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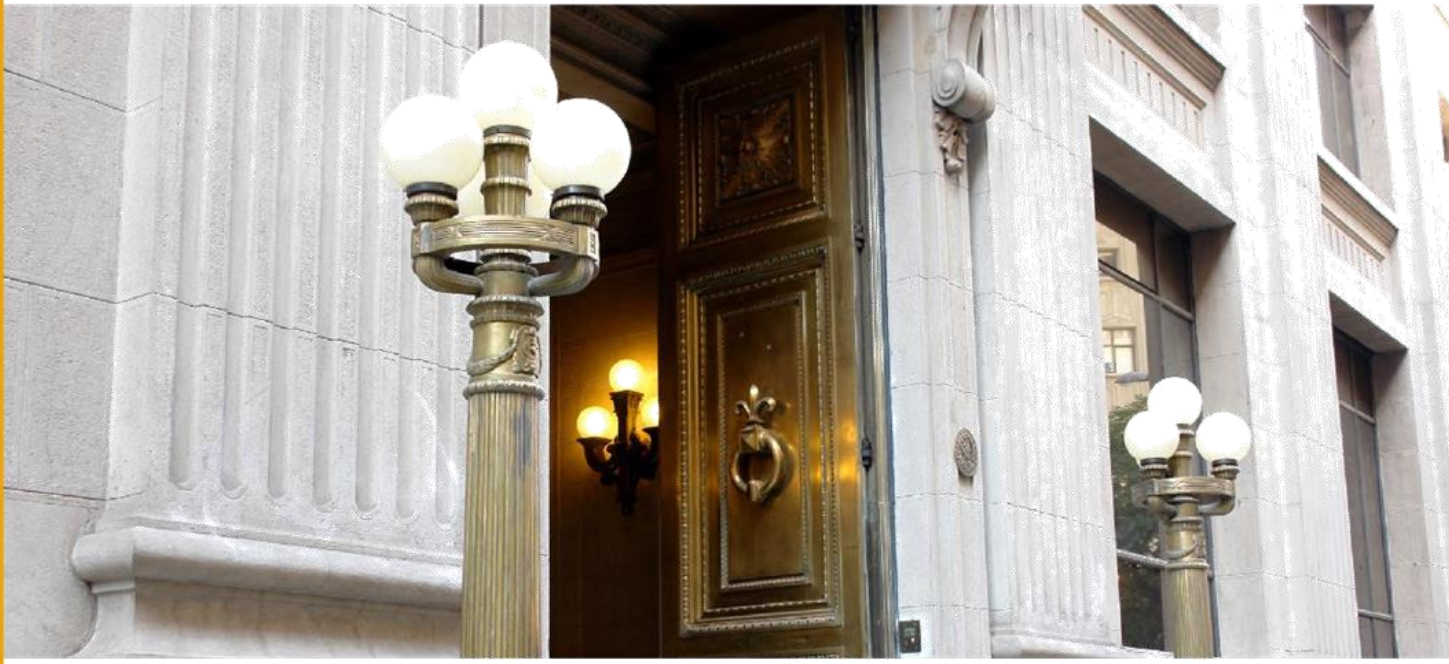

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Pass-through from monetary policy to bank interest rates: A-symmetry analysis*

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Abstract

This paper analyzes the effect of monetary policy in the credit market, by modeling the dynamics of banks' interest rates relative to its equilibrium level. We estimate the banks' equilibrium interest rates, which include latent spreads and/or specific margins. Additionally, we allow a gradual convergence to the target and asymmetric adjustment speeds, as it may be different for active and passive rates and it depends on whether these adjust to higher or lower levels as compared to the current one. The use of regimes based on the relative level of the rate to its objective has advantages over only differentiating between increases and decreases in the monetary policy rate (MPR), since it also recognizes changes in spreads, which exploit the heterogeneity of the banks and include the effects of specific factors. Using Chilean data from January 2004 to September 2019, we find that although there is a direct transmission of MPR on the banks' interest rates, this is not immediate. In particular, we show that the adjustment of deposits rates to changes in the MPR is faster in a monetary easing, while, for commercial rates, banks adjust their rates more rapidly to a tightening. This result is consistent with international evidence, in particular for larger institutions, but this effect is diluted in a period of less than a year.

