Macroprudential and Monetary Policy: Loan-Level Evidence from Reserve Requirements

Cecilia Dassatti Camors* † José-Luis Peydró Francesc R. Tous

December, 2015

Abstract

Emerging markets with capital inflows may prefer to tighten reserve requirements, especially stemming from the foreign wholesale market, rather than increasing monetary rates. In this paper we analyze the impact of reserve requirements on the supply of credit to the real sector. For identification, we exploit a tightening of reserve requirements in Uruguay and its credit register that follows all bank loans granted to non-financial firms. The tightening of requirements was stronger for banks with higher liabilities from foreign banks and in foreign currency. Following a difference-in-difference approach, we compare lending to the same firm before and after the policy change among banks differently affected by the policy. We find that the tightening of the reserve requirements for banks imply a reduction of the supply of credit to firms; more affected banks increase their exposure into riskier firms; and larger and more solvent banks mitigate the effects. Importantly, the stronger quantitative results are for the tightening to bank liabilities stemming from foreign banks. Moreover, the firm level analysis reveals that the cut in credit supply in the loan-level analysis was binding for firms. The results have implications for macroprudential, monetary and capital inflows policies.

*Cecilia Dassatti Camors: Banco Central de Uruguay: cdassatti@bcu.gob.uy, (+598)219671994; José-Luis Peydró: ICREA - Universitat Pompeu Fabra, CREI, Barcelona GSE, CEPR, jose.peydro@upf.edu, (+34)935421756; Francesc R. Tous: Bank of England and UPF, francesc.rodriguez-tous@bankofengland.co.uk, (+44)2034617268. We are extremely grateful to the Central Bank of Uruguay for providing the data for this study. We thank Stephane Bonhomme, Marco Lombardi, Javier Suarez, Rafael Repullo, Judit Montoriol-Garriga, Stijn Claessens, Xavier Freixas, David Martinez-Miera, participants at The French Prudential Supervisory Authority conference on "Risk Taking in Financial Institutions, Regulation and the Real Economy", and seminar participants at the Federal Reserve Board, Central Bank of Uruguay, CEMFI, UPF and EBRD for very helpful comments and suggestions.

†The views expressed in this article are the sole responsibility of their authors and do not compromise the institutional positions of the Central Bank of Uruguay and the Bank of England.

1 Introduction

Past banking crises and also the recent global financial crisis have shown the importance of credit and monetary policy on both the aggregate economy and financial stability (Bernanke (1983); Reinhart and Rogoff (2009); Schularick and Taylor (2012)). Financial crises are typically preceded by bank credit booms that can be fuelled by foreign liquidity (Jorda, Schularick and Taylor (2013), Gourinchas and Obstfeld (2013)) and local domestic monetary policies through interest rates may be ineffective (Rey, 2013; Rajan (2014). Not surprisingly, many emerging countries are trying to use reserve requirements, often on non-insured non-deposit liabilities, which are very related to the new macroprudential policies that are discussed (Hanson, Kashyap, Stein, 2013) and also on liquidity requirements of Basel III. Moreover, the identification of the bank lending channel through reserve requirements (Bernanke and Blinder (1988 and 1992); Stein (1998) and Kashyap and Stein (2000)) have been elusive.

In this paper we analyze the impact of reserve requirements on the supply of credit to the real sector. Uruguay offers an excellent setup to study these effects for two main reasons: the policy changes introduced on reserve requirements on May 2008, and the exhaustive credit registry of all granted bank loans in the system. On May 2008 (binding on June), the monetary authority of Uruguay introduced changes in the regulation associated to the percentage of funds that banks must keep as reserves on the Central Bank: an increase in reserve requirements for short-term liabilities in both foreign and domestic currencies (10 and 8 percentage points respectively), an increase in the requirements for liabilities from the non-financial non-resident sector (5 pp), and the introduction of a reserve requirement for funds from foreign banks (35 pp). These changes were implemented under a context of economic growth and threats of inflationary pressures derived from the high prices of the most relevant commodities for the Uruguayan economy. The main motive behind the tightening was inflation. Moreover, we have access to the Credit Registry of the Central Bank of Uruguay, which is an exhaustive dataset of all the loans granted by each bank. This dataset is complemented with bank balance-sheet information from all the institutions that report to the Central Bank of Uruguay in its role as regulator and supervisor of the banking system.

To study the effects on credit availability, we first match each loan with the relevant bank balance-sheet variables and then aggregate all the different loans for each bank-firm pair in each month in order to construct a measure of total committed lending from January 2008 to December 2008. By focusing on firms' borrowing from multiple banks, we follow a difference-in-difference approach which compares lending to the same firm before (April, 2008) and after (July, 2008) the policy change among banks with different degrees of exposition to the sources of funds targeted by the policies (Jiménez, Ongena, Peydró, Saurina, 2013). This allows us to identify the effects of the new reserve requirements on the average supply of loans, both on the intensive and the extensive margins, and the heterogeneous effects of these changes among different firm and bank characteristics. In particular, on firms' heterogeneity, we analyze whether the impact is different from firms with different ex-ante risk, and on banks' heterogeneity, we

analyze bank size, solvency and liquidity (Kashyap and Stein, 2000). Moreover, as we lose a significant number of firms imposing multiple banks loans, we also control for unobserved borrower fundamentals with industry fixed effects. Finally, we also analyze the period before (January to April 2008) and after (July to October 2008) to run a placebo test.

The results on the intensive margin of lending suggest that the tightening of requirements reduces the supply of credit to non-financial firms. Controlling for unobserved borrower fundamentals by focusing on lending to the same firm, we find that banks more affected by the policy cut more on credit volume. These effects are statistically and economically significant: a 10 percentage points increase on total reserve requirements translates into a cut in committed lending of 4 pp. Moreover, when we analyze the impact of the introduced policies across different firm and bank characteristics, we find that the cut in committed lending is lower for ex-ante riskier firms and that larger and more solvent banks are more capable of mitigating the effects of the policy. In addition, we find that the tightening of requirements has a positive effect on the likelihood of ending a lending relationship with a firm.

The loan-level results suggest that the increase in reserve requirements tightened the supply of bank credit. However, some firms could have mitigated the negative effects of the bank lending channel by resorting to loans from banks less affected by the policy changes. In order to address this, we analyze the change in committed lending by all banks to a given firm between July and April, 2008. The results from the firm-level analysis suggest that the loan-level results are binding at the firm-level, i.e. that firms with higher ex-ante credit from banks more affected by the policy obtain less overall bank credit ex-post. Finally, we do not find significant effects for the period before the policy (a placebo test run on January to April 2008), and for the period after (July to September 2008).

We mainly contribute to three strands of the literature. First, the bank lending channel of monetary policy through reserve requirements has been shown theoretically among others by Bernanke and Blinder (1988) and Stein (1998), however the empirical evidence has been analyzed with macro data (Bernanke and Blinder (1992)) and with bank level data (Kashyap and Stein (2000), Mora (2014)). As Khwaja and Mian (2008) among others show, loan-level data is needed to identify the supply of bank credit stemming from a bank shock. In this paper we identify the bank lending channel of monetary policy through reserve requirements with an exhaustive credit register (and the change in regulation).

Second, we contribute to the literature on macroprudential policy and capital controls. As argued by Rey (2013), domestic monetary policy through interest rates is problematic in emerging markets with capital inflows. Reserve requirements can therefore be useful for changing the stance of monetary policy, and, moreover, as reserve requirements can target differently distinctive bank liabilities, they can tighten even more short-term wholesale-uninsured foreign liabilities that may be more fragile in crisis times. This

links monetary policy with macroprudential policies and policies on capital controls. Importantly, in Uruguay we find the strongest quantitative effects for the introduction of a reserve requirement for funds from foreign banks. Interestingly, the tightening of requirements cut credit supply for firms, but more affected banks reacted by concentrating more their credit supply to ex-ante riskier borrowers, probably to compensate for the reduction in bank profits stemming from the liquidity funds in the central bank at a penalized low rates.

We also contribute to the recent literature on the impact of reserve requirements on financial stability. There has been a renewed interest on this policy, mainly due to the search for new macroprudential tools (Tovar et al., 2012, Montoro and Moreno, 2011, Federico et al., 2014). While the previous papers study country-level evidence on the effectiveness of reserve requirements, our paper is, to our knowledge, the first one to identify the effect on credit by using disaggregated data on individual loans and hence to be able to control for credit demand.

The rest of the paper proceeds as follows. Section 2 discusses the data that we use and the policy change that we study. Section 3 introduces the empirical strategy and presents the results. Section 4 concludes with a summary of the results and a discussion on some policy implications.

2 Data and policy change

We have access to two datasets from the Central Bank of Uruguay in its role as banking regulator and supervisor. Both datasets cover the period from January 2008 to December 2008 and are available on a monthly frequency. The first dataset is the Credit Registry of the Central Bank of Uruguay (*"Central de Riesgos"*), which is an exhaustive record of all loans granted in the system with detailed information at the loan level. In particular, it contains information about the identity of the borrower, whether the borrower is a firm or a household, the country of residence, the economic sector to which it belongs, all the financial institutions with which it has a loan, the amount of the loan, the currency of the loan, its maturity, and the credit rating given by the bank to the firm. The rating given by the bank takes into account the current situation of the loan, and it can go from 1 to 5, being 5 the riskiest rating.[1] Moreover, banks provide information of whether the outstanding loan with a particular firm represents a substantial amount in terms of the bank balances (through a 'High Debt' dummy). On the other hand, we also have access to a dataset with balance sheet information for all the banks operating in the system during the period 2008.

We focus on loans granted to non-financial private firms, making a total of 46.595 firms and 19 financial institutions for the total sample (January to December 2008). Given that we focus only on loans granted to firms, this dataset is comprehensive, since the monthly reporting threshold is of approximately

[1] Appendix Table A1 provides a more detailed description of all variables.

USD 1.500. The sample includes one public bank, 12 private commercial banks and 6 non-bank financial institutions.[2]

During this period there were changes in the structure of the market. In particular, there was a fusion between two banks present in the Uruguayan banking system, and an acquisition of one bank by a foreign bank (not present in the country until that moment). Both cases were treated as if they were present from the beginning of the period (in order to avoid loosing the observations associated to the banks that disappeared), which means that the final number of banks under analysis is 18.

The Uruguayan Financial System

2002 crisis The decade of the 1990s was characterized by the implementation of new and important economic reforms in Uruguayan neighboring countries: the Convertibility Plan (Argentina, 1991) and the Real Plan (Brazil, 1993), which linked the value of the domestic currency to the American dollar. At the same time, in Uruguay, the goal that guided the design of the whole policy was the achievement of lower inflation levels, so that fiscal and exchange rate measures taken were functional to the implementation of the Stabilization Plan.

The Stabilization Plan of 1991 led to an economic boom in the Uruguayan economy. However, the negative regional context experienced during the following years made evident the difficulties that the Uruguayan economy was experiencing: in particular, the increasing fiscal deficits and the deterioration of the country risk. The devaluations of the Brazilian real first and the Argentinean peso afterwards introduced doubts about the convenience of maintaining the flotation band for the exchange rate.

The problems experienced in Argentina had fostered an increase of Argentinean deposits in the Uruguayan banking system from the end of 1987 until 1991, when the parity of the Argentinean peso to the American dollar started to gain confidence. The growth rate of these deposits remained stable during the first half of the nineties, but the consequences of the Mexican crisis and the economic turbulences in Argentina during 2001 (being one of them the abandonment of the parity which resulted in significant losses from the compulsive conversion of deposits to pesos) renewed the attraction of Argentinean depositors to the Uruguayan system. This came to an end on December 2001, when two important institutions that had significant links with Argentina started to experience large runs. During the first two months of 2002 these withdrawals expanded to domestic deposits and to other institutions as a consequence of a series of events: the interruption of activities of Banco Galicia, the official knowledge of an important fraud in Banco Comercial and the loss of the investment grade of the sovereign debt. Finally, the bank run reached record levels on June 2002 as a consequence of the abandonment of the flotation band regime for the exchange rate and the intervention of Banco Montevideo by the Central Bank of Uruguay.

