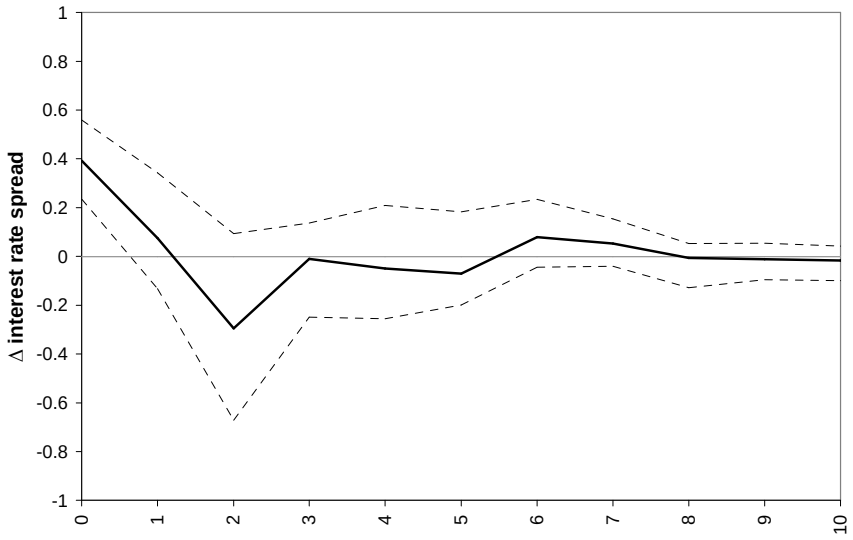
Panel C. Effect of inflation shock on endog rr.



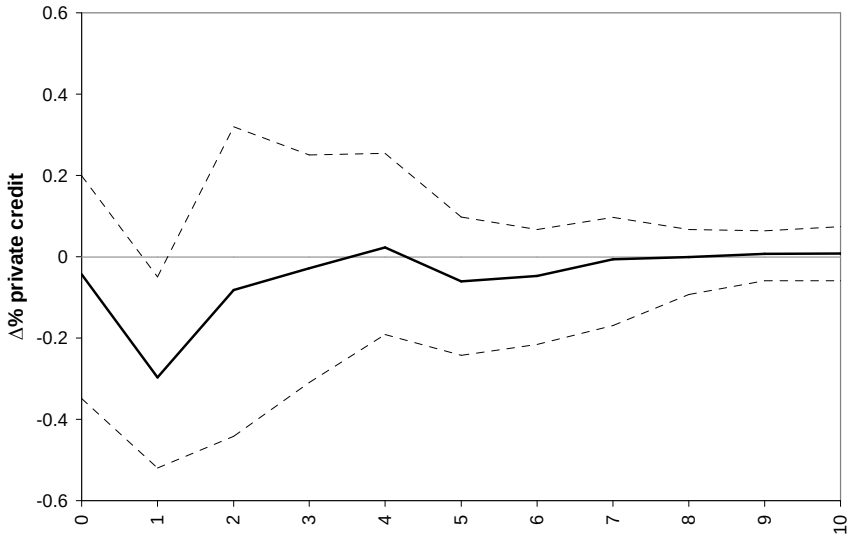
Note: The three variables in panel VAR are real GDP growth rate, inflation, and endogenous changes in reserve requirement (endog rr); in that order. Changing the order of variables and/or including changes in central bank interest rate does not affect qualitatively our main (cumulative) results. For example, if we ordered the variables as endogenous changes in reserve requirement, GDP growth rate, inflation, and changes in central bank interest rate the cumulative effect on endog rr to real GDP shock will be positive. Results are now shown for brevity. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 10. Other macroeconomic effects of reserve requirement policy. One percentage-point increase in reserve requirement. Five-variable panel VAR.

Panel A. Effect on interest rate spread.