Resumen

Este artículo analiza el efecto de la política monetaria en el mercado de crédito, modelando la dinámica de las tasas de interés de los bancos en relación con su nivel de equilibrio. Estimamos las tasas de interés de equilibrio de los bancos, que incluyen márgenes latentes y/o márgenes específicos. Adicionalmente, permitimos una convergencia gradual al objetivo y velocidades de ajuste asimétricas, ya que puede ser diferente para las tasas activas y pasivas y depende de si estas se ajustan a niveles más altos o bajos en comparación con el actual. El uso de regímenes basados en el nivel relativo de la tasa a su objetivo tiene ventajas sobre solo diferenciar entre aumentos y disminuciones en la tasa de política monetaria (TPM), ya que también reconoce cambios en los márgenes, que aprovechan la heterogeneidad de los bancos e incluyen los efectos de factores idiosincráticos.

Utilizando datos de Chile de enero de 2004 a septiembre de 2019, encontramos que, si bien existe una transmisión directa de la TPM sobre las tasas de interés de los bancos, esta no es inmediata. En particular, mostramos que el ajuste de las tasas pasivas ante cambios en la TPM es más rápido en una relajación monetaria, mientras que para las tasas comerciales los bancos ajustan sus tasas más rápidamente ante una restricción. Este resultado es coherente con la evidencia internacional y más acentuado en instituciones de mayor tamaño, pero este efecto se diluye en un período menor a 1 año.

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* The opinions expressed in this article are the authors' own and do not necessarily represent the views of the Central Bank of Chile or its Board Members. The usual disclaimer applies.

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1 Introduction

The role of monetary policy has been widely studied in the literature. However, the transmission mechanisms from monetary policy rates to banks' interest rates are less well defined and are still a focus of research. Given that the effectiveness of monetary policy is highly related to the transmission channels and their adjustment mechanisms, it is necessary to understand their dynamics and the determinants that govern them. For instance, for monetary policy (either expansionary or contractionary) to be successful, the change in the policy rate must be transmitted quickly to the market, in particular to banks' interest rates. Therefore, knowledge about the speed of transmissions, asymmetries or information about the degree of persistence of banks' interest rates are key issues for well-defined monetary policy changes.

The macroeconomic literature stresses the credit channel of monetary policy, which distinguishes between two mechanisms, namely, the balance sheet and bank lending mechanism (Bernanke and Gertler, 1995). The former captures demand side effects, while the latter focuses on the supply effects. This channel emphasizes the role of financial intermediaries and financial frictions. More recently, Drechsler et al. (2017) presented a new monetary policy transmission channel framework, the deposits channel. They argue that when the Fed raises its rates, banks react by raising the spreads on deposits, making them flow outside the banking system and triggering a contraction in lending. Furthermore, the 2007 great financial crisis period was followed by expansions in bank deposits along with deposit rates that were beyond policy rates, possibly providing further insights in monetary policy transmission. Bratsiotis (2018) highlighted the importance of the deposits channel in analysing the role of monetary policy, especially throughout periods when the monetary policy rate is at the zero lower bound (ZLB). His conclusions were drawn from a DSGE framework enriched with financial frictions and based on two plausible factors explaining this channel, the interest on reserves and the precautionary demand for liquidity.

Moreover, there are issues such as the stickiness of banks' interest rates, speed of transmission and asymmetry have been also studied in the literature. Interest rates stickiness illustrates the fact that after a change in the monetary policy rate, banks adjust their interest rates in a smaller amount. It happens not only in the short-run, but possibly also in the long-run. Cottarelli and Kourelis (1994) analysed what determines the short-run stickiness using a dynamic panel data model for the lending rate. They documented at least two interesting findings. First, the degree of stickiness is different across countries. Second, the structure of the financial system strongly influences the degree of lending rate stickiness. On the other hand, deposits rates also exhibit a certain degree of rigidity, especially when the incentive for a deposit rate change is towards a higher level (Berger and Hannan, 1991).

