Does Monetary Policy Affect Bank Lending? Evidence for Bolivia

Óscar A. Díaz Quevedo
C. Tatiana Rocabado Palomeque

Abstract

This paper explores the existence of a bank lending channel for Bolivia. The estimates used panel data through GMM and fixed effects model. The results show that changes in monetary policy have direct effects on the banks' loans supply, because increases in the securities' supply lead to reductions in loan growth. Moreover, interactions size and capital of entities with variable monetary policy would reflect the existence of different bank's reactions.

Keywords: monetary policy, lending channel, GMM.
JEL classification: E5, G21.

1. INTRODUCTION

Analysis of monetary policy transmission mechanism is one of the major areas of research in macroeconomic literature and is of particular interest to central banks. A proper assessment of such mechanisms allows for understanding and anticipating the impact of monetary conditions on the real economy.

The bank lending channel recognizes the existence of imperfect information in financial markets and assigns an active role to bank

The authors are both officials of the Banco Central de Bolivia. The opinions expressed in this paper are those of the authors and do not necessarily reflect the views of the Banco Central de Bolivia. For all correspondence: <odiaz@bcb.gob.bo> and <trocabado@bcb.gob.bo>.

loan supply in the transmission of monetary policy. In this context, a restrictive monetary policy reduces lendable funds, the supply of loans from the banking sector, and forces agents that depend on this type of funding to decrease their investment spending. The effectiveness of this mechanism can vary amongst banks according to the level of access they have to other sources of funding. As Bernanke and Gertler (1995) and Hubbard (1995) point out, the credit channel is complementary and not a substitute for the traditional channel (interest rates channel) of monetary policy.

Analyzing and testing the existence of a bank lending channel in Bolivia is important given the dependence on bank credit of certain segments of the population and the large share of deposits in the structure of bank liabilities. Moreover, the significant process of de-dollarization of the economy allowed for enhancing the effectiveness of monetary policy. Nevertheless, the literature is still scarce, which is why this paper aims to offer empirical evidence on the topic.

Kashyap and Stein (1995, 2000) and Ehrmann (2003) exploit the cross-sectional heterogeneity and behavior of time series to identify the effects of a monetary policy shock on the loan supply of the Bolivian banking system for the period 2005-2013. This type of calculation offers differentiated responses according to the characteristics of banks, identifying those that are most affected. The findings show that monetary policy has the capacity to directly affect bank loan supply (direct lending channel). Moreover, interactions of the banks' size and capital variables with the monetary policy variable would reflect different reactions; that is, smaller, less capitalized banks would reduce their loans to a larger degree in response to a tightening of monetary policy.

The paper consists of seven sections. Section 1 contains the introduction. Section 2 gives a brief summary of the theory of monetary policy transmission mechanisms and, in particular, the bank lending channel. Section 3 presents some stylized facts on the monetary policy regime and the main characteristics of the banking sector in Bolivia. Section 4 summarizes the most important results of the empirical research. Section 5 describes the model used in the paper and presents the econometric methodology. Section 6 contains the results of the model for the case of Bolivia. Finally, Section 7 contains the conclusions.

2. CONCEPTUAL FRAMEWORK

One of the functions of central banks is monetary policy management with the principal objective of maintaining price stability. In recent years, they have also conducted actions toward financial activity and preserving financial stability. It is therefore important for a central bank to identify whether the monetary policy tools it employs can influence the activity of the real sector, affecting aggregate demand and inflation through so-called transmission channels.

Mishkin (1996) identified four transmission channels of monetary policy: The interest rate channel, the credit channel (composed of the broad credit channel and the bank lending channel), the exchange rate channel and assets price channel.[1]

The interest rate channel (money channel) represents the traditional approach of monetary policy and suggests that when the central bank implements a contractive monetary policy the money supply decreases (exchanging securities for bank reserves) with the resulting increase in nominal and real long-term interest rates (the impact of monetary policy on interest rates is produced under the assumption that prices are sticky in the short-term). Higher interest rates lead to a reduction in current investment and consumption, causing a contraction of aggregate demand, which affects output and prices.

Bean et al. (2002) establish the existence of the following components in the interest rates channel: *a)* high rates, and therefore high capital costs, lead to higher required rates of return for an investment project and reduced investment spending, *b)* an increase in interest rates changes the pattern of consumption, that is, the impact of restrictive monetary policy can be broken down into a substitution effect and an income effect, the former is negative given that the increase in interest rates reduces the price of future consumption, while the latter depends on consumers' net asset positions, and *c)* in the case of a floating exchange rate regime, movements in interest rates cause exchange rate volatility, affecting price competitiveness and, therefore, net exports.

The interest rates channel assumes that financial intermediaries do not play any special role in the economy. Aggregate demand

[1] A broad discussion of monetary policy transmission channels can be found in Mies et al. (2004). Only the first two are addressed below.

models usually downplay the importance of the role played by financial intermediaries given that bank loans are grouped together with other debt instruments in a bond market. Money on the other hand is given a special role in the determination of aggregate demand. Bernanke and Blinder (1988) show that the traditional interest rates channel rests on at least one of the following three assumptions: *a)* loans and bonds are perfect substitutes to borrowers, *b)* loans and bonds are perfect substitutes to lenders, or *c)* commodity demand is insensitive to the loan rate.

However, Bernanke and Gertler (1995) show empirical evidence that the interest rates channel was not successful in explaining large changes in output and aggregate demand, giving rise to the production of a large body of literature that attempted to identify and quantify other transmission mechanisms.

At the end of the eighties, the link between credit and output began to become important because it was observed that given the existence of asymmetric information, financial intermediaries played an important role in supplying credit, considerably affecting aggregate demand. Since then a series of studies has emerged explicitly analyzing how the effects of monetary policy could be amplified and propagated in the face of changes in the different agents' financial conditions. This type of model belongs to the so-called credit channel theory, which starts by rejecting the hypothesis that bonds and bank loans are perfect substitutes. Nevertheless, this should not be understood as an independent or parallel transmission channel to the traditional one, but rather as a set of factors that amplify and propagate conventional effects of changes in interest rates (Bernanke and Gertler, 1995).