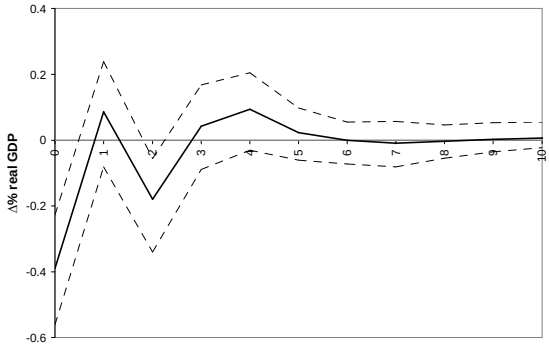
Panel B. Effect on private credit.



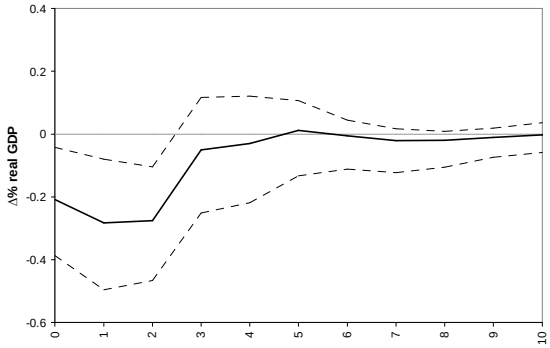
Note: The five variables in panel VAR in Panel A are exogenous changes in reserve requirement, real GDP growth rate, inflation, interest rate spread, and changes in central bank interest rate; in that order. Interest rate spread is defined as lending minus deposit interest rates. In Panel B, private credit growth rate is used instead of interest rate spread. Similar results are obtained if changes in endogenous reserve requirement and/or changes in central bank interest rate are included in the system. Results are now shown for brevity. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 11. Relative effect of reserve requirement versus monetary policy. One standard-deviation shocks.

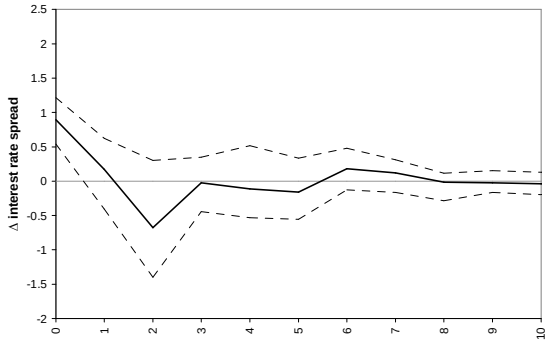
Panel A. Effect of reserve req. policy on real GDP.



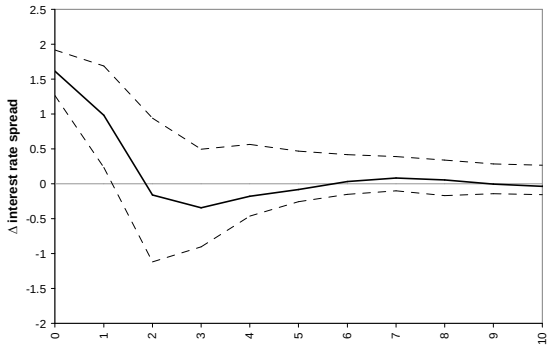
Panel B. Effect of monetary policy on real GDP.



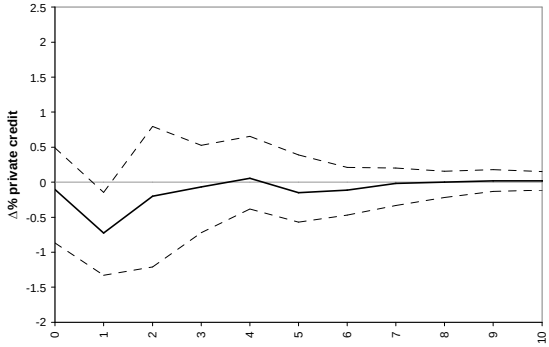
Panel C. Effect of reserve req. policy on interest rate spread.