Furthermore, the adjustment of banks' rates to policy rates is not necessarily symmetric. For instance, following a decrease in the policy rate, banks adjust their loan rates to a lower level but at a measured speed and not entirely. On the other hand, the response to an increase in the policy rate is at a higher speed and nearly for an equal amount. Lim (2001) used a multivariate error correction model to analyse the adjustment process of loan and deposit rates in Australia. He found asymmetric responses in both sizes and speeds, between periods of expansionary and contractionary monetary policy. He also reported that these asymmetries are only present in the short-run. Similarly, Gambacorta and Iannotti (2007) used Lim (2001) asymmetric framework to examine the effect of monetary policy shocks on Italian banks' interest rates. They assessed the relationship between an average short-run lending rate, a weighted average rate paid on accounts (deposit rate), an interbank rate and a proxy for monetary policy rate. Conditional on the degree of competition in the banking system, the direction of the change in the monetary policy rate has a differentiated effect (in size and speed) in both deposit and lending rates. For instance, in the case of a monetary tightening, banks with some degree of market power could increase their loan rate by more and faster than their deposit rate and vice versa. More recently, Roelands (2012) proposed a continuous time model to explain this asymmetry in terms of two regulatory measures faced by banks, liquidity and capital requirements. When banks face binding capital or liquidity requirements the shadow value of both liquidity and capital becomes higher. Then, they will raise their loan rate high relative to the policy rate, because holding capital or assets that can be exchanged or sold easily becomes a valuable strategy.

The identification of the effects of monetary policy on interest rates and its transmission mechanisms is challenging and still a point where macroeconomic research should be developed. Nevertheless, in spite of theses difficulties, there is evidence about certain properties such as persistence or asymmetry as mentioned before. In addition, the banking sector plays an important role in the identification process through the heterogeneity across banking institutions where the emphasis is in relevance of the banking credit channel (Kashyap and Stein, 2000). Previous empirical evidence for the Chilean case highlight the relevance of the credit channel as well as the interest rates' persistence. In fact, compared to other countries, Chile have one of the more flexible interest rates. However, there is some degree of persistence in bank lending rates. At the individual bank level, this persistence seems to be influenced by factors such as loan risk level, type of customers and bank's size (Berstein and Fuentes, 2003). More recently, the role of heterogeneity in the transmission of interest rates has been studied as a risk measure. In addition, credit risk is found to have effects on how commercial banks set its lending rates following a change in the policy rate (Pedersen, 2016, 2018).

The objective of this paper is to bring into discussion additional insights about the transmission of the monetary policy rate to banks' interest rates in Chile. We analyze three important issues: i) the convergence of the banks' interest rates to policy rate, ii) the asymmetric convergence conditional on the direction and magnitude of the monetary policy rate, and iii) the effect of the market structure on the elasticity of banks' interest rates.

Our work focuses on the commercial portfolio and uses a panel data estimation with fixed effects, from January 2004 to September 2019. Estimates show a persistence of bank rates. The empirical evidence indicates that the convergence hypothesis is accepted for both deposits and loan rates. The relative importance of the target spread for the system is greater for the deposit rate than for commercial loans. On the other hand, there is information contained in the heterogeneity between banks. The percentage of banks that are in a regime of higher targets is volatile and does not necessarily coincide with the periods of increases in the MPR. This variability is what allows the identification of asymmetric elasticities. Thus, we find that the adjustment of interest rates towards its objective is asymmetric with respect to the increases and decreases of the target rates, while the MPR has a full effect on the target rates. In particular, the sensitivity to the MPR is different for deposit and commercial loans rates. The adjustment of deposits rates to changes in the MPR is faster downwards, whereas the commercial rates adjust more rapidly to the increases. In this context, it can be seen that banks have incentives to maintain a greater margin when they face decreases in their target rates and, to a lesser extent, in the increases. Also, we find that this effect is greater for larger banks.

The rest of the paper is structured as follows. Section 2 presents the econometric framework and the estimation methods. Section 3 describes the data. Section 4 presents the results and discusses its policy implications, and Section 5 concludes.