In particular, there are two mechanisms through which the credit channel can operate: The broad credit channel (the balance sheet channel) and the bank lending or narrow channel (Bernanke and Gertler, 1995). The main idea of the balance sheet channel is that, in the presence of imperfect capital markets, asymmetric information between lenders and borrowers creates a gap between the cost of internal and external financing for borrowers. A restrictive monetary policy that raises real interest rates reduces borrowers' net cash flow, thereby weakening their financial position. Raising interest rates also lowers the value of assets that act as guarantees and, consequently, reduces the ability of borrowers to obtain financing. In both cases the net value of a firm decreases, and being inversely related to the cost

(premium) of external financing, for a certain amount of required funding, the firm's spending and activity decline (limiting its borrowing possibilities).

The second mechanism focuses on bank loan supply: Changes in monetary policy do not just affect the interest rates on loans granted by banks, but also on their ability to supply new loans. In particular, a restrictive monetary policy that implies an increase in reserves requirement for banks generates a fall in available bank deposits and creates a need for obtaining alternative sources of funding in order to maintain the volume of loans. If such funding is scarce or unavailable, banks are forced to reduce their supply of loans, having a negative impact on the planned consumption and investment of borrowers that depend on this type of financing (small businesses and consumers). Thus, competition for the reduced supply of bank loans might lead to an increase in interest rates with adverse effects on investment and consumption. The bank lending channel therefore amplifies the impact of monetary policy tightening on aggregate demand, giving a special role to banks.

Unlike the traditional credit channel, the impact of monetary policy on the real economy through the balance sheet channel and the bank lending channel has significant distributive consequences. Banks with different dependency on deposits and businesses with different financial positions and dependence on bank loans are not affected in the same way by monetary policy shocks.

The monetary policy transmission mechanism through the bank lending channel rests on two pillars: The capacity of central banks to affect the bank loan supply and the dependence of businesses and households on bank loans.

a) *Monetary policy actions must affect the bank loan supply.* Banks cannot have perfect substitutes for loans nor significant sources of funding other than deposits (external loans and securities, among others), that is, deposits are one of the least costly sources of financing and, consequently, for some banks it would be expensive and sometimes impossible to replace lost deposits with other sources of funds in order to maintain the same supply of loans. Under such conditions, a restrictive monetary policy reduces the aggregate volume of deposits and affects bank loan supply. Thus, deposits and bonds must be imperfect substitutes for banks.

The fact that the impact of monetary policy on loan supply also depends on the characteristics of the banking sector should be taken into account. In general terms, the stronger a country's banking sector, the weaker the expected impact of changes in monetary policy. Larger and healthier banks are less sensitive to policy changes because their reserves can be replaced quickly with alternative types of financing. Thus, bank size, market concentration, level of capitalization and liquidity are the most commonly studied factors: A relatively small size, weak market concentration and lower levels of liquidity and capitalization suggest existence of a stronger credit channel given that banks are more exposed to market imperfections and would face more difficulties to obtain funding other than from deposits.[2]

Another important factor is ownership structure, given that State influence, exercised through either direct public ownership of banks, State control or public guarantees, provides additional funding possibilities and reduces asymmetric information. Foreign participation in the domestic banking system also weakens the credit channel, as subsidiaries of foreign banks can face lesser funding restrictions due to the possibility of obtaining additional financing from their parent banks.

Kashyap and Stein (1993) argue that the impact on bank loan supply also depends on the regulatory framework, given that risk based regulatory capital requirements can tie up the capacity of a bank to grant loans up to the amount of its own funds and restrict credit. Moreover, the behavior of loan supply can also be affected by deposit insurance requirements –the higher the insurance, the lower customers' risk. A low level of risk reduces the cost of deposits for banks and, therefore, increases dependence on this type of liabilities.

Finally, the speed of monetary policy transmission depends on loan maturity and the type of interest rate. The larger are short-term variable rate loans, the faster loan supply responds to changes in monetary policy.

b) *There must not be any other alternative source of funding that is a perfect substitute for bank lending.* Faced with a reduction in the supply of loans, borrowers (businesses, households) cannot turn to other sources of financing without incurring some costs, for

[2] Financial solvency can also be characterized by loan loss provisions, operating costs and returns on assets, as well as the number of past bankruptcies.

instance, issuing bonds, stocks or turning to other financial intermediaries. There is evidence that firms, particularly small ones, depend on banks for financing. They generally lack access to bond markets, an effect that is even more important for countries with less developed capital markets such as Bolivia. With respect to capital, lower capitalization as compared to total assets or loans implies a high bank dependence on lenders and, therefore, a stronger credit channel.

3. STYLIZED FACTS

3.1 Monetary Policy in Bolivia

In accordance with Law 1670 of the Banco Central de Bolivia (BCB), its objective is to ensure the stability of the domestic currency's purchasing power. To this end, the BCB regulates the liquidity of the financial system, mainly through open market operations (OMO) that affect the volume of credit and amount of money in the economy. The BCB also establishes mandatory reserve requirements for financial intermediaries and grants liquidity loans guaranteed by the Fondo RAL[3] to the institutions. Furthermore, repo operations are an additional source of liquidity.

According to Cossio et al. (2007) the BCB conducts its monetary policy through an intermediate targeting scheme, fixing limits for its net domestic credit and a floor for the variation in net international reserves (NIR).[4] Given that it is not possible to directly control the intermediate target, monetary policy actions are implemented through an operating target, defined as excess financial system liquidity, that is, the amount above legal reserve requirements.

Precisely because of the deepening bolivianization process that began in the middle of the past decade, the current monetary policy regime is more effective. In the period prior to 2005, when financial dollarization levels were above 90% and OMO were carried out in US

[3] Fund of required liquid assets.

[4] Targets for NIR allow for anchoring net domestic credit (NDC), providing the flexibility necessary in the growth of monetary emission, which in recent years has been explained by economic expansion and the process of dedollarization (bolivianization) in the economy.

dollars, decisions to inject liquidity implied losing the scarce NIR available at that time, limiting their use for offsetting the adverse effects of economic cycles. This capacity has now recovered and the BCB is able to inject large amounts of resources when the economy requires them, such as at the end of 2008 and during 2009, inducing a sharp decline in interest rates, an increase in credit and a strenghtening of economic activity. The mechanism is also effective under environments where it is necessary to withdraw liquidity and, supported by reserve requirements, commissions on external capital flows, exchange position, provisions, direct securities placement[5] and other tools, has allowed for drawing in liquidity and reducing inflationary pressures without substantially affecting interest rates, while preserving the strength of economic activity (Figure 1).