A bank holiday was declared between July 29 and August 5. During this period, Uruguay signed a

[2]There is another public bank in the Uruguayan banking system, but it has been excluded from the sample since its main line of business are mortgages to households (while our focus is on loans granted to private firms) and it has experienced several restructures and recapitalizations.

stand-by agreement with the IMF and the Parliament approved a law for rescheduling the maturity of the foreign currency time deposits held in public banks. The financial aid received contributed to the implementation of a Stability Fund for the Banking System to guarantee all the foreign currency deposits held in public banks. These funds were also used for refunding of some of the deposits from three suspended institutions (Banco Comercial, Banco Montevideo-Caja Obrera, and Banco De Crédito).
The consequences of 2002 crisis led to regulatory reforms (which included the 17.613 "Law for Strengthening the Financial System") in order to correct some market failures, covering issues such as the introduction of a deposit insurance (in order to avoid the implicit guarantee from the Government from previous financial crises), the creation of a Superintendence for the Protection of Bank Savings, the development of a financial safety net and the strengthening of the supervisor and liquidator attributions of the Central Bank of Uruguay. In addition, after the increase of September 2002, the Superintendence of Financial Institutions reduced the level of reserve requirements for domestic currency deposits for maturities of less than one year (April 2003) and eliminated the requirements for longer maturities (November 2002) in an attempt to discourage dollarization. Also, given the important bank run from non-residents and the inexistence of reserve or liquidity requirements associated to these deposits, the Superintendence gradually introduced (from 2003) minimum reserve requirements over the total level of non-residents' deposits. Later reforms also included different levels of provisions for domestic and foreign currency loans and the introduction of Basel Standards of capital requirements.

Monetary policy after the crisis From 1990 until July 2002 the prevalent currency regime was based on flotation bands, so the monetary policy was focused on preserving the level of international reserves and reducing the exchange rate volatility. The results of the stabilization plan in terms of inflation were positive: inflation decreased from an average level of 112% on 1990 to 4.4% on 2001. The exchange rate band width was initially set to 7% (1992) but was later reduced to 3% (1998). However, the problematic events of 2001 and 2002 led to a significant decrease in the level of international reserves, so the width was first amplified to 6% in 2001, and further increased to 12% in 2002. Finally, the consequences of the financial crisis determined the abandonment of the flotation band regime on June 2002 and the adoption of a free exchange rate regime.
After the abandonment of the currency bands and the strong deterioration of the level of international reserves, the potential strategies of the Central Bank of Uruguay had become very restricted: the available options were to anchor inflation expectations through the management of the interest rate or the quantity of money. However, the high degree of dollarization and the fact that Uruguay is a small open economy made the interest rate instrument less attractive. This situation led to the adoption of a monetary target regime, for which the main ingredient was the existence of a stable relationship between the intermediate objective (the monetary aggregate selected) and the final objective (inflation). In addition, an operational target was needed in order to have an effect on the intermediate target, so the initial compromise set on 2003 was defined over the average monetary base , announced for a 12 months

horizon jointly with the inflation target for that period. The operational characteristics of the regime were gradually changed as the agents' expectations started to align with the compromises announced by the monetary authority.

Summing up, until July 2007 monetary aggregates became the main component of the new policy. In the first stage, which lasted throughout the course of 2003, the monetary policy was based on the strict compliance with monetary base targets in order to recover the Central Bank's reputation and to anchor market expectations, elements that had been deeply affected during 2002 crisis. From early 2004 until the first half of 2005, and as a result of a more favorable macroeconomic environment, the monetary policy began to pay more attention to the evolution of inflation. This was achieved through the determination of a range of variation for monetary base instead of setting goals in the form of specific values, thus allowing for greater flexibility in the conduct of monetary policy. From the second half of 2005, price stability took on a greater role as an objective of monetary policy since the variations caused in the monetary base were declared as the policy instrument, which was handled based on prices behavior. Finally, towards the end of 2005 the Central Bank of Uruguay stopped announcing the path of the monetary base and proceeded to guide the use of all monetary policy instruments available to the achievement of the level of inflation projected, moving further to an inflation targeting scheme. However, monetary aggregates continued fulfilling its role as the effective anchor of the monetary policy. Thus, the Central Bank of Uruguay announced the inflation rate to be achieved within the next 12 months, concentrating exclusively on the evolution of the money supply (M1).

Garda, Lanzilotta and Mantero (2006) analyzed the relationship between the monetary aggregates and inflation in Uruguay during this period and concluded that it was asymmetric, nonlinear, and particularly sensitive to inflationary environment. In particular, since 2003, the relationship between monetary aggregate growth and inflation significantly weakened. The authors conclude that when inflation falls to low levels, money-price relationship becomes very weak. However, the Monetary Policy Committee positively assessed the monetary targeting regime implemented, as it was able to reduce and maintain inflation at single-digit values. Nonetheless, the Committee recognized that the monetary aggregates instrument was inadequate to stabilize inflation when it is low. As a consequence, in July 2007, the Central Bank of Uruguay started to gradually implement the management of the interest rate as the main monetary policy instrument.

As a result, monetary policy guidelines changed in response to the behavior observed in the inflation rate in 2007, which registered levels above the upper limit of the target range. The causes behind this evolution were factors related to costs rather than demand, in particular, increases in the international prices of agricultural commodities and oil. However, inflationary pressures of domestic origin, such as increases in wage costs and the greater dynamism of private demand, were also playing a role. Under these circumstances, the Central Bank of Uruguay started to use the interest rate (call rate on overnight interbank loans) as the main monetary policy instrument. Initially, the call rate range was defined between 4% and 6%, but due to the persistence of inflationary pressures in the economy successive upward

adjustments were decided.

So the conduct of monetary policy from 2003 was oriented progressively to the objective of inflation control, first by controlling the growth of monetary aggregates until July 2007, and then by managing the monetary policy rate. This change was based on the persistence of inflationary pressures and following consideration of the instrument of monetary aggregates as no longer effective for achieving the inflation target given the weak relationship of this variable with inflation.

Financial system during 2008 In 2008, the Uruguayan financial system was composed of 2 public banks, 12 private commercial banks and 6 non-bank financial institutions. The number of institutions has decreased as a consequence of the financial crisis of 2002 (around 30 institutions were present in the market as of December 2001) and processes of merges and acquisitions that took place afterwards. Some of the main characteristics of the system are given by a significant degree of dollarization, a high proportion of short term deposits over total deposits and sound levels of solvency and liquidity indicators. The 2008 dollarization rate was around 80% for deposits and 56% for loans, lower than the levels displayed before the 2002 crisis which were above 90% and 60% respectively. Another remarkable difference with respect to the situation of the system in the aftermath of the financial crisis was the significant participation of deposits from the foreign non-financial sector over total deposits: on December 2001, the portion of non-resident's foreign deposits was near 50% of total deposits, while on April 2008 these deposits only represented 21% of total deposits. This is an important feature since one of the drivers of the 2002 crisis was through the massive withdrawal of deposits from Argentina.

Reserve requirements

Uruguayan prudential banking regulation dates back at least to 1865, when a type of capital requirement was introduced. In the following decades, some other forms of regulation, including reserve requirements, were introduced as well. The big piece of banking legislation, called the "General Banking Law", was passed in 1938 to pursue the financial stability and safety of the banking system through three pillars: the requirement of a minimum level of capital, a minimum requirement for the relationship between capital and reserves, and a liquidity requirement. The minimum reserve requirement was set to 16% for deposits with a maturity of less than 30 days and 8% for deposits of higher maturities. Reserve requirements had to be constituted with gold, bills, public bonds and sight deposits in the National Bank, while the deposits that surpassed the limit of eight times the capital and reserve fund of the bank had to be fully backed with liquid reserves (such as public bonds, treasury bonds or current account deposits in the National Bank).

The later regulation on reserve requirements continued adapting the instrument to the reality of the

financial system in each period. As a result, the current reserve requirements vary according to both maturity and currency of the liabilities in order to contemplate the dollarization of the Uruguayan financial system and the diverse stability that deposits of different maturities display. Moreover, additional requirements such as marginal reserve requirements were temporarily introduced.

Policy change

Although the negative impact of the financial crisis in 2008 led to a downwards revision of the projections about the performance of the developed economies, the growth figures for the emerging economies remained solid. Instead, the main concerns for these economies were the inflationary pressures originated mainly by the higher prices of the commodities, context to which Uruguay was no stranger: the accumulated inflation rate for the year 2007 reached 8.50%. Under these conditions, the Uruguayan monetary authority introduced changes in the regulation of reserve requirements in order to reduce the amount of money in circulation.

We focus on the effects of the increase in the reserve requirements introduced in Uruguay on June 2008 but announced one month earlier, the 6th of May 2008. It can be summarized in three main changes: an increase in the reserve requirements for short-term liabilities from residents, an increase in the reserve requirements for liabilities from non-residents, and the introduction of a reserve requirement for funds from foreign banks. In particular, reserve requirements for (short-term) liabilities from residents increased from 17% to 25% if denominated in local currency (pesos), while they increased form 25% to 35% for liabilities denominated in foreign currency (mainly US dollars and Argentinean pesos)[3]. Liabilities from non-residents had an increase of reserve requirements from 30% to 35%. More importantly, before the reform, liabilities from other banks were not subject to a reserve requirement. After the reform, liabilities from foreign banks were subject to a reserve requirement of 35%. [4] Liabilities from domestic banks, however, continued to be exempt from reserve requirements. Hence, the different degrees of exposition of banks to these three sources of funding determines the intensity of the impact of the policy changes.

Reserve requirements in Uruguay have to be constituted of cash and deposits at the central bank. This change in reserve requirements was the first one since the beginning of 2004, as Uruguay did not actively used this policy tool until that moment (Federico et al., 2014).[5] Moreover, as the requirements vary by maturity and currency, and are applied to all types of liabilities,[6] this policy is very related to the new liquidity standards proposed in Basel III, especially the "Liquidity Coverage Ratio":[7] this Basel

[3]Uruguay is a highly dollarized economy.

[4]The changes were introduced through the following acts of the Central Bank of Uruguay: "Circular 1991", "Circular 1992".

[5]We report all reserve requirement changes in Appendix Table A2.

[6]Except borrowings from other resident banks.

[7]The two standards have also some important differences: for instance, retail demand deposits are considered to be more stable than wholesale deposits in the LCR, while borrowings from other domestic banks are not subject to reserve

III liquidity requirement is intended to ensure that a bank can withstand a situation of funding distress during 30 days, and hence requires banks to hold liquid assets for those liabilities that are more prone to run (i.e., short-term).

The reason for the increase in reserve requirements was an inability to control inflation by using the policy rate alone in a dual-currency economy. The target inflation rate was 5%, the monetary policy rate was 7.25%, and the actual inflation rate had been fluctuating around 8% during the last year. The policy rate had been increased from 5% to 7% in October 2007 and then raised again 25 basis points one month later. As mentioned before, inflation remained well above the objective.

Policy variable

We build our policy variable of interest by taking into account the change in the reserve requirements for local and foreign currency deposits, deposits from foreign non-financial sector and deposits from foreign financial sector. We hence multiply the increase in reserve requirements by each source of funding (as of April 2008, before the announcement of the reform): 8% for short-term liabilities in local currency from residents, 10% for short-term liabilities in foreign currency from residents, 5% for liabilities from non-financial non-residents, and 35% for liabilities from non-resident banks. We sum up the four increases and divide them by total liabilities to construct our dependent variable:[8]

$$RR_{b,t-1} = \frac{TotalAdditionalReserveRequirements_{b,t-1}}{TotalLiabilities_{b,t-1}}$$

We use the actual change in reserve requirement -instead of a measure taking into account the actual reserves of the banks- for the following reasons. The actual amount of reserves above the minimum (i.e., the buffer) is an endogenous decision that takes into account the requirement as well as the ability of the bank to easily raise reserves[9]. Since the cost of breaching the minimum is substantial -from a reputational and potential supervisory intervention perspective-, banks target buffers rather than actual reserves. Moreover, if banks do not adjust their asset composition after the reform and instead use their buffers, it is unlikely that we find any significant results on credit supply.