2 Bank rates' asymmetric convergence estimation (BRACE)

This section first defines a simple convergence model for banks' interest rates. Additionally, we introduce asymmetric elasticities in response to both positive and negative shocks in the level of convergence. Then, we propose an estimation method, which we call Bank rates' asymmetric convergence estimation or BRACE, where we introduce this specification and test the hypothesis of convergence, dependence and asymmetry.

2.1 Model Specification

We assume that banks are financed by depositors at a rate r^d (which, for simplicity, will be also assumed to equal the interbank rate). Additionally, depositors have access to a risk free asset which has a rate m fixed by the Central Bank. Therefore, given a competitive environment, in equilibrium the depositors breaks even such the expected return from its deposits is equal to the investment in the risk free asset. On the other hand, the expected return of deposits depends on the probability of failure or the credit risk of the bank which is related to its level of capital and liquidity (Bratsiotis, 2018).

On the other hand, the banks charge a lending rate r^l such that the expected income covers the cost of funding (Bratsiotis, 2018). Additionally, the lending rate incorporates the credit risk of debtors, but also affected by the concentration of the industry and the market power of the banks (Drechsler et al., 2017). Therefore, the loans interest rates not only depend on its own risk, but also on the banks' risks, and the risk free rate.

2.1.1 Convergence of bank' interest rates to the monetary policy rate

The dynamics of funding (i.e. deposits) interest rate $r^d_{i,t}$ of bank i at time t follows a partial adjustment model (Cottarelli and Kourelis, 1994; Flannery and Rangan, 2006):

$$r^d_{i,t} = \alpha r^d_{i,t-1} + (1-\alpha)(m_t + B_{i,t}) + \epsilon^d_{i,t} \tag{1}$$

where m_t is the monetary policy rate (or risk free rate), $B_{i,t}$ is the bank's risk premium, and $\epsilon^d_{i,t}$ is a white noise. As a result, in the long run the deposit interest rate converges to the monetary policy rate[1] plus a bank's risk premium:

$$\bar{r}^d_{i,t} = m_t + B_{i,t} \tag{2}$$

In spite of the fact that the convergence level change according to m_t and $B_{i,t}$, $B_{i,t}$ is not directly observable[2]. However it can be approximated as a linear function of risk factors $b_{i,t}$, which includes

[1]Strictly speaking, the deposit interest rate must converges to the expected monetary policy rate. However, we assume that the monetary policy rate is a martingale in the short run, therefore the expected rate corresponds to the current rate. An extension to the methodology involves modeling the dynamics of the risk-free rate and incorporate it in the model. As we test later with the data, this assumption is reasonable.

[2]Typically the risk premium is defined as the residual or difference between the interest rate and the monetary policy rate. Nonetheless, that is only true in equilibrium.

macro variables and fixed effects, such as:

$$B_{i,t} = b'_{i,t}\rho \tag{3}$$

On the other hand, the loan interest rate $r^l_{i,t}$ includes a spread $S_{i,t}$, which reflects the risk premium of debtors, to the funding cost $r^d_{i,t}$. Hence, we define the dynamics of loans rates as follows:

$$r^l_{i,t} = \beta r^l_{i,t-1} + (1-\beta)(m_t + B_{i,t} + S_{i,t}) + \phi\epsilon^d_{i,t} + \epsilon^l_{i,t} \tag{4}$$

where $\epsilon^l_{i,t}$ is a white noise. Additionally, the parameter ϕ captures the effect of idiosyncratic shocks of the funding cost on the loans' rates[3]. Similarly, the loan interest rate $r^l_{i,t}$ converges to the funding rate $\bar{r}^d_{i,t}$ plus $S_{i,t}$. Therefore, using (2) we have that:

$$\bar{r}^l_{i,t} = \bar{r}^d_{i,t} + S_{i,t} = m_t + B_{i,t} + S_{i,t} \tag{5}$$

Where the risk premium $S_{i,t}$ is defined as a linear function of risk factors $s_{i,t}$:

$$S_{i,t} = s'_{i,t}\psi \tag{6}$$

Notice that both α and β are the persistence of the funding and loan interest rate, respectively. Therefore, if $\alpha = 0$ and (or) $\beta = 0$ the transmission of the monetary policy rate on banks' interest rates, discounting the effects of risk factors $b_{i,t}$ and $s_{i,t}$, is instantaneous.