3.2 The Bolivian Banking Sector

The banking system performs an important role in the Bolivian economy. As of June 2014 it accounted for over 50% of the financial system's assets[6] and in recent years has recorded significant growth in its loan portfolio. The strength of banking system intermediation activities was reflected in higher financial deepening indicators, the portfolio to GDP ratio shifted from 21% in September 2008 to 32% at the end of 2013. As of June 2014, 31% of the banking portfolio corresponded to loans granted to households (consumer and mortgage credit) and the remaining 69% to business loans. The 49% of the latter percentage funded micro, small and medium-sized firms.

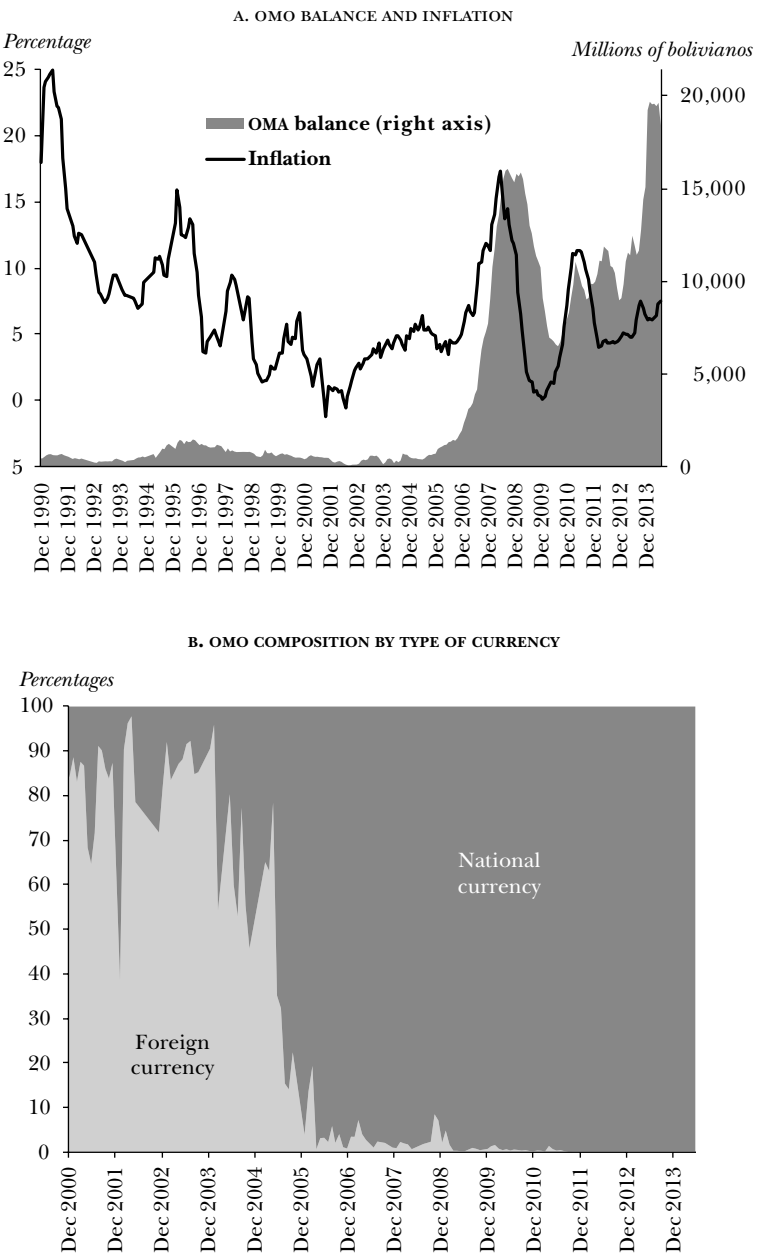
As for the destination of credit, the banking system constitutes the main source of financing for labor intensive firms, while large capital intensive firms obtain funding via external debt. Foreign direct investment is also concentrated in those sectors. Despite the development of the stock market in recent years, financing of non-financial firms through this mechanism is still limited. There are

[5] In October 2007, through Directory Resolution No. 108/2007, the BCB introduced the direct sale of securities to individuals and legal entities.

[6] The Bolivian financial system is composed of financial intermediaries (commercial banks, MSME banks, savings and credit cooperatives, housing finance institutions), managers that administer the Integrated Pensions System, investment fund management associations and insurance companies. Only commercial banks and MSME banks are considered in this study.

Figure 1

EVOLUTION OF OMO



Sources: INE y BCB.

therefore segments of the population (households and small, medium and micro firms) that depend significantly on bank financing.

Over the last few years the number of banking institutions has remained relatively unchanged. As of June 2014, 13 institutions were operating in the market, two of which were subsidiaries of foreign banks (with a less than 1% share of total banking system assets). Foreign ownership in the sector is limited and there is only one large foreign bank, whose capital is raised in the country, which accounts for 11% of total banking system assets. As of December 2013, there was just one first tier public bank with a 13.4% share of total assets (third largest bank). The small participation of foreign and public banks strengthens the credit channel as said institutions face less funding restrictions due to the potential supply of additional resources they are able to obtain from their parent banks and the State, respectively.

A significant market concentration can generate rigidities in the transmission of monetary policy. A Hirschmann-Herfindhal index[7] of 1,121 for assets indicates medium concentration, which has declined in recent years and has favored the credit channel in Bolivia. Moreover, the five largest banks' share of assets, portfolio and deposits in the financial intermediation system (institutions that capture deposits and grant loans) has exhibited a downward trend from values close to 75% at the start of the decade to values slightly above 65% at the end of 2013 (Table 1).

Since 2010 the banking system has recorded average portfolio growth of over 20% driven by loans in domestic currency that, thanks to bolivianization measures implemented by the BCB in coordination with the Executive Body and the Financial System Supervision Authority (ASFI), represented around 90% of banks' total portfolios in 2013 as compared to 7.5% at the end of 2005. The growing share of loans in domestic currency strengthens the credit channel.