Until June 2008, term deposits at the central bank that were kept to satisfy the reserve requirements were remunerated[10]. However, this remuneration changed to zero after the policy change. Therefore, banks

requirements in Uruguay.

[8] We use the time subscript $t-1$ to refer to the level as of April 2008; we use $t+1$ to refer to the July 2008 level of the variable.

[9] As in Martinez-Miera and Suarez (2012) with capital requirements

[10] The rate offered to term deposits at the central bank denominated in pesos was 4%, which is half of the inflation rate at that time; if the deposit was denominated in a foreign currency, the rate depended on the policy rate of the currency's

suffered another policy shock at the same time. Although both shocks need not be related -one refers to the increase in reserve requirements and the other to the mix of demand and term deposits at the central bank to satisfy those requirements-, we control for this change as well. Since only term deposits at the central bank were remunerated, those banks with a higher proportion of term deposits (with respect to the reserve requirements) suffered a stronger drop in interest income. Therefore, we construct the following variable for each bank to control for this effect: $Remuneration_{b,t-1} \equiv \frac{Termdepositsat CB_{b,t-1}}{TotalReserveRequirements_{b,t-1}}$.

Summary statistics

The dependent variable of interest is the change in credit to firms during the reform. In particular, we use the change in (the log of) credit committed by bank b to firm i between April and July 2008. In other words:

$$\Delta logL_{bf,t+1} = logL_{bf,t+1} - logL_{bf,t-1}$$

where

$$logL_{bf,t-1} = log(Loan_{bt,t-1})$$

We remove the 1st and 99th percentiles to reduce the noise of extreme observations. Summary statistics for this variable, as well as for the policy variables and the bank controls that we use (Size, Solvency Ratio, Liquidity Ratio, and Foreign Assets), can be seen in Table 1.

On average, credit decreased during this period around 1.8%. However, the median value in terms of change in credit is at around -0.05%, which is negligible. Therefore, the distribution is skewed to the left, with several loans suffering a significant decrease. One way to see this is to compare the 25th percentile (a drop of 11%) and the 75th percentile (an increase of 2%). As mentioned before, we remove the extremes to make sure that the results are not driven by outliers.

We can also see the size of a typical loan, which is of $922,000 (median). There are very large loans in our sample, as one can see that the mean loan is above the 75th percentile. These loans, however, can only bias the results to the extend that they suffer sharp changes in volume, which is taken care of by removing the extremes of the dependent variable. Nevertheless, the results are robust to removing the top (99th percentile) loans.

The average impact of the increase in reserve requirements is 7.5% of total liabilities, which indicates the importance of this policy change. There is some heterogeneity in the impact, ranging from 4.7% to 14.8%. All banks are hence significantly affected, although the impact for some is three times larger

country.

than for others.

Figure 1 plots the evolution of aggregate bank credit to non-financial corporations during the year of study, 2008. After a period of strong credit growth, the trend flattens in June, when the reserve requirements reform came into effect. This provides some suggesting evidence that the change in reserve requirements had an impact on credit supply, but one needs disaggregated data to properly identify such effect. This is what we do in the next section.

3 Empirical Strategy and Results

We test different empirical models throughout this section, but we highlight here the basis of the estimations. We estimate the following model:

$$\Delta logL_{bf,t+1} = \beta RR_{b,t-1} + \alpha_f + \theta Y_{b,t-1} + \epsilon_{bf} \tag{1}$$

As explained before, the change in (the log of) committed credit from bank b to borrower f from April to July 2008 is the dependent variable. We choose April -instead of May, since it was not until June when the reform was introduced- to alleviate any endogeneity issues coming from the banks' reaction to the announcement of the reform.

Following a difference-in-difference approach, we compare lending for the same firm before (April, 2008) and after (July, 2008) the policy change among banks that are differently affected by the changes in the reserve requirements. One key aspect of the identification strategy is the focus on firms with more than one bank relationship; by analyzing the change in committed lending for the same firm, we proxy for credit demand by using firm fixed effects (Khwaja and Mian (2008)) and hence focus on credit supply. In addition, we analyze whether the effects of the policy changes were different across different firm and bank characteristics. That is, we want to check if the policy changes had effects, not only on the average supply of loans, but on the risk-taking behavior of banks.

3.1 Intensive margin

Before introducing borrower fixed effects, however, we start the empirical analysis by estimating the following model, controlling for credit demand by using observable firm characteristics:

$$\Delta logL_{bf,t+1} = \beta RR_{b,t-1} + \eta X_{f,t-1} + \theta Y_{b,t-1} + \epsilon_{bf} \tag{2}$$

Where $logL_{bf,t+1}$ is the change in committed credit from bank b to borrower f between April and July 2008. The coefficient of interest is β, which corresponds to the policy variable, the change in reserve requirements (as % of total liabilities), $RR_{b,t-1}$. $X_{f,t-1}$ are firm characteristics (in April 2008), which

include industry dummies, the credit rating set by the bank, and information about the level of indebtedness of the firm. $Y_{b,t-1}$ includes bank-level characteristics, such as size, solvency, liquidity, and the amount of deposits affected by the change in reserves remuneration.

The results can be seen in Table 2. Column 1 includes only firm- and loan-level controls and the policy shock variable. The coefficient on the policy variable is negative and significant, meaning that a higher impact of the reserve requirement reform is associated to a higher drop in credit. The coefficient almost doubles in Column 2, where we include the mentioned bank-level variables. Bigger banks tend to increase lending as compared to smaller banks; more solvent banks, on the other hand, decrease lending during this period. There is some evidence that banks with a higher proportion of liquid assets are also able to lend more. Interestingly, banks more affected by the change in the remuneration of central bank deposits decrease lending, hence reinforcing the effect of our main policy variable, the change in reserve requirements.

Since there were moments of important financial global turmoil during this period -the rescue of Bear Stearns occurred in March, two months before announcing the change in reserve requirements- we include in Column 3 the variable $ForeignAssets$ to control for the amount of foreign investment made by banks. The coefficient of interest remains negative and significant, even more than before. In terms of economic significance, the coefficient in column 3, -0.552, implies that an increase of reserve requirements equal to 10% of the total liabilities (the average is 7.5%) is associated to a higher decrease of credit by 5.5 percentage points. The coefficient for foreign assets is negative and significant at 10.2%, which suggests that banks with higher investments abroad also decreased lending more. The results are robust to including a dummy for branches and removing the public bank.

As the dependent variable is the percentage change of credit, one concern is that the results could be driven by firms with very little credit. From the macroprudential point of view, bigger firms might be more important to understand how to dampen the credit cycle. Hence, we repeat the same regressions in columns 4, 5 to 6 restricting the sample to firms borrowing more than \$60,000. This threshold leaves less than 10% of borrowers out of the sample. The coefficients for the policy variable decrease slightly but are not significantly different from the ones in columns 1-3. The coefficients for size, solvency, liquidity, remuneration, and foreign assets are robust to this sample change as well.

Regarding the loan-level variables, the coefficients for Ratings 3 and 4 are negative and significant in all regressions.[11] This suggests that when the rating set up by one bank to a particular borrower is 3 or 4 -which are riskier ratings than Rating 1, the 'reference' (i.e. omitted dummy) rating-, the credit to this firm is more likely to decrease. Nevertheless, this is not the case for the worst rating, Rating 5:

[11] Except for the coefficient of the Rating 4 dummy in column 1.

when looking at all loans, banks are more likely to increase the lending to these firms. However, this is mainly driven by smaller loans: the results are no longer significant in columns 4 to 6. The high debt dummy is also not significant.

Even when controlling for firm characteristics, the concern remains that firms borrowing from banks more affected by the policy shock are fundamentally different than firms borrowing from less affected ones, and hence the coefficient could be driven, in the previous specification, by credit demand rather than credit supply. This is especially important when the change in reserve requirements disproportionally affects some type of liabilities (for instance, liabilities from foreign financial institutions). Failure to properly control for credit demand, hence, can bias the results. As discussed before, we make use of firm fixed effects to compare the evolution of committed credit to the same firm between April and July 2008, in order to remove the potential demand bias. In particular, we estimate the model (1).

Note that this specification restricts the sample to those firms borrowing from two or more banks.[12] This happens because the fixed effect fully explains the dependent variable if there is only one observation for a particular borrower. For this reason, in Columns 1 and 2 in Table 3 we repeat the previous specification (without and with bank controls) using only firms borrowing from two or more banks. This is done to remove sample bias concerns and show the result of introducing firm fixed effects in the coefficients. Note that the coefficients in columns 1 and 2 are very similar to the ones obtained in the previous table. Columns 3 and 4 estimate model 1. The only difference with columns 1 and 2 is the change of firm variables for firm fixed effects. The coefficient on our main policy variable in column 4 is -0.490. Economically, this result indicates that a one standard deviation increase in reserve requirements (i.e., 2 percentage points) translates into a one percentage point decrease in committed credit. To compare it with the actual change in credit, the mean change in credit in this period was a 1.77% decrease.

Interestingly, the introduction of firm fixed effects makes the rest of the bank controls lose their significance (also the impact of the end of remuneration, although the coefficient is always negative). This shows the importance of controlling for credit demand, and remarks the importance of the policy change for credit supply.

As previously discussed, the variables regarding borrower credit rating and indebtedness are set by each bank individually at loan level. This implies that two banks can set different credit ratings and indebtedness for the same borrower at the same time, since these variables reflect their own exposure to it.[13] Therefore, two banks could behave differently with the same firm just because the initial conditions with the borrower are different. Hence, we also include these variables in columns 5 and 6 in order to

[12] To be precise, it restricts the sample to firms borrowing from two or more banks and that had a different change in committed credit.

[13] This situation -two banks assigning a different rating to the same firm- happens for almost half of the sample.

further control for bank-firm (i.e., loan) heterogeneity.

The coefficients of our variable of interest barely changes. We observe, however, that after controlling for firm fixed effects, worse-rated borrowers (Ratings 4 and 5) experience a bigger reduction in lending than other borrowers. Something similar happens with the high debt dummy: those borrowers that are heavily indebted (given banks' capital) suffer a stronger reduction of lending.

We subject the results to a number of robustness checks. The results are robust to dropping the public bank from the sample, since it could have a different behavior and has an important share of the market; we also control for whether the bank is a branch or not; we also drop from the sample the biggest loans; the main results do not change: banks more affected by the change in reserve requirements reduce credit supply as compared to other (less-affected) banks.

Another potential concern is the fact that the policy shock is not random, since the funding structure of each bank is the result of an optimization problem. Even after controlling for borrower characteristics, there could be some unobserved bank heterogeneity (correlated with the impact of the change in reserve requirements) that biased the results. In order to alleviate these concerns, we run a 'placebo' test consisting in estimating the same model as if the change in regulation would have occurred in two other moments: January 2008 and July 2008. In the first case (looking at the change in credit from January to April 2008) we find that the coefficient on the policy change is -0.10 with a p-value above 50%, while in the second case (change in credit from July to October 2008) the coefficient equals -0.02, with a p-value above 90%. In other words, looking outside the period when the policy change occurred we do not observe any significant result.

Summing up, we have shown that, across different samples and excluding and including firm fixed effects, banks that suffer a higher reserve requirements increase lend less to firms. The economic significance of this decrease is important: a 10 percentage points increase in reserve requirements imply a 4-5 percentage points lower credit change.

Foreign bank funding

The most important -and possibly unexpected- part of the reform is the introduction of reserve requirements of 35% to all foreign bank funding. In fact, the first announcement made the 6th of May 2008 ('Circular 1991') continued to exclude foreign bank funding from the requirements, and it was not until ten days later when the Central Bank of Uruguay amended this part by including also foreign bank funding ('Circular 1992').[14] Moreover, it is precisely this part of the requirement that is of most interest to combat the potential adverse effects of using the short-term rate to conduct mone-

[14]The other amendment in 'Circular 1992' referred to the maturity of the liabilities from non-residents subject to the requirement, which went from below 181 days to include all of them.

tary policy in emerging economies. For these reasons we replicate Table 3 using the change in reserve requirements on liabilities from foreign banks as the policy variable. The results can be found in Table 4.