Now consider a shock Δm_0 in the equilibrium $r^d_{i,-1} = \bar{m} + \bar{B}_i$ and $r^l_{i,-1} = \bar{m} + \bar{B}_i + \bar{S}_i$. Then, the dynamics of $r^d_{i,t}$ and $r^l_{i,t}$ defined by (1) and (4), respectively, are:

$$r^d_{i,t} - r^d_{i,0} = r^d_t - r^d_0 = \sum_{\tau=0}^{t-1} \alpha^\tau (1-\alpha)\Delta m_0 \tag{7}$$

$$r^l_{i,t} - r^l_{i,0} = r^l_t - r^l_0 = \sum_{\tau=0}^{t-1} \beta^\tau (1-\beta)\Delta m_0 \tag{8}$$

Using (7) and (8), the speed of the transmission of the monetary policy to the interest rate of deposits and loans are given by:

$$ms^d_c = \left[\frac{\ln(1-c)}{\ln\alpha} - 1\right] \tag{9}$$

$$ms^l_c = \left[\frac{\ln(1-c)}{\ln\beta} - 1\right] \tag{10}$$

[3]This specification also incorporates the correlation between the error terms of deposits and loan equations.

Where c is the level of convergence expressed in percentage. Both ms_c^d and ms_c^l are expressed in units of t. For instance, using monthly data and $\alpha = 0.4$, 99% of the change in the monetary policy rate is transferred to the deposits' interest rate in approximately 4 months.

2.1.2 Asymmetric convergence

We suppose that the convergence process of interest rates depends on the sign of the deviation from its long-run equilibrium. In other words, converging upwards from below equilibrium is different from converging downwards from above it.

Typically, the (a)symmetry depends on the direction of the shocks (i.e. increase or decrease of the monetary policy rate) such as Gambacorta and Iannotti (2007) and Roelands (2012). However, not only the sign the shocks are relevant but also its relative position respect to the equilibrium. For example, if the interest rate is higher enough than its equilibrium level, positive or negatives shocks could keep converging downwards. In such a case, a positive shock narrows the distance, while a negative increases it. Furthermore, if the shock is sufficiently strong, it could change the regime of convergence (to converging upwards, in our example).

Hence, the dynamics of interest rates of deposits $r_{i,t}^d$ and $r_{i,t}^l$ describe in equations (1) and (4), respectively, follows two regimes of convergence: upwards (superscript b) and downwards (superscript a). Therefore, considering equations (3) and (6), we define the BRACE equations as:

$$r_{i,t}^d = \begin{cases} \alpha^b r_{i,t-1}^d + \left(1-\alpha^b\right)\left(m_t + b_{i,t}'\rho\right) + \epsilon_{i,t}^d, & \text{if } m_t + b_{i,t}'\rho \geq r_{i,t-1}^d \\ \alpha^a r_{i,t-1}^d + \left(1-\alpha^a\right)\left(m_t + b_{i,t}'\rho\right) + \epsilon_{i,t}^d, & \text{otherwise} \end{cases} \tag{11}$$

$$r_{i,t}^l = \begin{cases} \beta^b r_{i,t-1}^l + \left(1-\beta^b\right)\left(m_t + b_{i,t}'\rho + s_{i,t}'\psi\right) + \phi^b \epsilon_{i,t}^d + \epsilon_{i,t}^l, & \text{if } m_t + b_{i,t}'\rho + s_{i,t}'\psi \geq r_{i,t-1}^l \\ \beta^a r_{i,t-1}^l + \left(1-\beta^a\right)\left(m_t + b_{i,t}'\rho + s_{i,t}'\psi\right) + \phi^a \epsilon_{i,t}^d + \epsilon_{i,t}^l, & \text{otherwise} \end{cases} \tag{12}$$

Where the superscript b refers to a convergence from below and a from above. The condition in (11) can also be expressed as $\Delta m_t + \Delta B_{i,t} \geq r_{i,t-1}^d - m_{t-1} - B_{i,t-1}$. Thus, the convergence regime depends on three components. First, the change in the monetary policy. Second, the shocks from other risk factors. Finally, it also depends on the past deviations of the interest rate from its convergence level[4].