The growth of credit was not accompanied by a reduction in the quality of the banks' assets. On the contrary, the delinquency indicator (default portfolio/gross portfolio) registered historically low

[7] The Hirschmann-Herfindhal index is a measure for estimating market concentration through the relative share of its participants. The index is calculated as the sum of the squares of the relative sizes of the variables used for measuring market structure. An index of above 1,800 classifies the market as highly concentrated, between 1,000 and 1,800 moderately concentrated and below 1,000 unconcentrated.

Table 1

BANKS: FINANCIAL INDICATORS
Percentages

	2005	*2007*	*2009*	*2011*	*2013*
Concentration (assets)					
Hirschmann-Herfindhal index	1,416	1,293	1,230	1,155	1,121
Share of the five largest banks	75.2	71.9	70.0	68.6	67.3
Liquidity					
Liquidity/assets	33.5	39.0	48.9	39.1	37.5
Liquidity/short-term obligations	85.6	84.3	98.2	79.4	79.4
Solvency					
CAP	14.6	12.5	13.2	12.2	12.7
Profitability					
ROA	1.0	2.2	2.3	2.1	1.7
ROE	9.9	24.4	27.0	25.4	20.7
Quality of assets					
Delinquency ratio	11.0	5.3	3.3	1.7	1.5
Bolivianization					
Portfolio	7.5	19.1	38.7	69.5	87.6
Deposits	15.6	35.7	47.2	63.5	77.3

Source: ASFI.

levels, below 2% since the beginning of the second half of 2011. The portfolio is mostly backed with real guarantees and delinquency is covered by appropriate levels of provisions, which shows that the strength of the banking sector is not associated with a financial weakening or a reduction in asset quality.

As pointed out in the conceptual framework section, besides the two conditions necessary for the existence of a credit channel, it is also important to take into account that the impact of monetary policy on loan supply depends on the characteristics of the banking sector. Liquidity measured in relation to assets and short-term

obligations increased between 2005 and 2009, but has registered a downward trend since then. Meanwhile, hedging of short-term obligations remains at high levels.

Public deposits, mostly in bolivianos, have also exhibited considerable strength in recent years and constitute the main source of bank lending. Between 2005 and 2013 on average they represented around 90% of bank liabilities (Table 2). The large share of obligations with the public in bank liabilities significantly increases their sensitivity to monetary shocks and the potential strength of the credit channel. Thus, banks do not possess or employ sources of financing other than deposits, which is one of the conditions for the existence and efficiency of a credit channel.

Some of the characteristics of the banking system mentioned above (the bolivianization achieved, the large share of public deposits in bank lending, the significant dependence of some sectors on bank funding, the majority share of private national banks) would indicate that the credit channel could be important in the case of Bolivia. Meanwhile, banking institutions have different levels of liquidity, capitalization and size that could mean monetary policy has different effects depending on such characteristics.

Table 2

MAIN BANKING SYSTEM BALANCE SHEET ACCOUNTS
Millions of bolivianos

	2005	*2007*	*2009*	*2011*	*2013*
Asset	32,726	42,851	62,376	78,026	108,829
Liquid assets	3,269	4,937	12,097	15,902	17,314
Financial investments	7,687	11,796	18,375	14,590	23,513
Gross portfolio	21,571	25,758	31,365	46,547	66,621
Default portfolio	2,371	1,378	1,047	773	1,010
Other assets	200	360	539	987	1,382
Liability	29,046	38,729	56,914	71,413	99,927
Obligations with the public	23,488	33,122	49,710	61,898	84,991
Other liabilities	5,558	5,608	7,204	9,515	14,936
Equity	3,681	4,122	5,462	6,613	8,902

Source: ASFI.

4. LITERATURE REVIEW

Analysis of the credit channel has gained special attention from researchers over the last 25 years. One of the first theoretical and empirical studies was carried out by Bernanke and Blinder (1988, 1992), who in their theoretical analysis incorporated banks into the IS-LM model and then in their empirical research estimated a reduced-form loan supply equation using aggregate data. They found evidence for the existence of a credit channel when banks are not able to replace deposits with alternative sources of financing in times of contractionary monetary policy.

Stein (1998) proposed theoretical microfoundations for the model of Bernanke and Blinder, taking into account situations where the structure of bank assets and liabilities is potentially subject to adverse selection problems.

The first authors to find evidence for the existence of a bank lending channel in the microeconomic sphere were Kashyap and Stein (1995 and 2000). They used the central bank intervention interest rate as the monetary policy tool and demonstrated that monetary policy in the United States has heterogeneous effects on the growth of bank lending depending on bank size (1995) and liquidity (2000), that is, that small banks with less liquidity might have problems for maintaining their loan portfolio during a monetary tightening.

Based on the abovementioned result, Kishan and Opiela (2000) found that the impact differs according to the level of bank capitalization, that is, undercapitalized banks have less access to funds other than deposits and are therefore forced to reduce the supply of loans to a greater degree than well-capitalized banks.

Walsh (2003) also extended the analysis of Bernanke and Blinder. He studied the conditions under which loan supply could be perfectly elastic. His results showed that if loans and deposits are complimentary in the costs function of a bank, a change in reserve requirements that reduces deposits can increase the cost of loans, which leads to a displacement in the credit supply function (bank lending channel) causing a reduction in loans.

Along the same lines, Ehrmann et al. (2003) modelled a loan market also inspired by Bernanke and Blinder. They obtained from the solution of their model an equation for bank loans that relates to monetary policy, both directly (via the money channel) and through the

characteristics of each bank (the credit channel). The authors used an explicit demand function for bank loans (that introduce aggregate variables of output and prices), taking into account that banks are perceived as risky, leading banks' funding sources to demand an external finance premium. The results of their model showed that a bank lending channel has operated in Germany, France, Italy and Spain, and that less liquid banks have a greater reaction to changes in the monetary policy stance, while size and capitalization are not important.

Worms (2003) reported that the average response of banks in Germany to changes in monetary policy depends on the share of short-term interbank deposits in total assets. Gambacorta (2005) employed data for Italy and showed that bank size is not related to the impact of monetary policy and that monetary shocks are weaker for banks with more liquid assets.