The coefficients mimic the ones obtained in Table 3: banks more affected by the change in reserve requirements targeting liabilities from foreign financial institutions reduce credit supply more. Therefore, the negative effect from the increase in reserve requirements is mainly driven precisely by the part of the increase that refers to foreign banks funding[15]. This has important implications from a macro-prudential perspective, which we discuss in the final section.

Heterogenous Effects

The results obtained so far show that banks that suffered a higher change in reserve requirements reduce on average lending (to the same firm) by more. We look now at whether these results differ across different firm and bank characteristics. In order to do so, we start by estimating the following model to capture potential firm heterogeneity in the effects of reserve requirements on credit supply:

$$\Delta logL_{bf,t+1} = \beta RR_{b,t-1} + \gamma RR_{b,t-1}X_{f,t-1} + \alpha_f + \theta Y_{b,t-1} + \epsilon_{bf} \tag{3}$$

Where now we have two coefficient of interest: β -as before- and γ, the coefficient of the interaction between the policy change and firm characteristics; in other words, we want to know whether the reduction in credit supply driven by the increase in reserve requirements depends also on the riskiness and the debt of the borrower. Several banking models (Cordella et al., 2014) suggest that increases in funding costs by banks may cause a risk-shifting behavior in order to compensate for the decrease in income. If that is the case, then the effect of the policy change would be less important -or even positive- for riskier borrowers.

We present the results from estimating model 3 in Table 5, columns 1 to 3. Column 1 presents model 3 without firm fixed effects, but with industry dummies and risk and debt information. The coefficient of our main policy variable now focuses on how credit supply changes due to the change in reserve requirements for Rating 1 borrowers. The coefficient is twice the one found in previous tables, suggesting that the reduction of credit supply to these particular firms due to the change in reserve requirements is stronger. Regarding the coefficients of the interactions, we observe that the negative effect of reserve requirements is even stronger for Rating 4 firms; on the other hand, the opposite is true for Rating 5 (riskiest) firms: the reduction in credit is lower.

Column 2 incorporates firm fixed effects. Column 3 incorporates also all the interactions between the bank controls and the risk and debt variables, to allow for this heterogeneity to be present for other bank

[15]We also run a Placebo test for this specification -important given the turmoil in the international financial markets at that time- and find no significant effects before or after the period of the policy change.

variables. The results on the main policy variable and the interaction with Rating 5 dummy remain robust[16]. Consistent with the mentioned theoretical models, hence, we find that banks reduce credit less to the riskiest borrowers (those with rating in the fifth category).

Since the coefficient of interest γ is associated to the interaction between bank and firm characteristics (i.e., a bank-firm dimension), we can further saturate the specification by using bank fixed effects. This is what we do in columns 4 and 5, which replicate columns 2 and 3 adding bank fixed effects. Therefore, we control for any firm and bank heterogeneity. The results remain consistent: more affected banks reduce credit supply less to firms (loans) with the highest risk.[17]

Interestingly, the coefficient on Rating 5 is consistently negative and significant. This means that banks only marginally affected by the change in reserve requirements decrease lending to the riskiest firms (as compared to better rated firms, since none of the coefficients for the other ratings are significant). But as observed in the positive and significant coefficient of the interaction, this differentiated behavior against riskiest firms disappears if banks are strongly affected by the policy shock.

Given the importance of the previous results, we run, as robustness, the same regressions as in Table 3, columns 5 and 6, splitting the sample depending on the rating of the loan. In columns 1 and 2 we focus on loans with ratings from 1 to 4. The coefficient of the policy variable is, as before, negative and significant, but twice as big in absolute terms as compared to Table 3. Economically, this suggests that an increase of reserve requirements equal to the average (i.e., 7 percentage points) is associated to a decrease in lending of more than 6 percentage points. The results for Rating 5 loans, on the other hand, show the opposite picture: banks more affected by the increase in reserve requirements increase credit supply by more than less affected banks[18]. There is, hence, an important element of risk-shifting behavior due to the change in reserve requirements.

Our next step is to understand how bank characteristics can influence the effect of reserve requirements on credit. Our hypothesis is that some bank characteristics may alleviate the negative impact of reserve requirements on credit shown in Tables 2, 3, and 4. In particular, bigger banks might be able to accommodate the increase in reserve requirements by shifting more easily to cheaper sources of financing. Moreover, more solvent banks might be less reacting since they can obtain longer-term funding at a cheaper price than less solvent banks. Finally, banks that have a higher proportion of liquid assets could actually increase reserves by selling some of those liquid assets rather than reducing credit.

[16]The interaction with Rating 4 is no longer significant once we include firm fixed effects.

[17]We run also a triple interaction between RR, $Solvency$ and $Risk5$, to understand whether the differentiated effect for riskier borrowers is reduced for more solvent banks (i.e., banks with lower agency problems, as in Jimenez et al. (2014)); although the coefficient of the triple interaction is negative -and big-, in line with this intuition, it is not significant.

[18]It is important to highlight that, consistent with the previous results, the constant term in these regressions is negative and significant, as opposed to the constant term in columns 1 and 2. In other words, on average lending to Rating 5 loans decreases.

In order to test our hypotheses, we construct several dummies to identify the top banks in the previous variables (similar to the approach to test firm heterogeneity). We create a dummy to identify those banks above the 75th percentile in terms of size in April 2008.[19] For solvency and liquidity, we choose the median in April 2008 as our threshold: the dummies equal 1 for banks above the median in terms of the solvency ratio and the liquid assets ratio, respectively. Each of the dummies roughly splits the sample of loans in half.

Therefore, the model that we estimate is the following:

$$\Delta logL_{bf,t+1} = \beta RR_{b,t-1} + \delta RR_{b,t-1}Z_{b,t-1} + \gamma Z_{b,t-1} + \alpha_f + \theta Y_{b,t-1} + \epsilon_{bf} \quad (4)$$

where $Z_{b,t-1}$ is the corresponding dummy for bigger, more solvent, or more liquid banks.

The results can be seen in Table 7.[20] Column 1 shows that bigger banks are able to diminish the impact of reserve requirements on credit: for a given level of reserve requirements increase, bigger banks increase credit supply by more (or decrease it by less) than smaller banks do. We introduce the actual size, solvency, and liquidity variables in Column 2, but this does not change the result. In Columns 3 and 4 we repeat the same exercise with the solvency ratio, obtaining very similar results: better capitalized banks reduce lending by less relative to worse capitalized banks. While these results have important implications for the effectiveness of reserve requirements, we postpone the discussion for the last section. We do not observe this differentiated behavior for more liquid banks (Columns 5 and 6).[21]

The results hence suggest that the impact of reserve requirements on credit supply is negative on average but presents big differences depending on firm and bank characteristics. In particular, more affected banks seem to shift lending towards (ex ante) riskier exposures, while bigger and more solvent banks appear to be less affected by the increase in reserve requirements. This suggests that the effectiveness of reserve requirements as a macro-prudential tool to curb the credit cycle can be diminished by the biggest financial institutions and potentially by other types of prudential regulation, such as capital requirements. We discuss these points in the conclusion.

[19] We choose the 75th percentile because the distribution of banks' loans is very skewed to the right, and choosing a different threshold (the median, for instance) would imply that almost all observations in the credit register belong to banks labeled as 'big'.

[20] All regressions include the variable Remuneration_b as well as its corresponding interaction, to make sure that we are capturing the differentiated impact of reserve requirements.

[21] Given the turmoil in the international financial markets at that time, we also study whether the reserve requirements have a different impact on credit if the bank is a branch, but we do not observe any significant difference.

3.2 Extensive Margin

So far we have focused on lending relations between banks and borrowers that have continued from April to July 2008. However, a potential effect of a credit supply reduction is the end of some loan relations. Therefore, we extend our analysis to understand whether higher reserve requirements can make a lending relationship less likely to continue. In order to do so, we estimate a regression very similar to model 1:

$$DEnd_{bf,t+1} = \beta RR_{b,t-1} + \alpha_f + \theta Y_{b,t-1} + \epsilon_{bf} \tag{5}$$

where $DEnd_{bf,t+1}$ is a dummy variable that equals 1 if an existing loan relationship in April 2008 has disappeared in July 2008, and 0 otherwise.

The results can be seen in Table 7. Column 1 does not include fixed effects and studies the whole sample (i.e., not restricting the analysis to firms with two or more loans in April 2008). The coefficient on the main policy variable is positive and significant: more affected banks are more likely to terminate a loan relationship between April and July 2008. In column 2 we introduce firm fixed effects show that, without controlling for other bank characteristics, more affected banks are more likely to terminate a lending relationship. We introduce bank controls in column 3, and in column 4 we further control for loan characteristics (ratings and indebtedness): the coefficient in column 4, for instance, shows that a bank that has an increase of reserve requirements of 10 percentage points (with respect to its liabilities) has a 2 percentage points higher likelihood of terminating a lending relationship.

In column 5 we introduce a variable to control for the importance of the particular loan in the asset portfolio of the bank: $Credit_{bf}/TA_b$. Banks may be less willing to terminate a loan relationship if the loan represents a big part of their portfolio. This issue is partially controlled with the high debt dummy, but only for the biggest loans. The coefficient on this variable is negative, as expected, but not significant (the p-value is 15%). Nevertheless, the coefficient on our main policy variable does not change.

Given the results found in Tables 5 and 6, we analyze whether the likelihood of terminating a loan relationship due to the increase in reserve requirements depends on the rating of the loan. We hence introduce the interactions between the main policy variable and the ratings dummies as before. The results are shown in column 6. As before, the negative effect of reserve requirements on credit supply (now on the extensive margin) is mitigated for loans with a worse credit rating[22]. We also observe that more affected banks are more likely to terminate loan relationships with Rating 3 loans.

As before, we can confirm these results by saturating the specification with bank fixed effects to control

[22]Due to space constraints, we do not include here the coefficients for the rating dummies. Contrary to what we obtained in the intensive margin, rating 5 loans do not have a different likelihood to be terminated as compared to rating 1 loans; ratings 2 and 3 loans, however, are less likely to be terminated.

for bank heterogeneity. This is what we do in column 7. The heterogeneous results for loan characteristics remain the same.

We have shown that banks more affected by the increase in reserve requirements not only reduce the amount of credit to borrowers, but also increase the probability of finishing a lending relationship. This result is robust to controlling for credit demand, introducing other bank controls, and even controlling for the importance of the loan in the asset portfolio of the bank. Moreover, the likelihood of terminating the lending relationship due to the policy change varies with the credit rating of the loan: riskiest (rating 5) loans are less likely to be terminated.

3.3 Firm-Level Analysis

Even if credit supply decreases, however, firms may be able to substitute it by going to another bank. This point is extremely relevant to understand how reserve requirements can dampen the credit cycle. Firms could also use other forms of financing (bonds, for instance), but in the case of Uruguay, with less developed capital markets, this possibility is less likely. We then study whether firms borrowing from banks more affected by the reform are able to compensate the reduction in credit supply by obtaining bank credit from another institution. In order to do so, we study how lending from all banks has evolved at firm level; i.e., we study the following variable: $\Delta logL_{f,t+1} = logL_{f,t+1} - logL_{f,t-1}$.

