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# Countercyclical reserve requirements in a heterogeneous-agent and incomplete financial markets economy[☆]

Christian Bustamante[a,*], Franz Hamann[b]

[a] Department of Economics, Ohio State University, 1945 North High St., Columbus, OH 43210, United States
[b] Banco de la República, K 7 No. 14-78, Bogotá, Colombia

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For a long time reserve requirements fell into disuse as a countercyclical monetary policy tool. Recently, while developed countries struggled to deal the financial crisis, several emerging countries resorted to them as part of the macro-prudential policy toolkit. The apparent success of such non-conventional instruments in mitigating business cycle fluctuations raises the question whether they deserve full credit for that or some merit should be given to conventional instruments, like short-term interest rates. To answer this question, we use a dynamic stochastic general equilibrium model with risk-averse financial intermediaries, heterogeneous agents facing uninsurable idiosyncratic risk and a central bank that implements countercyclical policy using two instruments: short-term rates and reserve requirements. In this environment, in which agents' wealth matters for their consumption and savings decisions, we find that using reserve requirements as a countercyclical tool marginally helps to reduce the consumption volatility and that its effect becomes quantitatively relevant only if banks are sufficiently risk averse. Two factors drive our results: the presence of interest rate risk and the imperfect substitution between bank liabilities.

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## 1. Introduction

For much of the twentieth century, reserve requirements (henceforth RRs) were considered one of the main monetary policy instruments of policy makers. In many economies it fell into disuse as the monetary policy framework changed from controlling monetary aggregates to inflation targeting regimes. The occurrence of financial crises, especially in emerging countries, changed this view. These painful experiences led central banks and financial regulatory authorities to explore alternative and unconventional policy measures. For some, to avoid extreme scenarios, such as the above mentioned, abandoning the paradigm of using only one monetary policy instrument (the short-term interest rate) is a necessary condition to achieve macroeconomic and financial stability. This new approach to monetary policy has brought attention for the use of the so called "macro-prudential" tools designed to achieve macroeconomic and financial stability.

RRs are now part of this toolkit and policies aimed to influence the demand as well as the supply of reserves have also been part of this framework. Developed and emerging economies have implemented measures such as remuneration on reserves and changes in reserve requirements under complex frameworks and multiple objectives. For instance, in 2008 the Federal Reserve

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[*] Corresponding author. Tel.: +16142922069.
*E-mail addresses:* bustamanteamaya.1@osu.edu (C. Bustamante), fhamansa@banrep.gov.co (F. Hamann).

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started to pay interest on reserve balances trying to align the average effective federal funds rate with the target rate. In this fashion, the Fed used the interest on reserves to dampen the interbank liquidity generated by its large injections of liquidity into the financial system (Bech and Klee, 2011).

On the other hand, recently, emerging market economies have used RRs as a countercyclical tool to face upward inflation pressures and contain credit growth. Some of them have also used reserve requirements to deal against large capital inflows and alleviate real appreciations of their currencies. Montoro and Moreno (2011) document how Latin American emerging market economies used RRs as a supplemental countercyclical tool aimed to reduce (increment) the credit supply at the same time price stability was being pursued. This was the case of Brazil, Colombia and Peru which actively used average and marginal reserve requirements in order to complement their interest rate policy. During 2008, these emerging economies experienced the highest inflation rates in the second half of the decade and credit growth levels above 20%. However, the presence of the largest capital inflows in the latest five years, made inconvenient to raise interest rates for the central banks of these economies because of the risk of attracting even a higher level of foreign capital. In this context, the central banks used reserve requirements in a countercyclical fashion by raising them prior to the Lehman Brothers bankruptcy, and lowering them after the crisis started. Other countries such as India, Malaysia and Turkey have used RRs as the main instrument to pursue financial stability.