The existence of a credit channel has also been examined in Eastern European countries. Pruteanu (2004) detected the existence of a credit channel for the Czech Republic between 1996-1998, where capitalization influences the impact of monetary policy. Liquidity also seems to make a difference with respect to monetary policy, but only in banks with mostly domestic ownership. Benkovskis (2008) also studied the existence of a credit channel for Latvia. His results showed that some banks react significantly to a domestic monetary shock. Nevertheless, the reaction of total lending from all the banks was not found to be statistically significant. A domestic monetary shock has a solely distributional impact, only affecting smaller domestically owned banks with less liquidity and capitalization.

In Latin America, the credit channel was studied by Takeda et al. (2005). The study was based on a dynamic panel data model for Brazil; the results of which suggest evidence for a bank lending channel because reserve requirements affect bank loans. Said impact is larger for smaller banks, meaning monetary transmission is therefore greater as well.

Alfaro et al. (2003) also analyzed evidence on the bank lending channel in Chile for the period 1990-2002. The authors estimated an econometric data panel of banks in order to identify shifts in bank loan supply in response to monetary policy changes. For this purpose, they constructed an aggregate variable aimed at capturing the main mechanisms behind the bank lending channel. Said variable is used to estimate a VAR to test whether this transmission

channel amplifies the impact of a change in the monetary policy interest rate on economic activity. The results showed how the bank lending channel operated as a monetary policy transmission mechanism in Chile during the period analyzed, and had an independent and significant impact on economic activity.

Gómez-González and Grosz (2006) attempted to find evidence for a credit channel in Colombia and Argentina between 1995-2005. Their results showed that while in Argentina it was not possible to prove that bank lending represents a factor amplifying the effects of a monetary policy shock, in Colombia there was evidence for a bank lending channel and the heterogeneous impact of monetary policy on credit intermediaries according to capitalization and liquidity levels.

Carrera (2011) also studied the existence of a bank lending channel for Peru using bank level data. The results showed that a credit channel has been operating in Peru, but it is not important for identifying the monetary policy transmission process toward economic activity.

In the case of Bolivia, there are only few studies done focusing on the theory and effectiveness of the lending channel. Orellana et al. (2000) analyzed three monetary policy transmission channels: Interest rates, exchange rate and credit channel, with VAR models, variance analysis and impulse-response functions for the period 1990-1999. The results established that the credit channel is the most appropriate in the case of Bolivia, given that through it monetary policy could temporarily and partially change the path of GDP growth. Furthermore, economic agents' expectations, the public's preference for cash over deposits, prudential standards of financial regulation and banks' own corporate policy can affect the credit channel.

Rocabado and Gutiérrez (2009) examined the credit channel as a mechanism of monetary policy transmission in Bolivia. The data used included banks' monthly information and other macroeconomic variables for the period 2001-2009. Panel data was employed and the generalized method of moments (GMM) was used, taking into account two monetary policy variables. The results demonstrated empirical evidence for the bank lending channel when the monetary policy indicator is the Treasury bill rate in foreign currency or the Treasury bill rate in housing promotion units. In the first case, the findings are supported through interactions between bank capitalization and liquidity, while in the second bank size and

capitalization play an important role. Moreover, when the effective reserve rate is used as an indicator of monetary policy, there is no direct credit channel in any of the periods analyzed, although there is evidence of an indirect channel through the interaction between reserve requirements effective rate and liquidity.

5. THEORETICAL MODEL AND ECONOMETRIC SPECIFICATION

The model most used for explaining a bank lending channel in the economy is that developed by Kashyap and Stein (1995 and 2000) and Ehrmann et al. (2003). The authors propose a simple aggregate demand model, where the market for deposits is determined by the equilibrium between deposits (D) and the amount of money (M), both in relation to the interest rate (z) set by the central bank.

1 $$M = D = -\psi z + \chi, ,$$

where χ is a constant and ψ is the coefficient of the interest rate set by the central bank.

The bank i faces a demand for loans $\left(L_i^d\right)$ which depends positively on economic activity $\left(y\right)$, inversely on the nominal interest rate of loans $\left(i_L\right)$ and the inflation rate $\left(\pi\right)$. A priori there is no expected sign for the inflation coefficient:[8]

2 $$L_i^d = \phi_1 y + \phi_2 \pi - \phi_3 i_L .$$

The supply of bank loans $i\left(L_i^s\right)$ is a function of the amount of money (or deposits) available, the nominal interest rate of loans and the central bank intervention rate (z). When a bank uses the interbank market to obtain resources, the central bank interest rate is the variable that determines the opportunity cost of such funds. The loan supply is therefore expressed as follows:

3 $$L_s^i = \mu_i D_i + \phi_4 i_L - \phi_5 z.$$

[8] The theoretical models indicate any sign is possible.

This model also takes into account that banks have different levels of dependence on deposits, that is, the larger the variable characterizing banks (x_i) (size, liquidity or degree of capitalization), the smaller the impact of a change in deposits. Said heterogeneity is captured with coefficient μ_i, which measures the effect of asymmetric information according to the following:

4 $$\mu_i = \mu_0 - \mu_1 x_i \, .$$

Equalizing equations of demand 2 and supply 3, and replacing 1 and 4 within the model gives the equilibrium condition:

5 $$L_i = \frac{\phi_1\phi_4 y + \phi_2\phi_4\pi - (\phi_5 + \mu_0\psi)\phi_3 z + \mu_1\psi\phi_3 z x_i + \mu_0\phi_3\chi - \mu_1\phi_3\chi x_i}{\phi_3 + \phi_4}.$$

Equation 5 can be expressed as follows:

6 $$L_i = ay + b\pi - c_o z + c_1 z x_i - dx_i + \text{constant}.$$

Coefficient $c_1 = \frac{\mu_1\psi\phi_3}{\phi_3 + \phi_4}$ captures the reaction of bank lending in response to monetary policy, given the characteristics of the financial institutions. Considering the assumptions of the model, a significant c_1 coefficient implies that monetary policy affects loan supply. One identification assumption implicit in the model is that interest rate elasticity of loan demand does not depend on bank characteristics (x_i); coefficient ϕ_3 is therefore the same for all banks.

The assumption of a homogeneous reaction of loan demand is instrumental for identifying the effects of monetary policy on loan supply. This assumption does not take into account cases where, for instance, customers of large or small banks are more sensitive to interest rate changes. Furthermore, this assumption seems to be reasonable for Bolivia given that bank loans are the principal source of funding for businesses.