We transform the original bank-level variables, including the policy change, into firm-level variables. We do so by computing a weighted average of those variables for each firm, where the weights are determined by the proportion of credit obtained from each bank in April 2008. Therefore, the variable of interest is:

$$RR_f = \sum_b \frac{L_{bf}}{L_f} RR_b$$

We estimate a very similar model to that we have used so far, but with all variables at firm-level, although we cannot introduce firm fixed effects. The results are shown in Table 9. Column 1 shows the regression of the change in (log of) credit experienced by each firm with the bank-level controls as firm-level weighted averages. Firms borrowing more from banks more affected by the change in reserve requirements suffer a drop in total credit. The coefficient is not only statistically significant but also economically relevant: a 10 percentage points increase in reserve requirements (as % of total liabilities) is associated to a 2.7 percentage points decrease in lending for the firm. We also see that firms borrowing from banks more affected by the change in central bank deposit remuneration also experience a decrease in credit. However, firms borrowing from bigger, less solvent, and more liquid banks experience an increase in total bank credit.

We saw in Tables 5 and 6 that the negative effect of reserve requirements on credit supply was less important for riskier firms; in other words, more affected banks reduce credit supply less to loans that have a Rating 5. In column 2 we introduce a dummy variable, Rating5_f, that equals 1 if the weighted average rating of the firm in April 2008 is greater or equal to 4.5, and 0 otherwise. A weighted average rating above 4.5 implies that most of the credit of the firm is rated as the riskiest type. Similar to Table 5, we introduce an interaction between the main policy variable and the Rating 5 dummy. The coefficient on the change in reserve requirements is now almost doubled, indicating that non-rating-5 firms suffer a larger drop in credit when borrowing from banks more affected by the policy change. The coefficient on the interaction, however, is positive and significant: the previous effect is less important for Rating 5 firms. The risk-shifting behavior, hence, has real effects. This result is particularly important because one could think that since better-rated firms suffer a stronger credit crunch, they could manage to shift to other banks. Yet this is not the case, as our results show.

Results in column 2 show the differentiated effect for Rating 5 firms with respect to other firms. Nevertheless, from a macro-prudential point of view, it is also important to know whether Rating 5 firms borrowing from more affected banks increase total bank credit, and not only in relation to less risky firms. In columns 3 and 4 we repeat the same regression from column 1 but splitting the sample: column 3 shows the results for non-Rating 5 firms, while column 4 shows the results for Rating 5 firms.

The coefficient of the main policy variable in column 3 suggests an even higher negative impact of reserve requirements on credit. In particular, a non-Rating 5 firm borrowing from banks that have a 10 percentage points increase in reserve requirements (as % of total liabilities) suffers a contraction in total credit of 6.1 percentage points. This result is consistent with what we see in column 2 (the two coefficients are not statistically different). The result in column 4, however, suggests that this effect is much smaller for a Rating 5 firm: in the same situation, a Rating 5 firm suffers a decrease in total credit of only 0.7 percentage points, one order of magnitude smaller in absolute value. Nevertheless, the coefficient is still negative, which suggests that Rating 5 firms also suffer a total credit contraction as result of the increase in reserve requirements, albeit a much smaller one.

In column 5, we use the change in reserve requirements for liabilities from foreign financial institutions as the policy variable, in line with the results reported in Table 4. Confirming previous findings, firms borrowing from banks more affected by this particular change in reserve requirements suffer a bigger drop in credit.

Since we cannot control for firm fixed effects in these specifications, we estimate the same specification as in column 1 for the period of January to April (column 6) and the period of July to October 2008 (column 7) as placebo tests. These placebo tests show that firms borrowing from more affected

banks do not have a differential total bank credit evolution during the period before the policy change and the period after[23].

We have shown that the increase in reserve requirements caused firms borrowing from more affected banks to suffer a bigger reduction in total bank credit. Therefore, the reduction in credit supply was binding at firm-level, with potential consequences for hiring and investment decisions.

3.4 Pricing analysis - loan rates

We further analyze whether the increase in reserve requirements is associated to increases in loan rates. As noted above, we do not have data on actual rates from the credit register. We obtain aggregated data on the average loan rates that individual banks apply to three different sectors (agriculture, industry, and services). We estimate the following model:

$$\Delta RL_{b,i,t} = \beta_1 RR_{b,t-1} + \gamma_i + \theta_1 Y_{b,t-1} + \epsilon_{bi} \tag{6}$$

Where $\Delta RL_{b,i,t}$ is the three-month change of loan rates applied by bank b to industry i in local currency. Our coefficient of interest is, as before, β_1. We introduce industry dummies. Note that we only have 34 observations, since loan rates for some banks are missing.

Results are displayed in Table 10. β_1 is positive throughout the specifications, but it is never statistically significant.

3.5 Funding

So far we have focused on how banks adjusted their asset side -i.e., credit supply. However, the regulatory change also altered the relative prices of different sources of funding. The most affected source was the funding from foreign banks, since the reserve requirement increased from 0% to 35%. Therefore, banks may have changed their funding structure as a result of the policy shock. While we have mentioned that the increase in reserve requirements was done due to inflationary pressures, from a macro-prudential perspective one should also monitor whether banks become very dependent of some (not subject to reserve requirements) sources of funding. In the case of Uruguay, these are long-term funding from residents and the domestic interbank market.

Nevertheless, to the extend that the Modigliani-Miller theorem does not (perfectly) hold, one should not expect a big change in funding sources. If banks could immediately adjust, then there would be no effect on credit supply. More importantly, banks that are particularly biased towards a particular (affected)

[23]We do find that the variable controlling for the change in remuneration has a negative and significant coefficient in the period before; therefore, we conclude that the negative effect observed during April-July is not due to the end of central bank deposit remuneration.

source of funding may find it very costly to change it.

In order to study this issue, we start by comparing the evolution of the different funding categories from January to April and from April to July (the policy shock). We compare the percentage change in these funding categories for the median bank, so that our results are not driven by extremes. The different changes can be seen in Figure 2.

The figure shows that, for the median bank, the only category of liabilities that decreases is the funding from foreign banks, precisely the most targeted source of funding by reserve requirements. This decrease is not seen in the first part of the year -from January to April. On the opposite side we find short-term funding from residents (STLC and STFC), which barely change from their pre-policy trend, and funding not subject to reserve requirements (NonRR), which increases almost 5%. Moreover, funding sources not subject to reserve requirements (fifth category) increase by 5%.

We look this issue in more detail by computing the correlations between the changes in each source of funding and our two main policy variables (total reserve requirements change and the change associated to foreign bank funding). We need to keep in mind, however, that we have a limited number of banks. The correlations are shown in Table 11. As one can see, the correlation between the change in reserve requirements and the different sources of financing are all negative, but only important for two sources: short-term resident funding in local currency and funding from foreign financial institutions.

Results are slightly different when looking at the correlation between the change of reserve requirements in foreign bank funding and the different sources of funding. More affected banks seem to increase their reliance on funding not subject to reserve requirements, mainly from the domestic interbank funding. Instead of reducing their reliance on foreign bank funding, and consistent with a limitation of the Modigliani-Miller theorem, they decrease other sources of funding to which they are less dependent. Nevertheless, as a result they are more exposed to the domestic interbank market, increasing interlinkages and the possibility of spillovers (Allen and Gale, 2000).

4 Conclusions

Although the use of reserve requirements as macroprudential tools has been very popular in Latin American economies, there is little evidence about the impact of these policies. In this paper, we study the role of reserve requirements as macroprudential tools. In particular, we analyze the effects of the increase in the reserve requirements for different sources of funding on the average supply of credit and on the risk-taking behavior of banks.

Uruguay offers an excellent setting to study these effects given the changes introduced in the regulation regarding reserve requirements in June 2008 and the comprehensive datasets we have access to. We use a difference-in-difference approach comparing lending before and after the introduction of the policy changes among banks with different degrees of exposition to the funds targeted by the policies.

The results on the intensive margin suggest that the main assumptions of the bank lending channel of monetary policy hold: Modigliani and Miller propositions are not satisfied for banks. In particular, increases in reserve requirements for different sources of funding (short-term funding from residents, funds from the foreign non-financial sector and funds from foreign banks) have an impact on non-financial firms through changes in banks' lending behavior. That is, restrictions to short-term funding imply a reduction on the supply of loans. In addition, we find that more affected banks increase their exposure to riskier firms while larger and more solvent banks are more capable of mitigating the effects of the lending channel.

These policies may also have real costs for corporate firms. When we analyze the effects of the higher reserve requirements at the firm level, we find that, on average, firms were not able to insulate from the negative impact of the policy changes. This is a relevant conclusion for an economy like Uruguay, where the development of the capital market is in a very early stage and, as a consequence, bank financing plays a key role in the investment decisions of firms.

The results of this study entail policy implications for macroprudential regulation. Although restrictions to short-term funding by banks may contribute to prevent threats that can later translate into risk propagation among the banking system, the strong reliance of banks on these type of funds plays an important role on the lending behavior of these institutions. As a consequence, the new liquidity standards proposed by Basel III, which are similar to the reserve requirements in Uruguay, may have a cost in terms of credit availability, as suggested by Diamond and Rajan (2001) and Calomiris and Kahn (1991).

Nevertheless, we have shown the effectiveness of reserve requirements as a macro-prudential tool to dampen the credit cycle, especially for the part coming from the global credit cycle. While our results show that reserve requirements are effective on average, they also raise three main issues. First, banks shift credit towards riskier firms: this raises concerns regarding the potential threat to financial stability that this shift represents. From the point of view of a macro-prudential regulator, a careful calibration would be necessary to make sure that the benefits of a decrease in credit growth are higher than the costs in terms higher risk-taking. The second concern is the fact that big banks are able to compensate the impact of reserve requirements: since those are typically the banks that provide more credit to the real sector, the effectiveness of reserve requirements to control the credit cycle could be lower than suggested

by our results. Finally, the fact that more solvent banks are also able to mitigate the effects of the policy change points towards the need for understanding the interaction among different policy tools, in this case between reserve and capital requirements.

5 Tables and Figures

Table 1:
Summary statistics

Panel A: Dependent variable						
	Mean	Std.	P25	Median	P75	Obs.
$\Delta logL_{bf,t+1}$	-0.0177	0.3493	-0.1087	-0.0005	0.0215	32,004
Credit_{bf} April 08	12,100	90,393	401	922	2,740	35,596
Credit_{bf} July 08	12,339	91,044	416	953	2805	36,143

Panel B: Bank variables in April 2008						
	Mean	Std.	P25	Median	P75	Obs.
RR_b	0.075	0.023	0.059	0.07	0.08	18
Size_b	3.597	1.339	2.665	3.503	4.034	18
Solvency ratio_b	0.298	0.249	0.118	0.191	0.405	18
Liquidity ratio_b (%)	18.13	12.17	10.45	13.58	24.43	18
Foreign assets_b (%)	35.36	18.65	21.77	29.30	49.70	18

This table reports the summary statistics of the variables used in the paper. $\Delta logL_{bf,t+1}$ is the difference in the logarithm of credit received by borrower f from bank b between April and July 2008. Credit_{bf} is the total credit received by borrower b from bank b, expressed in $ thousands. RR_b is the increase in reserve requirements for bank b over total liabilities. $\text{Size}_b$is the logarithm of total assets of bank b. Solvency ratio_b is the regulatory capital over risk-weighted assets held by bank b. Liquidity ratio_b is the ratio of liquid assets over total assets of bank b. Foreign assets_b is the ratio of assets held outside Uruguay over total assets for bank b. All bank-level variables are computed in their April 2008 value. Detailed variable definitions are provided in Appendix Table A1.