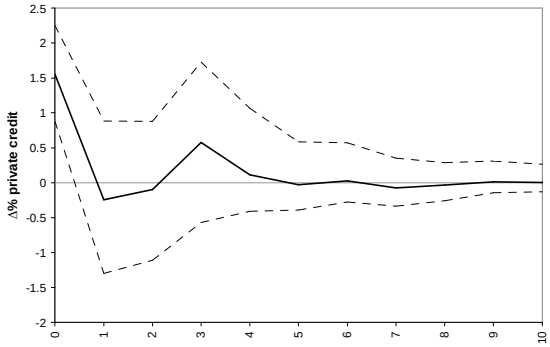
Panel D. Effect of monetary policy on interest rate spread.



Panel E. Effect of reserve req. policy on private credit.



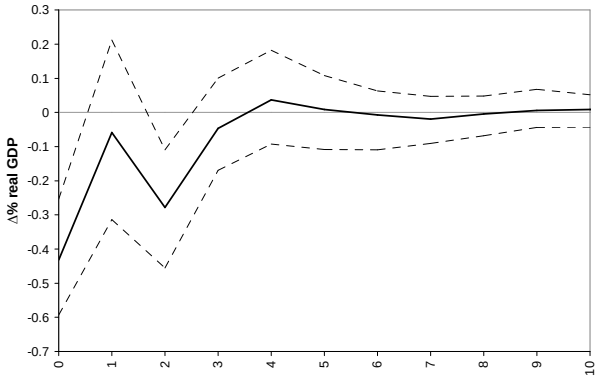
Panel F. Effect of monetary policy on private credit.



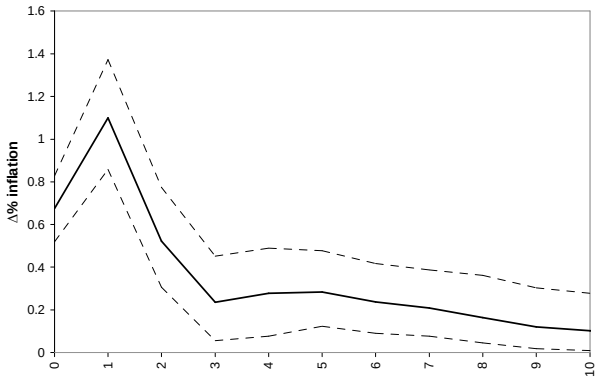
Note: Panels A and B use a four-variable panel VAR. The four variables are exogenous changes in reserve requirement, changes in central bank interest rate, real GDP growth rate, and inflation; in that order. Panels C and D use a five-variable panel VAR. The five variables are exogenous changes in reserve requirement, changes in central bank interest rate, real GDP growth rate, inflation, and interest rate spread; in that order. Interest rate spread is defined as lending minus deposit interest rates. Panels E and F use a five-variable panel VAR. The five variables are exogenous changes in reserve requirement, changes in central bank interest rate, real GDP growth rate, inflation, and private credit growth rate; in that order. Both, the reserve requirement and monetary (i.e., central bank interest rate) shocks involve a one standard-deviation shock. Changing the order of changes in central bank interest rate does not affect qualitatively our main (cumulative) results. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 12. Fear of free falling. One standard-deviation increase in nominal exchange rate (i.e., depreciation). Five-variable panel VAR.

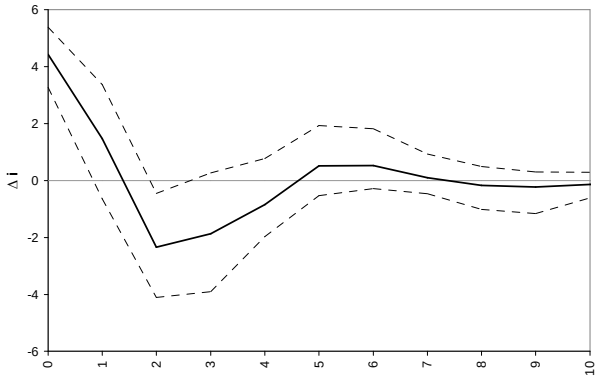
Panel A. Effect on real GDP.