For a better understanding of the sign of the end interaction coefficient, the logarithm is applied to both sides of Equation 6:

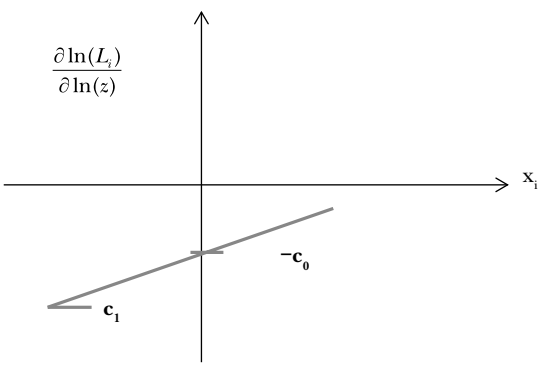
$$\ln(L_i) = \ldots + c_0 \ln(z) + c_1 x_i \ln(z) + \ldots$$

where L_i is the amount of loans of bank i; z is the central bank controlled short-term interest rate (corresponds to the monetary policy indicator measured by the net balance of monetary regulation bonds in the case of this paper); c_0 is the coefficient of the direct impact of monetary policy; x_i is characteristic x of bank i; and c_1 is the interaction coefficient between characteristic x of bank i and $\ln(z)$.

It seems reasonable to assume that $\partial \ln\left(L_i\right) \Big/ \partial \ln(z) = c_0 + c_1 x_i < 0$, which implies that the amount of loans of bank i decreases in the face of interest rate hikes. If the bank characteristics variable x_i represents liquidity, size or capitalization, it would be expected that $c_0 < 0$ y $c_1 > 0$. Assuming that x_i represents the liquidity position of bank i, a positive c_1 coefficient would imply that more liquid banks respond to a lesser degree to monetary tightening represented by an interest rate hike.

Figure 2

SIGN OF THE INTERACTION COEFFICIENT BETWEEN BANK CHARACTERISTICS AND MONETARY POLICY TOOL



5.1 Specification of the Econometric Model

Based on a reduced form of the model presented in Equation 6, it is possible to widen the empirical specification in a way that the growth of the bank loan supply is explained by its lags, the monetary policy variable, the interaction of bank characteristics with monetary policy (key term of the analysis), GDP growth, inflation and banks' own characteristics.

$$7\quad \Delta\log(L_{it}) = \sum_{j=1}^{m} a_j \Delta\log\left(L_{it-j}\right) + \sum_{j=0}^{m} b_j \Delta\log\left(OMA\right)_{t-j} + \sum_{j=0}^{m} c_j \Delta\log\left(y_{t-j}\right)$$
$$+ \sum_{j=0}^{m} d_j \pi_{t-j} + ex_{it-1} + \sum_{j=0}^{m} f_j x_{it-1} \Delta\log\left(OMA\right)_{t-j} + \varepsilon_{it},$$

where, i is the bank i, i=1, ..., N; t represents time, t=1, ..., T; Δ is the first difference operator; m, the number of lags; L_{it}, the loans balalance of bank i in period t; OMA_t, the monetary policy indicator measured by the net balance of monetary regulation bonds; y_t, the economic activity indicator; π_t, the inflation rate; x_{it}, the individual characteristics of the banks, such as size, liquidity and capitalization; η_i, the specific bank error (individual effects); μ_{it},the residual error; and ε_{it}, the total error $\varepsilon_{it} = \eta_i + \mu_{it}$.

Dynamic specification of the equation (loan growth rate) takes into account the fact that banks react to changes in monetary policy by adjusting the concession of new loans.

The coefficients of interest are those that capture the effects of the monetary shock (b_j) and the coefficients of the interaction between monetary policy and bank characteristics (f_j) that attempt to capture whether bank characteristics make any difference in the way banks react to changes in monetary policy.[9] The asymmetric effects of monetary policy are captured by significant terms of interaction coefficients (f). Studies carried out found that banks which are smaller (Kashyap and Stein, 1995 and 2000), less liquid (Kashyap and Stein, 2000) or with lower levels of capital (Peek and Rosengren, 1995) react more to changes in monetary policy.[10] These results imply positive coefficients for the terms of interaction.

5.1.1 Variables

The dependent variable is represented by the balance of banking institutions' gross portfolio.

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[9] The bank characteristics coefficient (e) has an illustrative function, only showing whether there is a linear relation between a change in the supply of bank loans and bank characteristics.

[10] Size, level of capitalization, and liquidity are compared relative to the average for banking institutions analyzed in each of the studies mentioned.

The net balance of monetary regulation bonds was used as an indicator of monetary policy due to the fact that BCB adopts a strategy of quantity intermediate targets for the growth of net domestic credit.

Bank characteristics are represented by variables that correspond to the lending channel theory: size *(size)*, liquidity *(liq)* and capitalization *(cap)*. These variables are compared to the average of the total for banking institutions.

- Bank size is important: larger banks face less asymmetric information problems than smaller banks, therefore, making it easier for them to find sources of funding other than deposits in response to a monetary shock.

8
$$size_{it} = \log A_{it} - \frac{1}{N_t}\sum_{i=1}^{N_t} \log A_{it},$$

where $size_{it}$ is the relative size of a bank; A_{it} is the total assets of the bank; and N_t is the number of banks in period t.

- Another important characteristic is liquidity. Liquid banks are able to use their assets to protect their loan portfolios, while this is more difficult for relatively less liquid banks. The argument is that a reduction in banks' lendable funds (deposits), caused by a monetary tightening, does not imply a reduction in loans if the bank has the option to sell its bonds or other liquid assets.

9
$$liq_{it} = \frac{Lq_{it}}{A_{it}} - \frac{1}{T}\sum_{t=1}^{T}\left(\frac{1}{N_t}\sum_{i=1}^{N_t}\frac{L_{it}}{A_{it}}\right),$$

where liq_{it} is the relative liquidity of a bank; Lq_{it} is the liquid assets of a determined bank: The sum of assets and temporary investments, excluding liquid asset reserve requirements and permanent investments; and A_{it} is the total assets of the bank.

- Banks with above average capitalization levels can more easily access alternative sources of financing, meaning they do not have to reduce their loan supply as much as less capitalized banks in times of monetary tightening.