[4]In the special case when $\Delta m_t + \Delta B_{i,t} = r_{i,t-1}^d - m_{t-1} - B_{i,t-1}$ the interest rate converges in t such that $r_{i,t}^d = r_{i,t-1}^d$ and the values of α^b and α^a are irrelevant.

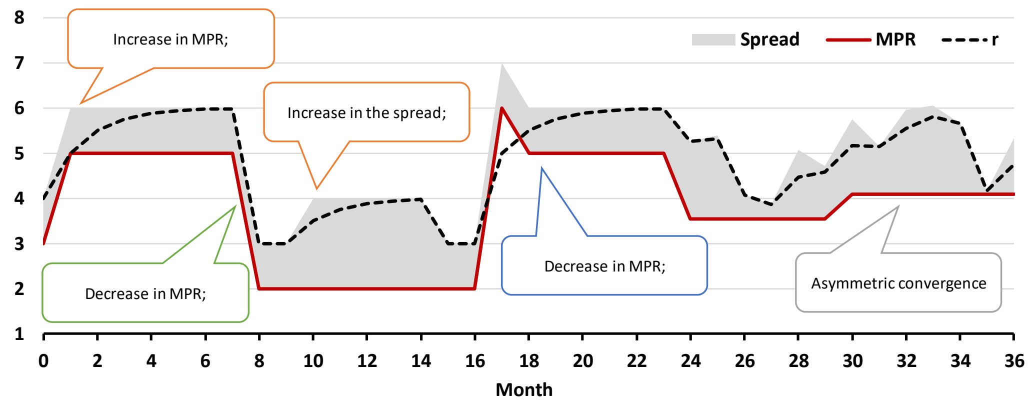

Figure 1. Asymmetric convergence condition (percentage). Simulation based on $\alpha^b = 0.5$ and $\alpha^a = 0.0$. That is, the convergence from below if gradual, while there is an instantaneous adjustment from above.
Source: Own elaboration.

2.2 Estimation Method

The procedure considers a two-step panel estimation for both deposits and commercial interest rates, where we test the hypothesis of an asymmetric convergence to the monetary policy rate.

Lets define the binary indicator ω which:

$$\omega^d \equiv \mathbb{1}_{m_t + b'_{i,t}\rho \geq r^d_{i,t-1}} \tag{13}$$

$$\omega^l \equiv \mathbb{1}_{m_t + b'_{i,t}\rho + s'_{i,t}\psi \geq r^l_{i,t-1}} \tag{14}$$

where $\mathbb{1}$ is the indicator function. Therefore, equations (11) and (12) can be expressed as:

$$r^d_{i,t} = \left(\omega^d\alpha^b + \left(1 - \omega^d\right)\alpha^a\right) r^d_{i,t-1} + \left[1 - \left(\omega^d\alpha^b + \left(1 - \omega^d\right)\alpha^a\right)\right]\left(m_t + b'_{i,t}\rho\right) + \epsilon^d_{i,t} \tag{15}$$

$$r^l_{i,t} = \left(\omega^l\beta^b + \left(1 - \omega^l\right)\beta^a\right) r^l_{i,t-1} + \left[1 - \left(\omega^l\beta^b + \left(1 - \omega^l\right)\beta^a\right)\right]\left(m_t + b'_{i,t}\rho + s'_{i,t}\psi\right) + \left(\omega^l\phi^b + \left(1 - \omega^l\right)\phi^a\right)\epsilon^d_{i,t} + \epsilon^l_{i,t} \tag{16}$$

The parameters α^b, α^a,and ρ for the interest rate of deposits, and β^b, β^a, and ψ for interest rate of loans, are estimated in a two-step procedure.