Panel B. Effect on inflation.



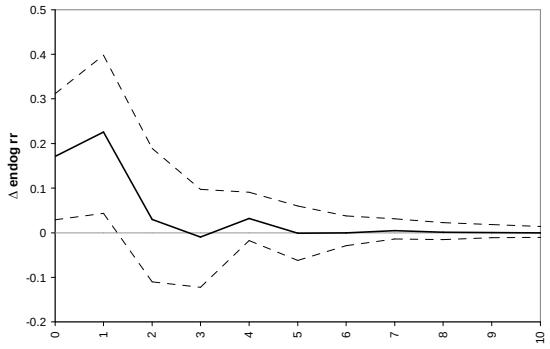
Panel C. Effect on central bank interest rate.



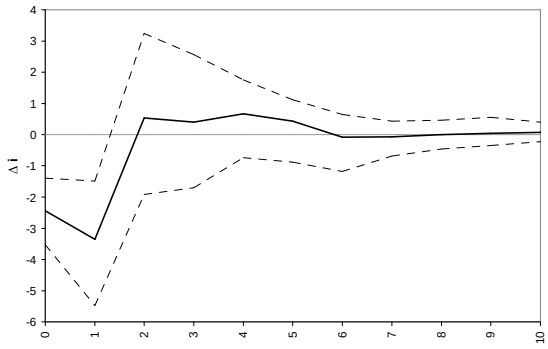
Note: The five variables in panel VAR are nominal exchange rate depreciation, real GDP growth rate, inflation, changes in central bank interest rate, and endogenous changes in reserve requirement; in that order. Changing the order of nominal exchange rate depreciation does not affect our main (cumulative) results. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Figure 13. Substitutability between reserve requirement and monetary policies. One standard-deviation shocks.

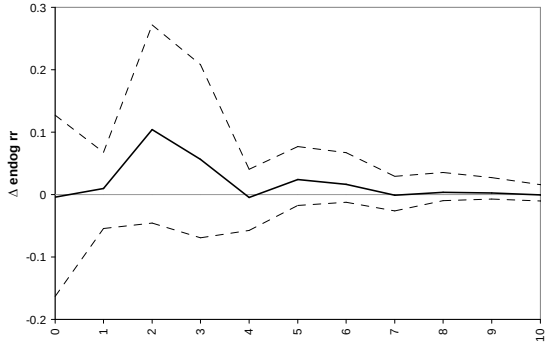
Panel A. Effect of real GDP shock on reserve req. policy.



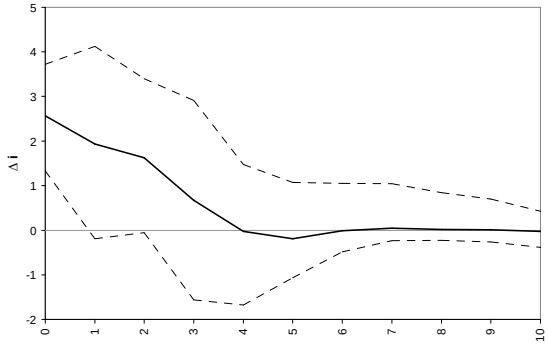
Panel B. Effect of real GDP shock on monetary policy.



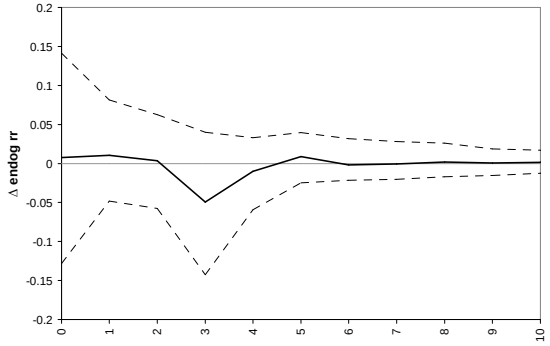
Panel C. Effect of private credit shock on reserve req. policy.