10
$$cap_{it} = \frac{C_{it}}{A_{it}} - \frac{1}{T}\sum_{t=1}^{T}\left(\frac{1}{N_t}\sum_{i=1}^{N_t}\frac{C_{it}}{A_{it}}\right),$$

where cap_{it} is the relative capitalization of a bank; C_{it}, the capital and reserves of a bank; and A_{it}, the total assets of the bank.

Equations 9 and 10 establish that the global average of liquidity and capitalization is equal to zero across time and among banks, meaning said bank characteristics are zero for all the observations, but not necessarily in every period *t*. This allows the degree of global liquidity and capitalization to vary across the periods. Thus, for the analysis, temporary changes are not removed from the average of these variables.

The definition of size in Equation 8 excludes the rapid growth of the banking sector, adjusting average bank size to equal zero for each time period. This procedure gets rid of unwanted nominal changes in this variable, with which the size of a bank as compared to the size of all the banks in a given period is a relevant measure.

The three bank characteristics are standardized with respect to the average for the group of banks in order to obtain indicators that add up to zero across all the observations. Therefore, the average of the interaction term in Equation 7 is zero, meaning coefficients b_j can be directly interpreted as a measure of the total impact of monetary policy on bank loans.

GDP growth rate and inflation are employed as macroeconomic variables to control for demand shocks.

5.1.2 Data Sources

The period analyzed runs from March 2005 to December 2013. Bank data is taken from the quarterly balance sheets that financial institutions report to the ASFI <www.asfi.gob.bo> and only consider banks currently operating and whose capital is based in the country. The balance sheets published by the ASFI contain the information required for constructing the dependent variable (annual growth of banks' loan portfolio) and the size, liquidity and capitalization coefficients defined in Equations 8 to 10, respectively.

The macroeconomic variables employed are taken from the National Statistics Institute (INE, <www.ine.gob.bo>) and those of monetary regulation are sourced from the BCB (<www.bcb.gob.bo>). The 12-month growth rate for the three macroeconomic variables was considered.

Table 3 shows descriptive statistics for the variables employed in the model for the estimation period.

Table 3

DESCRIPTIVE STATISTICS FOR THE VARIABLES IN THE MODEL

Millions of bolivianos and percentages

	Mean	*Standard deviation*	*Minimum*	*Maximum*
Loan portfolio growth	16.9	12.7	−16.0	54.7
Net balance of OMO growth	83.0	115.3	−52.1	361.8
GDP growth	4.7	1.3	2.5	6.9
12-month inflation rate	6.5	4.0	0.3	17.3
Capital to assets ratio	7.5	2.0	3.7	17.0
Liquidity to assets ratio	33.3	12.6	10.0	63.2
Size (assets)	5,312	3,815	266	18,153

Sources: ASFI, BCB and INE.

5.2 Estimation Method

The simplest way to estimate the model is by using ordinary least squares method (OLS). One difficulty with this approach is probably the unobserved importance of heterogeneity in the conditional mean across financial institutions. A simple alternative for estimating the model would therefore be to use static panel data with fixed effects applied within transformation, given that the sample considers all the banking institutions in the system.

However, Equation 7 shows that the dependent variable is modelled through a dynamic specification, given that there might be lagged dependent variables as explanatory variables for the model.

Dynamic specification of a model with fixed effects or least squares dummy variables (LSDV) model is estimated by applying OLS to the model expressed in deviations from the mean of each unit in the panel with respect to time. However, Nickell (1981) showed that the LSDV estimator is biased and inconsistent, particularly when N is large and T is small, a bias which is not reduced by increasing N, or by adding explanatory variables. However, as T grows, the fixed effects estimators become consistent.

There have been attempts to correct the bias of the fixed effects LSDV estimator, among which are the instrumental variables (IV)

method and the generalized method of moments (GMM). Due to the dynamic nature of the model, the GMM proposed by Arellano and Bond (1991) was employed. To solve possible problems of endogeneity in the procedure based on Arellano and Bond, lagged values of the variables of Equation 7 are employed as GMM type instruments.[11]

The AR test is important when estimating dynamic models in order to analyze the autocorrelation of residuals. By construction, the residuals of the difference equation show first-order autocorrelation, but if the series independence assumption of the original errors is guaranteed, the residual differences should not show a significant *AR(2)* (there should not be any second-order autocorrelation in the residuals of the first-difference equation), which is verified with the *AR(1)* and *AR(2)* tests. The Hansen test was employed to validate the use of chosen instruments.

6. RESULTS

Equation 7 was estimated based on the methodology described in the previous section. It is important to mention that the coefficients reported in Table 4 are the long-term ones,[12] while the short-term coefficients are presented in the Annex. Long-term coefficients of the interaction terms were used to test whether there is a monetary policy impact on loan supply, assuming that the other variables included in Equation 7 capture the movements of credit caused by loan demand and supply factors other than changes in monetary policy.

The estimates[13] show that monetary policy has the capacity to directly affect bank loan supply because it presents the expected sign (negative) and is statistically significant in both models. This would

[11] The fact that bank characteristic variables are based on balance sheet data leads to the problem of endogeneity: If bank loans and bank characteristics are closely correlated, a priori it would not be clear which variable drives the other.

[12] The long-term coefficient of a variable is calculated as the sum of its contemporaneous coefficient and its (their) lag(s), divided by one minus the sum of the lagged dependent variable coefficients. The significance of long-term coefficients is tested using the Wald test.

[13] Due to the dynamic character of Equation 7, the preferred model is the one estimated by GMM. Nevertheless, Table 4 presents the results estimated by LSDV in order to test their robustness.

Table 4

LONG-TERM COEFFICIENTS OF THE REGRESSION OF MONETARY POLICY IMPACT ON BANK LOANS

Dependent variable: $\Delta \log(L_{it})$

	Fixed effects	*A&B*
$\Delta \log(OMA)$	−0.0474	−0.0478
	(0.07)	(0.06)
$size * \Delta \log(OMA)$	0.0380	0.0383
	(0.01)	(0.01)
$liq * \Delta \log(OMA)$	−0.5911	−0.5895
	(0.00)	(0.00)
$cap * \Delta \log(OMA)$	1.3303	1.3284
	(0.04)	(0.04)

Note: Probabilities are in parenthesis.

imply that a monetary policy tightening (increase in the supply of securities) leads to reductions in loan growth and would signal the existence of a direct lending channel [coefficient of the variable $\Delta \log(OMA)$].