Table 2:
Impact of Reserve Requirements on Credit

	(1)	(2)	(3)	(4)	(5)	(6)
RR_b	-0.251**	-0.443***	-0.552***	-0.215**	-0.392***	-0.505***
	(0.102)	(0.088)	(0.109)	(0.089)	(0.088)	(0.113)
$Rating2_{bf}$	0.006	0.005	0.005	-0.000	-0.001	-0.002
	(0.007)	(0.006)	(0.006)	(0.007)	(0.006)	(0.006)
$Rating3_{bf}$	-0.031***	-0.030***	-0.030***	-0.035***	-0.034***	-0.034***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
$Rating4_{bf}$	-0.014	-0.021**	-0.021**	-0.032***	-0.038***	-0.038***
	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)	(0.010)
$Rating5_{bf}$	0.022**	0.020**	0.020**	0.009	0.008	0.008
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
High $Debt_{bf}$	0.000	-0.001	-0.001	-0.004	-0.005	-0.005
	(0.018)	(0.017)	(0.018)	(0.019)	(0.019)	(0.019)
$Size_b$		0.023***	0.026***		0.019***	0.022***
		(0.005)	(0.005)		(0.004)	(0.005)
$Solvency_b$		-0.177***	-0.147***		-0.150***	-0.119***
		(0.049)	(0.046)		(0.046)	(0.043)
$Liquidity_b$		0.002*	0.002*		0.001	0.002*
		(0.001)	(0.001)		(0.001)	(0.001)
$Remuneration_b$		-0.001***	-0.002***		-0.001***	-0.001***
		(0.000)	(0.000)		(0.000)	(0.000)
Foreign $Assets_b$			-0.001			-0.001*
			(0.001)			(0.001)
Observations	32,004	32,004	32,004	30,039	30,039	30,039
R-squared	0.005	0.006	0.006	0.005	0.006	0.006

The dependent variable is $\Delta Log(Credit)_{b,j,}$, which is the change in (the log of) credit granted by bank b to firm j from April to July 2008. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. '$RatingX_{bf}$' are dummy variables that equal 1 if bank b assigns rating X to firm f in April 2008. '$High\ Debt_{bf}$' is a dummy variable that equals 1 if the debt of firm f with bank b is very high, 0 otherwise. Bank controls ($Size_b$, $Solvency_b$, $Liquidity_b$, $Foreign\ Assets_b$) are defined in Table 1. All regressions are estimated using ordinary least squares. Robust standard errors clustered at bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 3:
Impact of Reserve Requirements on Credit: Firm FE

	(1)	(2)	(3)	(4)	(5)	(6)
RR_b	-0.403***	-0.629***	-0.465***	-0.490**	-0.452***	-0.419**
	(0.142)	(0.149)	(0.132)	(0.174)	(0.140)	(0.179)
$Rating2_{bf}$	0.007	0.005			0.004	-0.001
	(0.011)	(0.010)			(0.018)	(0.019)
$Rating3_{bf}$	-0.040***	-0.040***			-0.024	-0.029
	(0.013)	(0.012)			(0.025)	(0.025)
$Rating4_{bf}$	-0.064***	-0.071***			-0.052**	-0.060***
	(0.017)	(0.017)			(0.020)	(0.020)
$Rating5_{bf}$	-0.018	-0.018			-0.039	-0.046*
	(0.012)	(0.012)			(0.028)	(0.027)
High $Debt_{bf}$	-0.031	-0.032			-0.139**	-0.141**
	(0.021)	(0.021)			(0.064)	(0.063)
$Size_b$		0.024***		0.008		0.013
		(0.006)		(0.009)		(0.010)
$Solvency_b$		-0.121**		-0.003		-0.003
		(0.057)		(0.063)		(0.066)
$Liquidity_b$		0.001		0.000		0.000
		(0.001)		(0.001)		(0.001)
$Remuneration_b$		-0.002***		-0.000		-0.001
		(0.000)		(0.001)		(0.001)
Firm FE	N	N	Y	Y	Y	Y
Observations	9,700	9,700	9,700	9,700	9,700	9,700
R-squared	0.006	0.007	0.489	0.489	0.491	0.491

The dependent variable is $\Delta\ Log(Credit)_{b,j}$, which is the change in (the log of) credit granted by bank b to firm j from April to July 2008. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. '$RatingX_{bf}$' are dummy variables that equal 1 if bank b assigns rating X to firm f in April 2008. 'High $Debt_{bf}$' is a dummy variable that equals 1 if the debt of firm f with bank b is very high, 0 otherwise. Bank controls ($Size_b$, $Solvency_b$, $Liquidity_b$) are defined in Table 1. Fixed effects are either included ('Y'), not included ('N'). Robust standard errors clustered at bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 4:
Impact of Reserve Requirements on Credit: Foreign Bank Funding

	(1)	(2)	(3)	(4)	(5)	(6)
RR foreign bank funding$_b$	-0.308***	-0.462***	-0.350***	-0.383**	-0.349***	-0.350**
	(0.090)	(0.099)	(0.099)	(0.132)	(0.105)	(0.133)
Industry dummies	Y	Y	-	-	-	-
Rating and debt dummies	Y	Y	N	N	Y	Y
Bank controls	N	Y	N	Y	N	Y
Firm FE	N	N	Y	Y	Y	Y
Observations	9,700	9,700	9,700	9,700	9,700	9,700
R-squared	0.006	0.007	0.489	0.489	0.491	0.491

The dependent variable is $\Delta\ Log(Credit)_{b,j}$, which is the change in (the log of) credit granted by bank b to firm j from April to July 2008. 'RR foreign bank funding$_b$' is the increase in reserve requirements for bank b due to the policy change of funding from foreign banks over total liabilities. Industry dummies, rating and debt dummies, bank controls, and fixed effects are either included ('Y'), not included ('N'), or spanned by other fixed effects ('-'). Robust standard errors clustered at bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 5:
Impact of Reserve Requirements on Credit: Firm Heterogeneity

	(1)	(2)	(3)	(4)	(5)
RR_b	-0.862***	-0.738***	-1.070***		
	(0.233)	(0.276)	(0.382)		
$Rating2_{bf}$	-0.000	-0.009	-0.032	-0.020	-0.044
	(0.040)	(0.036)	(0.162)	(0.039)	(0.182)
$Rating3_{bf}$	-0.022	-0.011	0.255	-0.014	0.311
	(0.028)	(0.049)	(0.194)	(0.041)	(0.225)
$Rating4_{bf}$	-0.011	-0.027	-0.077	-0.058	-0.035
	(0.032)	(0.052)	(0.234)	(0.039)	(0.230)
$Rating5_{bf}$	-0.064***	-0.102**	-0.229**	-0.155***	-0.255**
	(0.022)	(0.041)	(0.100)	(0.035)	(0.105)
High $Debt_{bf}$	-0.303***	-0.309**	-0.603***	-0.329**	-0.768***
	(0.106)	(0.126)	(0.209)	(0.150)	(0.245)
RR_b * $Rating2_{bf}$	0.133	0.101	0.424	0.173	0.188
	(0.564)	(0.569)	(0.881)	(0.586)	(0.939)
RR_b * $Rating3_{bf}$	-0.200	-0.200	-1.451	-0.183	-1.688
	(0.352)	(0.523)	(0.970)	(0.411)	(1.048)
RR_b * $Rating4_{bf}$	-0.700**	-0.365	0.090	-0.133	0.047
	(0.342)	(0.527)	(1.018)	(0.496)	(0.981)
RR_b * $Rating5_{bf}$	0.583***	0.699**	1.225***	1.073***	1.404***
	(0.202)	(0.307)	(0.415)	(0.256)	(0.375)
RR_b * High $Debt_{bf}$	3.719***	2.336	2.458	2.593	3.413
	(1.358)	(1.447)	(2.143)	(1.633)	(2.249)
Firm FE	N	Y	Y	Y	Y
Bank controls (levels)	Y	Y	Y	-	-
Bank controls (interactions)	N	N	Y	N	Y
Bank FE	N	N	N	Y	Y
Observations	9,700	9,700	9,700	9,700	9,700
R-squared	0.006	0.492	0.494	0.493	0.496

The dependent variable is $\Delta Log(Credit)_{b,j,}$, which is the change in (the log of) credit granted by bank b to firm j from April to July 2008. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. '$RatingX_{bf}$' are dummy variables that equal 1 if bank b assigns rating X to firm f in April 2008. '$High\ Debt_{bf}$' is a dummy variable that equals 1 if the debt of firm f with bank b is very high, 0 otherwise. Bank controls interacted and fixed effects are either included ('Y'), not included ('N'), or spanned by other fixed effects ('-'). Robust standard errors clustered at bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 6:
Impact of Reserve Requirements on Credit: Firm Heterogeneity - Sample split by ratings

	Ratings 1 to 4		Rating 5	
	(1)	(2)	(3)	(4)
RR_b	-0.764*	-0.875**	0.199***	0.264***
	(0.402)	(0.433)	(0.060)	(0.069)
$Rating2_{bf}$	0.004	0.001		
	(0.020)	(0.020)		
$Rating3_{bf}$	-0.035	-0.038		
	(0.029)	(0.027)		
$Rating4_{bf}$	-0.044*	-0.052**		
	(0.024)	(0.023)		
High $Debt_{bf}$	-0.141**	-0.142**	0.015*	-0.002
	(0.065)	(0.065)	(0.009)	(0.014)
Firm FE	Y	Y	Y	Y
Bank FE	N	Y	N	Y
Observations	7,406	7,406	2,294	2,294
R-squared	0.506	0.506	0.789	0.790

The dependent variable is $\Delta Log(Credit)_{b,j,}$, which is the change in (the log of) credit granted by bank b to firm j from April to July 2008. The sample in columns 1 and 2 is restricted to loans that obtained a rating between 1 and 4 in April 2008. The sample in columns 3 and 4 is restricted to loans that obtained a rating equal to 5 in April 2008. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. '$RatingX_{bf}$' are dummy variables that equal 1 if bank b assigns rating X to firm f in April 2008. '$High\ Debt_{bf}$' is a dummy variable that equals 1 if the debt of firm f with bank b is very high, 0 otherwise. Bank controls and fixed effects are either included ('Y') or not included ('N'). Robust standard errors clustered at bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 7:
Impact of Reserve Requirements on Credit: Bank Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
RR_b	-0.624***	-0.561***	-0.665***	-0.656***	-0.637***	-0.512**
	(0.193)	(0.198)	(0.234)	(0.230)	(0.214)	(0.226)
Dummy $size_b$	-0.564***	-0.582***				
	(0.179)	(0.203)				
RR_b * Dummy $size_b$	3.387***	3.689***				
	(0.960)	(1.103)				
Dummy $solvency_b$			-0.203*	-0.256**		
			(0.119)	(0.108)		
RR_b * Dummy $solvency_b$			2.273*	2.525**		
			(1.252)	(1.188)		
Dummy $liquidity_b$					-0.027	-0.169
					(0.096)	(0.121)
RR_b * Dummy $liquidity_b$					-0.274	2.113
					(1.133)	(1.615)
Firm FE	Y	Y	Y	Y	Y	Y
Bank controls	N	Y	N	Y	N	Y
Observations	9,700	9,700	9,700	9,700	9,700	9,700
R-squared	0.492	0.492	0.491	0.492	0.491	0.491

The dependent variable is $\Delta Log(Credit)_{b,j,}$, which is the change in (the log of) credit granted by bank b to firm j from April to July 2008. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. 'Dummy $size_b$' is a dummy that equals 1 if bank b is above the 75th percentile in terms of Size, 0 otherwise. '$Dummy\ solvency_b$' is a dummy that equals 1 if bank b is above the median in terms of Solvency, 0 otherwise. '$Dummy\ liquidity_b$' is a dummy that equals 1 if bank b is above the median in terms of Liquidity, 0 otherwise. All regressions are estimated using ordinary least squares. All regressions include a control and interaction for 'Remuneration' and dummy variables for borrowers' ratings and debt. Bank controls (Size, Solvency, and Liquidity) are either included ('Y') or not included ('N'). Firm fixed effects are included in all regressions. Robust standard errors clustered at bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 8:
Impact of Reserve Requirements on Credit: Extensive Margin