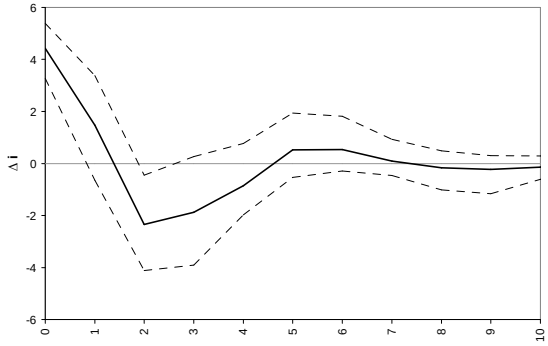
Panel D. Effect of private credit shock on monetary policy.



Panel E. Effect of nominal exchange rate depreciation shock on reserve req. policy.



Panel F. Effect of nominal exchange rate depreciation shock on monetary policy.



Panels A and B use a four-variable panel VAR. The four variables are real GDP growth rate, inflation, changes in central bank interest rate, and endogenous changes in reserve requirement; in that order. Panels C, D, E, and F use a five-variable panel VAR. The five variables in panel VAR are real GDP growth rate, inflation, private credit growth rate, changes in central bank interest rate, and endogenous changes in reserve requirement; in that order. Changing the order of variables does not affect our main (cumulative) results. Results are now shown for brevity. The five variables in panel VAR are nominal exchange rate depreciation, real GDP growth rate, inflation, changes in central bank interest rate, and endogenous changes in reserve requirement; in that order. Real GDP growth rate, private credit growth rate, and nominal exchange rate depreciation shocks involve a one standard-deviation shock. Dashed lines refer to 95 percent confidence intervals constructed using Monte Carlo simulations.

Table 1. Categories of changes in reserve requirements.

	total	exogenous	endogenous
Argentina (1992:1-2011:3)	33	20	13
Brazil (1995:1-2010:4)	20	14	6
Colombia (1992:1-2011:3)	6	1	5
Uruguay (1992:1-2011:4)	10	9	1
Total	69	44	25

Table 2. Correlation between change of reserve requirements

Panel A. Argentina: 1992-2011.

	Δ RR(local-demand)	Δ RR(local-saving)	Δ RR(local-term)	Δ RR(foreign-demand)	Δ RR(foreign-saving)	Δ RR(foreign-term)	Δ RR(average)
Δ RR(local-demand)	1						
Δ RR(local-saving)	0.52***	1					
Δ RR(local-term)	0.43***	0.42***	1				
Δ RR(foreign-demand)	0.92***	0.92***	0.46***	1			
Δ RR(foreign-saving)	0.56***	0.93***	0.41***	0.99***	1		
Δ RR(foreign-term)	0.40***	0.34***	0.88***	0.57***	0.51***	1	
Δ RR(average)	0.73***	0.86***	0.71***	0.94***	0.91***	0.73***	1

Panel B. Brazil: 1995-2011.

	Δ RR(demand)	Δ RR(saving)	Δ RR(term)	Δ RR(average)
Δ RR(demand)	1			
Δ RR(saving)	0.23**	1		
Δ RR(term)	0.22**	0.34***	1	
Δ RR(average)	0.74***	0.63***	0.75***	1

Panel C. Uruguay: 1992-2011.

	Δ RR(local-demand)	Δ RR(local-saving)	Δ RR(local-term)	Δ RR(foreign-demand)	Δ RR(foreign-saving)	Δ RR(foreign-term)	Δ RR(average)
Δ RR(local-demand)	1						
Δ RR(local-saving)	0.86***	1					
Δ RR(local-term)	0.60***	0.71***	1				
Δ RR(foreign-demand)	-0.03	-0.13	0.04	1			
Δ RR(foreign-saving)	-0.03	-0.13	0.04	1***			
Δ RR(foreign-term)	-0.03	-0.13	0.04	1***	1***		
Δ RR(average)	0.78***	0.75***	0.72***	0.50***	0.50***	0.50***	1