According to the findings, the coefficients for size and capital interactions were statistically insignificant, which reflects the existence of different reactions among the banks to changes in monetary policy through such variables, meaning the proposed methodology would prove the existence of a bank lending channel. The evidence therefore suggests that smaller banks with below average capitalization levels would reduce their loans to a greater degree in the face of a monetary tightening.

The results also imply that in times of monetary policy tightening borrowers of smaller less-capitalized banks on average experience a larger reduction in financing than borrowers of larger more capitalized banks.

Size is the indicator most used in the existing literature to reflect the capacity of banks to obtain sources of funding other than deposits. Small banks would tend to have greater difficulties in obtaining sources of funding given that they face higher information costs or a greater external financing premium, or both, than larger banks do. They are therefore less able to offset the impact of a monetary

tightening and are forced to reduce their loan supply to a greater degree than large banks.

High capitalization levels also mean that banks are less likely to experience asymmetric information and moral risk problems. Thus, the external finance premium for a bank with high levels of capitalization should be lower than that for a less capitalized bank, implying that the latter are forced to reduce their loans to a greater degree than the former.

In the case of liquidity, although the interaction variable was statistically significant, it does not present the expected sign. There is therefore no evidence for a bank lending channel with this indicator. According to Worms (2003) liquidity could be endogenous: Banks facing problems of imperfect information would probably decide to maintain a higher amount of liquid assets. The possibility that more liquid banks have greater risk aversion, meaning they would have higher standards for granting loans, cannot be excluded either. If this were the case, in response to monetary policy, there would be differences in the demand for loans between risky and less risky borrowers, meaning liquidity would not be a variable that allowed for discriminating the effects of monetary policy on loan supply.

Finally, autocorrelation tests *AR(1)* and *AR(2)* show that, as would be expected, there is a first-order correlation in the residuals, while there is no second-order correlation. The Hansen test shows that the instruments used are valid.[14]

7. CONCLUSIONS

Unlike the traditional interest rates channel, the bank lending channel assigns a significant role to banks in the transmission of monetary policy. The two necessary conditions for the existence of a bank lending channel are the capacity of monetary policy to affect loan supply and the dependence of certain economic agents on bank lending.

There are characteristics of the Bolivian banking system, such as the degree of bolivianization achieved, the large share of public deposits in bank funding, the significant dependence of some sectors on bank funding and the majority share of private domestic

[14] The results of the tests are reported in the Annex.

banks, which indicate that the lending channel could be important in Bolivia's case.

The estimates show that monetary policy has the capacity to directly affect bank loan supply, which would imply that increases in the securities' supply lead to reductions in loan growth. Moreover, interactions of size and capital with the monetary policy variable reflect the existence of different bank reactions, validating the existence of a bank lending channel. The findings would suggest that smaller less capitalized banks reduce their loans to a greater degree in times of monetary tightening.

ANNEX

Table A.1

SHORT-TERM COEFFICIENTS OF THE REGRESSION OF THE IMPACT OF MONETARY POLICY ON BANK LOANS WITH THE FIXED EFFECTS METHOD

Dependent variable: $\Delta \log\left(L_{it}\right)$

	Coefficient	*Standard error*	*Probability*
$\Delta \log(L)[-1]$	0.8727	0.0312	0.0000
$\Delta \log(OMA)$	−0.0016	0.0034	0.6540
$\Delta \log(OMA)[-1]$	−0.0045	0.0033	0.2110
$\Delta \log(PIB)$	0.2011	0.1595	0.2360
$\Delta \log(PIB)[-1]$	−0.1555	0.2972	0.6120
π	0.2636	0.1149	0.0450
$\pi[-1]$	−0.1223	0.1200	0.3320
size[−1]	−0.0240	0.0110	0.0540
liq[−1]	0.1402	0.0347	0.0020
cap[−1]	0.0705	0.2635	0.7950
size[−1] $*$ $\Delta \log(OMA)$	0.0008	0.0021	0.7000
size[−1] $*$ $\Delta \log(OMA)[-1]$	0.0040	0.0021	0.0820
liq[−1] $*$ $\Delta \log(OMA)$	−0.0266	0.0344	0.4570
liq[−1] $*$ $\Delta \log(OMA)[-1]$	−0.0487	0.0358	0.2030
cap[−1] $*$ $\Delta \log(OMA)$	0.1074	0.0414	0.0270
cap[−1] $*$ $\Delta \log(OMA)[-1]$	0.0620	0.0515	0.2560
Constant	0.0161	0.0149	0.3060

Table A.2

SHORT-TERM COEFFICIENTS OF THE REGRESSION OF THE IMPACT OF MONETARY POLICY ON BANK LOANS WITH THE GMM

Dependent variable: $\Delta\log\left(L_{it}\right)$

	Coefficient	*Standard Error*	*Probability*
$\Delta\log(L)[-1]$	0.8724	0.0310	0.0000
$\Delta\log(OMA)$	−0.0016	0.0034	0.6440
$\Delta\log(OMA)[-1]$	−0.0045	0.0033	0.2050
$\Delta\log(PIB)$	0.1963	0.1593	0.2440
$\Delta\log(PIB)[-1]$	−0.1576	0.2968	0.6060
π	0.2640	0.1151	0.0430
$\pi[-1]$	−0.1217	0.1195	0.3300
$size[-1]$	−0.0248	0.0108	0.0430
$liq[-1]$	0.1365	0.0325	0.0010
$cap[-1]$	0.0570	0.2574	0.8290
$size[-1]*\Delta\log(OMA)$	0.0009	0.0021	0.6910
$size[-1]*\Delta\log(OMA)[-1]$	0.0040	0.0021	0.0770
$liq[-1]*\Delta\log(OMA)$	−0.0268	0.0345	0.4540
$liq[-1]*\Delta\log(OMA)[-1]$	−0.0484	0.0358	0.2040
$cap[-1]*\Delta\log(OMA)$	0.1083	0.0414	0.0240
$cap[-1]*\Delta\log(OMA)[-1]$	0.0611	0.0512	0.2580
AR(1)			0.0320
AR(2)			0.6940
Hansen			1.0000

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