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RR_b	0.192***	0.283***	0.186**	0.199**	0.195**	0.231*	
	(0.064)	(0.074)	(0.086)	(0.084)	(0.085)	(0.131)	
$Remuneration_b$	0.001**		0.000	0.000	0.000	0.000	
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	
$Size_b$	-0.009*		-0.007*	-0.006*	-0.007	-0.006*	
	(0.004)		(0.004)	(0.004)	(0.004)	(0.003)	
$Solvency_b$	-0.050		0.003	0.018	0.029	0.033	
	(0.039)		(0.030)	(0.030)	(0.031)	(0.032)	
$Liquidity_b$	0.002***		-0.000	-0.000	-0.000	-0.000	
	(0.001)		(0.001)	(0.001)	(0.001)	(0.001)	
$Credit_{bf}/TA_b$					-0.017		
					(0.011)		
RR_b * $Rating2_{bf}$						0.465	0.471
						(0.329)	(0.329)
RR_b * $Rating3_{bf}$						0.574**	0.581**
						(0.213)	(0.222)
RR_b * $Rating4_{bf}$						-0.106	-0.105
						(0.211)	(0.232)
RR_b * $Rating5_{bf}$						-0.248**	-0.297**
						(0.106)	(0.116)
RR_b * $HighDebt_{bf}$						-0.147	0.011
						(0.707)	(0.628)
Firm FE	N	Y	Y	Y	Y	Y	
Loan controls	Y	N	N	Y	Y	Y	Y
Bank controls	Y	N	Y	Y	Y	Y	-
Bank FE	N	N	N	N	N	N	Y
Observations	35,589	10,067	10,067	10,067	10,067	10,067	10,067
R-squared	0.028	0.494	0.495	0.498	0.498	0.499	0.500

The dependent variable is $DEnd_{bf,t+1}$, which is a dummy variable that equals 1 if bank b is lending to borrower f in April 2008 but not in July 2008, and 0 otherwise. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. $Log(Credit)_{bf}$ is the (de-meaned) logarithm of the loan from bank b to borrower f in April 2008. $Credit/TA_{bf}$ is the (de-meaned) ratio of total credit of bank b to firm f over total assets of bank b. All regressions are estimated using ordinary least squares. Bank controls interacted and fixed effects are either included ('Y') or not included ('N'). Robust standard errors clustered at the bank-industry level are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 9:
Impact of Reserve Requirements on Credit: Firm-level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
RR_f	-0.274***	-0.501***	-0.607***	-0.069*		0.102	0.058
	(0.097)	(0.140)	(0.198)	(0.041)		(0.073)	(0.084)
$Rating5_f$		-0.002					
		(0.011)					
RR_f*$Rating5_f$		0.317***					
		(0.113)					
$RRfbank_f$		-			-0.254***		
					(0.064)		
$Remuneration_f$	-0.002***	-0.002***	-0.002***	-0.001***	-0.002***	-0.001***	0.002***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
$Size_f$	0.025***	0.025***	0.032***	0.014***	0.024***	0.023***	0.015***
	(0.005)	(0.005)	(0.007)	(0.002)	(0.005)	(0.005)	(0.003)
$Solvency_f$	-0.268***	-0.270***	-0.417***	-0.051**	-0.247***	-0.104**	0.063
	(0.043)	(0.044)	(0.074)	(0.023)	(0.041)	(0.043)	(0.041)
$Liquidity_f$	0.003***	0.003***	0.004***	0.000	0.003***	0.002***	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Observations	26,586	26,586	18,711	7,875	26,586	26,574	27,664
R-squared	0.002	0.003	0.002	0.004	0.002	0.001	0.002

The dependent variable is $\Delta Log(Credit)_f$, which is the change in (the log of) credit granted by all banks to firm f from April to July 2008. 'RR_f' is the weighted average (where the weights are the size of the loan) increase in reserve requirements for all banks lending to firm f. $Rating5_f$ is a dummy variable equal to 1 if the weighted average of the ratings received by firm f is above 4.5, 0 otherwise. The other bank controls are transformed into firm-level weighted averages in the same fashion. Column 3 restricts the sample to firms with $Rating5_f$ equals 0; column 4 restricts the sample to firms with $Rating5_f$ equal to 1. Columns 1 to 5 show the results for the April-July period; column 6 refers to the January-April period; column 7 shows the results for the July-October period. Robust standard errors are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

Table 10:
Impact of Reserve Requirements on Credit: Loan Rates

	(1)	(2)	(3)	(4)
RR_f	4.937	5.085	2.933	9.314
	(8.877)	(9.788)	(10.165)	(10.404)
$Remuneration_f$			-0.007	-0.011
			(0.006)	(0.016)
$Size_b$				0.032
				(0.362)
$Solvency_b$				2.229
				(3.315)
$Liquidity_b$				-0.075***
				(0.018)
Industry FE	N	Y	Y	Y
Observations	34	34	34	34
R-squared	0.010	0.020	0.038	0.291

The dependent variable is $\Delta RL_{b,i,t+1}$, which is the change in average loan rate of bank b for industry i from April to July 2008. 'RR_b' is the increase in reserve requirements for bank b due to the policy change over total liabilities. Fixed effects are either included ('Y'), not included ('N'). Robust standard errors are reported in parentheses. ***: Significant at 1 percent level; **: Significant at 5 percent level; *: Significant at 10 percent level.

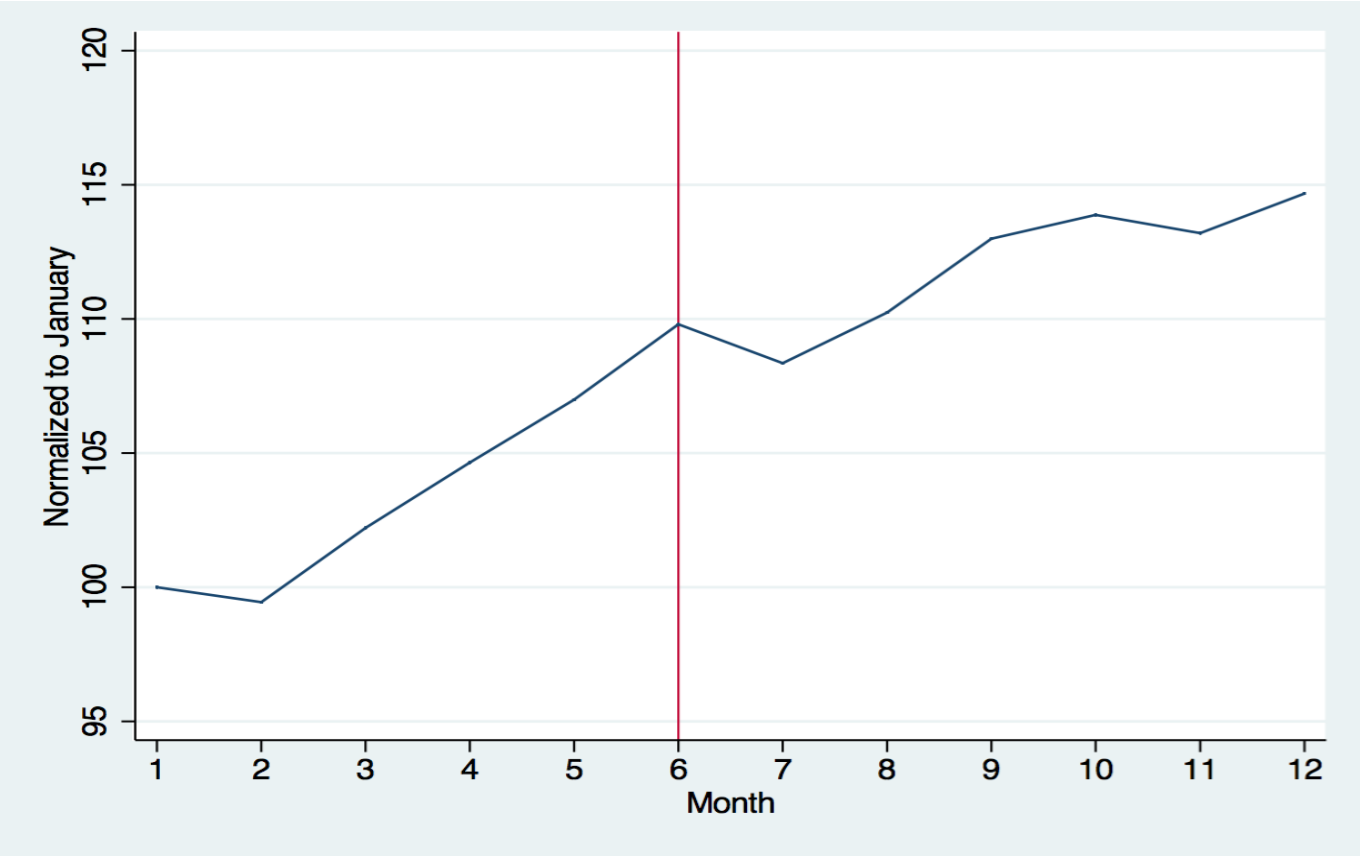
Table 11:
Reserve requirements changes and funding
Correlations

	Short-term liabilities from residents in local currency	Short-term liabilities from residents in foreign currency	Liabilities from non-resident non-financial institutions	Liabilities from non-resident financial institutions	Liabilities not subject to reserve requirements	Liabilities not subject to the change in reserve requirements	Liabilities from domestic financial institutions
RR_b	0.2316	-0.0957	0.0477	-0.2163	-0.0260	-0.0333	-0.0258
RR foreign $banks_b$	0.0494	-0.1935	0.0433	-0.1098	0.1223	0.1101	0.1169

This table shows the correlations between the main policy variables and the subsequent change in funding sources (as % of total liabilities).

Figure 1:

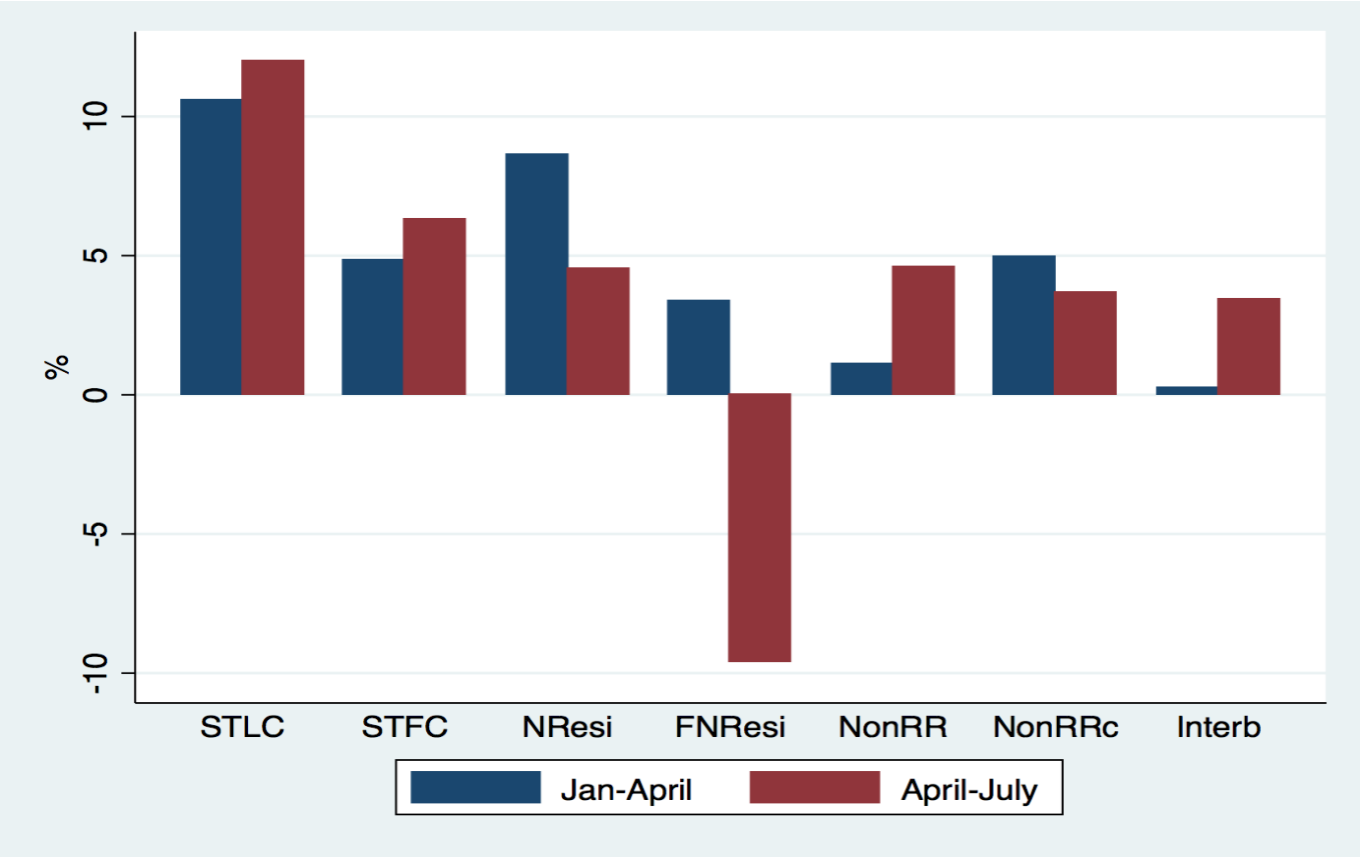
Aggregate bank credit evolution in Uruguay, 2008



This figure presents the evolution of aggregate bank credit to non-financial corporations in Uruguay for the year 2008, with the values normalized to the January level. The vertical red line reflects the introduction of the change in reserve requirements.