These practices have renewed the interest on studying the macroeconomic effects of RR policies. Glocker and Towbin (2012) propose a general equilibrium model to study the effectiveness of different reserve requirements policies aimed to achieve price and financial stability. Their conclusions indicate that in a frictionless economy with inflation targeting, RR policies have very small effects on economic stability. However, its impact becomes more important as financial frictions appear. Areosa and Coelho (2013) find a similar result by augmenting the model of Gertler and Karadi (2011) to include a compulsory reserve requirement ratio. Their model is a new-Keynesian DSGE model with financial intermediaries facing endogenous balance sheet constraints, which in turn generates imperfect substitutability in the intermediaries' funding structure. After estimating the model for the Brazilian economy, Areosa and Coelho conclude that the effect of a monetary policy shock to the interest rate is much stronger than the one to the reserve requirement ratio despite both shocks yielding similar dynamics in the macroeconomic aggregates.

Cúrdia and Woodford (2011) and Ireland (2012) have also researched on the role of RR policies in a general equilibrium context. Cúrdia and Woodford (2011) propose a model where monetary policy can operate controlling the supply of reserves or the interest paid on them. They are focused in assessing the importance of RR policies and the central bank's balance sheet when monetary policy reaches the zero lower bound. Meanwhile, Ireland (2012) studies the macroeconomic effects of paying interest on reserves and the additional degrees of freedom a monetary authority obtains with this tool. His results point out that a policy of remuneration on reserves has little effect on output and inflation, but that such effect can be larger for less developed financial systems.

Kashyap and Stein (2012) note the importance of RR policies to augment the possibilities of central banks to achieve financial stability while more traditional monetary policy tools can be used to deal with the inflation-output tradeoff. They find that reserve requirements could be considered as a Pigouvian tax used to internalize the externalities generated by high short-term debt exposition of financial intermediaries. Kashyap and Stein also suggest that RR policies, such as contraction in reserves supply, provide a useful tool when facing credit bubbles.

In this paper we study, in a general equilibrium framework, the macroeconomic effects of a countercyclical RR policy in presence of interest rate risk. In particular, we are interested in understanding if the apparent success of countercyclical RR policies implemented by several countries before and after the most recent financial turmoil could be explained by the use of reserve requirements *per se*, or because reserve requirements reinforced the effect of the traditional interest rate policy. In the context of an inflation targeting regime, there are two main factors determining the effectiveness of RRs. The first one is the interest rate risk, i.e. the mismatches between the repo rate and the commercial interest rates. When financial intermediaries try to hedge against this risk, they affect the deposits interest rate and therefore the deposits supply. The other factor is the imperfect substitutability between banks' funding sources. As the costs of getting funds through deposits increase when the RR is raised, the presence of imperfect substitution makes harder for the financial intermediaries to replace these funds with central bank credit. This feature opens a gap where the RR policy can act in order to affect the supply of credit. In absence of imperfect substitution, changes in the RR would have no effect on loans interest rates because banks can fully accommodate their funding structure.

Betancourt and Vargas (2009) find empirical support for this hypothesis for Colombia. Their empirical findings show that increasing the RR generates a more expensive financial intermediation (i.e. an increase in the spread between loans and deposits interest rates) because of the uncertainty about the policy rate. This allows to reduce credit demand and to control inflationary pressures. These results are in line with the analysis by Romer (1985), who concludes that in an OLG model with financial intermediation, changing the RR not necessarily affects inflation directly, but it does so through the adjustment of market interest rates and banks' balance sheets.

Our model extends the general equilibrium models by Diaz-Gimenez et al. (1992) and Aiyagari (1994) by including financial intermediaries in order to analyze the role of reserve requirements. In our setup, households face both aggregate and uninsurable idiosyncratic shocks in a context of borrowing constraints. We solve the model by using non-linear approximation methods for the stationary equilibrium and the economy dynamics. We find that the presence of interest rate risk and the subsequent imperfect substitutability between financial intermediaries' funding sources allow for the countercyclical RR policy to be employed as a useful complementary instrument to mitigate business cycles fluctuations. Our results also suggest that RRs are not as powerful as interest rates when dealing with macroeconomic volatility.

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