Figure 2:

Change in funding structure



This figure presents the median % change of different sources of funding for Uruguayan banks, from January to April 2008 (blue) and from April to July 2008 (red), the period of the policy change. 'STLC'' refers to short-term (below 30 days) liabilities from residents denominated in local currency. 'STFC' refers to short-term (below 180 days) liabilities from residents denominated in foreign currency. 'NResi' refers to liabilities from non-resident non-financial institutions. 'FResi' refers to liabilities from non-resident financial institutions. 'NonRR' refers to liabilities not subject to reserve requirements, which are mainly liabilities from residents in local currency with maturities above 1 year and borrowing form the domestic interbank market. 'NonRRc' refers to liabilities not subject to the change in reserve requirements, which include the categories in 'NonRR' as well as liabilities from residents in local currency of over 30 days and in foreign currency of over 180 days. 'Interb' refers to liabilities from domestic banks.

6 References

Banco Central de Uruguay (BCU), Regulation Acts from the Central Bank of Uruguay. http://www3.bcu.gub.uy/a22.html.

Bernanke, Ben, 1983, "Nonmonetary Effects of the Financial Crisis in Propagation of the Great Depression," *American Economic Review* 73(3): 257-76.

Bernanke, Ben and Alan Blinder, 1988, "Credit, Money, and Aggregate Demand", *American Economic Review*, 78(2): 435-439.

Bernanke, Ben and Alan Blinder, 1992, "The Federal Funds Rate and the Channels of Monetary Policy Transmission," *American Economic Review* 82(4): 901-921.

Blanchard, Olivier, Giovanni Dell'Ariccia, and Paolo Mauro, 2013, "Rethinking Macro Policy II: Getting Granular", *IMF Staff Discussion Note*.

Borio, Claudio, 2003, "Towards a Macroprudential Framework for Financial Supervision and Regulation", Bank for International Settlements working paper 128.

Calomiris, Charles and charles Kahn, 1991, "Role of Demandable Debt in Structuring Optimal Banking Arrangements", *American Economic Review* 81(3): 497-513.

Cordella, Tito, Pablo Federico, Carlos Vegh, and Guillermo Vuletin, 2014, "Reserve Requirements in the Brave New Macroprudential World," World Bank Policy Research WP 6793.

Diamond Douglas W. and Raghuram G. Rajan, 2001, "Liquidity Risk, Liquidity Creation and Financial Fragility: A Theory of Banking," *Journal of Political Economy* 109(2): 287-327.

Federico, Pablo, Carlos A. Vegh, and Guillermo Vuletin, 2014, "Reserve Requirement Policy over the Business Cycle," NBER WP 20612.

Gambacorta, Leonardo, and David Marques-Ibanez, 2011, "The Bank Lending Channel: Lessons from the Crisis", Bank for International Settlements working paper 345.

Goodhart, Charles, and Enrico Perotti, 2012, "Preventive Macroprudential Policy", Column VoxEU.org.

Gourinchas, Pierre-Olivier, and Mourice Obstfeld, 2012, "Stories of the Twentieth Century for the Twenty-First", *American Economic Journal: Macroeconomics* 4(1): 226-65.

Hanson, Samuel, Anil Kashyap, and Jeremy Stein, 2011, "A Macroprudential Approach to Financial Regulation", *Journal of Economic Perspectives* 25, 3-28.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina, 2012, "Credit Supply and Monetary Policy: Identifying the Bank Balance-Sheet Channel with Loan Applications", *American Economic Review* 102. 2301-2326.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina, 2013, "Macroprudential Policy, Countercyclical Bank Capital Buffers and Credit Supply: Evidence from the Spanish Dynamic Provisioning Experiments", European Banking Center Discussion Paper 2012-011.

Jiménez, Gabriel, Steven Ongena, José-Luis Peydró, and Jesús Saurina, 2014, "Hazardous Times for Monetary Policy: What do 23 Million Loans Say about the Impact of monetary Policy on Credit risk-Taking", *Econometrica* 82(2): 463-505.

Jordà, Òscar, Moritz Schularick, and Alan M. Taylor, 2013, "When Credit Bites Back," *Journal of Money, Credit and Banking* 45(s2): 3-28.

Kashyap, Anil, and jeremy Stein, 2000, "What do a Million Observations on Banks Say About the Transmission of Monetary Policy", *American Economic Review* 90(3): 407-428.

Khwaja, Asim, and Atif Mian, 2008, "Tracing the Impact of Bank Liquidity Shocks: Evidence from and Emerging Market", *American Economic Review* 98(4): 1413-1442.

Martínez-Miera, David, and Javier Suárez, 2012, "Banks' Endogenous Systemic Risk Taking," CEPR DP 9134.

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

Mora, Nada (2014), "Reason for Reserve? Reserve Requirements and Credit", *Journal of Money, Credit and Banking* 46(2-3): 469-501.

Rajan, Raghuram, 2014, "Containing Competitive Monetary Easing," article in Project Syndicate: http://www.project-syndicate.org/commentary/raghuram-rajan-calls-for-monetary-policy-coordination-among-major-central-banks.

Rey, Hélène, 2013, "Dilemma not Trilemma: The Global Financial Cycle and Monetary Policy Independence", working paper.

Schularick, Moritz, and Alan M. Taylor, 2012, "Credit Booms Gone Bust: Monetary Policy, Leverage Cycles, and Financial Crises, 1870-2008," *American Economic Review* 102(2): 1029-1061.

Stein, Jeremy, 1998, "An Adverse Selection Model of Bank Asset and Liability Management with Implications for the Transmission of Monetary Policy", *RAND Journal of Economics* 29(3): 466-486.

Tovar, Camilo E., Mercedez Garcia-Escribano, and Mercedes Vera Martin, 2012, "Credit Growth and the Effectiveness of Reserve Requirements and Other Macroprudential Instruments in Latin America," IMF WP 12/142.

Appendix

Appendix Table A1:
Definition of main variables

Variable name	Definition
Dependent Variables	
$\Delta logL_{bf,t+1}$	Change in the logarithm of (strictly positive) committed credit granted by bank b to firm f between $t-1$ and $t+1$.
$LEnd_{bf,t+1}$	dummy variable that equals 1 if the bank-firm relationship ends during the period ($t-1$,$t+1$), 0 otherwise.
Policy Variables	
ΔRR	Ratio of bank's total additional reserve requirements over total liabilities. Banks' additional reserve requirements is the sum of the change in reserve requirements for: short-term local currency deposits, short-term foreign currency deposits, deposits from foreign non-financial sector, and deposits from foreign financial sector.
ΔRR fbanks	Ratio of bank's total additional reserve requirements for liabilities from foreign financial institutions over total liabilities.
Remuneration	Ratio of bank's term deposits at the central bank over total reserve requirements.
Bank-Level Variables	
Size	Logarithm of total assets of bank b at $t-1$.
Liquidity	Ratio of Available Liquidity over Total Assets of bank b at $t-1$. The Available Liquidity includes liquid assets in excess to the liquidity in the Central Bank of Uruguay plus assets portfolio (excluding the portfolio of securities that cannot be sold but held until investment).
Solvency	=($Eligible\ Capital/RWA$ of bank b at $t-1$.
Branch	=1 if bank b is organized as a branch of a foreign bank, =0 otherwise.
Loan-Level Variables	
Rating 1	dummy variable equal to 1 if the loan has a rating of 1A ("borrower with loan fully covered by warranty") and 1C ("borrower with strong capacity to pay"), 0 otherwise. Safest rating.
Rating 2	dummy variable equal to 1 if the loan has a rating of 2A ("borrower with adequate capacity to pay", delay in payment<30 days) and 2B ("borrower with potential problems to pay", delay in payment<60 days), 0 otherwise.
Rating 3	dummy variable equal to 1 if the loan has a rating of 3 ("borrower with compromised capacity to pay", delay in payment<120 days), 0 otherwise.
Rating 4	dummy variable equal to 1 if the loan has a rating of 4 ("borrower with very compromised capacity to pay", delay in payment<180 days), 0 otherwise.
Rating 5	dummy variable equal to 1 if the loan has a rating of 5 ("irrecoverable debt", delay in payment$\geq$ 180 days), 0 otherwise. Riskiest rating.
Highdebt	dummy variable equal to 1 if the loan is classified as a "highdebt", i.e., the credit is a substantial amount of bank's own resources, 0 otherwise.

Appendix Table A2:
Reserve Requirements in Uruguay

Source / maturity	**Reserve Requirements levels**									
	10/1983	12/1983	04/1984	08/1984	10/1984	07/1985	08/1985	12/1988	10/1991	01/1992
RR residents - Local currency (Pesos)										
< 30 days	13%	14%	15%	15%	15%	15%	24%	25%	23%	10%
30 - 90 days	13%	14%	5%	5%	5%	4%	11%	12%	10%	4%
91 - 180 days	13%	14%	5%	5%	5%	4%	11%	12%	10%	4%
181 - 366 days	13%	14%	0%	0%	0%	0%	5%	6%	6%	2%
> 366 days	13%	14%	0%	0%	0%	0%	5%	6%	6%	2%
RR residents - Foreign currency										
< 180 days	-	-	5%	5%	3%	3%	10%	10%	10%	10%
> 180 days	-	-	0%	0%	0%	0%	4%	4%	4%	4%
RR non-residents										
Treatment	As residents	As residents	As residents	As residents	As residents	As residents	As residents	As residents	As residents	As residents
	04/2000	08/2002	09/2002	11/2002	04/2003	06/2003	07/2003	09/2003	10/2003	06/2008
RR residents - Local currency (Pesos)										
< 30 days	10%	10%	30%	30%	28%	23%	20%	18%	17%	25%
30 - 90 days	4%	4%	24%	24%	22%	17%	14%	12%	9%	9%
91 - 180 days	2%	2%	22%	5%	5%	5%	5%	5%	4%	4%
181 - 366 days	4%	4%	24%	24%	22%	17%	14%	12%	6%	6%
> 366 days	2%	2%	22%	0%	0%	0%	0%	0%	0%	0%
RR residents - Foreign currency										
< 180 days	10%	10%	10%	10%	10%	10%	10%	10%	25%	35%
> 180 days	4%	4%	4%	4%	4%	4%	4%	4%	19%	19%
RR non-residents										
Treatment	As residents	As residents	As residents	As residents	As residents	30%	30%	30%	30%	35%

This table shows the reserve requirements for the Uruguayan banking sector since 1983 until the date of the policy change that we study, 2008. In each date there is at least a change in the requirement for one or more types of liabilities. Most of the changes occur between 2002 and 2003, the period after the default of the Argentinean government and the subsequent default by the Uruguayan government. The first change in the policy since that episode is precisely the one we study. Until 2003, liabilities from non-residents were treated the same way as liabilities from residents. Until 1984, there were no reserve requirements for foreign currency-denominated liabilitiess.