In the first step, the equations (15) and (16) are estimated by panel data fixed effects[5] without asymmetry and using an unrestricted specification:

[5]Dynamic panel data estimators such as Arellano-Bond, Arellano-Bover, Blundell-Bond or Anderson-Hsiao are used for panel datasets with few time periods and many individual units. In this context, given the short time sample, fixed effects estimators suffer from Nickell Bias. However, as the T increases (i.e. more than 10 periods) this bias decreases, but the number of instruments used by dynamic estimators, largely increases. Nonetheless, we test for the presence of unit roots to check if its necessary to change the identification strategy.

$$r_{i,t}^{d} = \gamma_1^d r_{i,t-1}^{d} + \gamma_2^d m_t + \gamma_3^{d\prime} b_{i,t} + \upsilon_{i,t}^{d} \tag{17}$$

$$r_{i,t}^{l} = \gamma_1^l r_{i,t-1}^{l} + \gamma_2^l m_t + \gamma_3^l \hat{\rho}' b_{i,t} + \gamma_4^{l\prime} s_{i,t} + \gamma_5^l \hat{\upsilon}_{i,t}^{d} + \upsilon_{i,t}^{l} \tag{18}$$

Where the estimators of the parameters ρ and ψ are respectively:

$$\hat{\rho} = \left(1 - \hat{\gamma}_1^d\right)^{-1} \hat{\gamma}_3^d \tag{19}$$

$$\hat{\psi} = \left(1 - \hat{\gamma}_1^l\right)^{-1} \hat{\gamma}_4^l \tag{20}$$

Notice that $\left(\omega^d \alpha^b + \left(1 - \omega^d\right) \alpha^a\right) = \bar{\alpha}$ and $\left(\omega^l \beta^b + \left(1 - \omega^l\right) \beta^a\right) = \bar{\beta}$. Then we test the restrictions of the equation (11) and (12):

- **Convergence**. The interest rates converges to the MPR plus a spread in the long-run.

$$\text{Ho: } \gamma_1^d + \gamma_2^d = 1 \wedge \gamma_1^l + \gamma_2^l = 1 \tag{21}$$

- **Dependence**. The target interest rates of loans includes also the bank's risk premium.

$$\text{Ho: } \gamma_2^l = \gamma_3^l \tag{22}$$

If we cannot be reject the restrictions, then estimate the restricted version of (17) and (18).

In the second step we use (19) and (20) to estimate the dummies $\hat{\omega}^d$ of equation (13) and $\hat{\omega}^l$ of (14). Afterwards, estimate (15) and (16) using $\hat{\omega}^d$ and $\hat{\omega}^l$ from the first step:

$$r_{i,t}^{d} = \hat{\omega}^d \alpha_1^b r_{i,t-1}^{d} + \left(1 - \hat{\omega}^d\right) \alpha_1^a r_{i,t-1}^{d} + \hat{\omega}^d \alpha_2^b m_t + \left(1 - \hat{\omega}^d\right) \alpha_2^a m_t + \hat{\omega}^d \alpha_3^{b\prime} b_{i,t} + \left(1 - \hat{\omega}^d\right) \alpha_3^{a\prime} b_{i,t} + \varepsilon_{i,t}^{d} \tag{23}$$

$$r_{i,t}^{l} = \hat{\omega}^l \beta_1^b r_{i,t-1}^{l} + \left(1 - \hat{\omega}^l\right) \beta_1^a r_{i,t-1}^{l} + \hat{\omega}^l \beta_2^b m_t + \left(1 - \hat{\omega}^l\right) \beta_2^a m_t + \hat{\omega}^l \beta_3^{b\prime} b_{i,t} + \left(1 - \hat{\omega}^l\right) \beta_3^{a\prime} b_{i,t} + \hat{\omega}^l \beta_4^{b\prime} s_{i,t} + \left(1 - \hat{\omega}^l\right) \beta_4^{a\prime} s_{i,t} + \hat{\omega}^l \beta_5^b \hat{\varepsilon}_{i,t}^{d} + \left(1 - \hat{\omega}^l\right) \beta_5^a \hat{\varepsilon}_{i,t}^{d} + \varepsilon_{i,t}^{l} \tag{24}$$

Finally, we test the asymmetry between upwards and downwards convergence:

- **Asymmetry**. The speed of convergence upwards is different from downwards.

$$\text{Ho: } \alpha_1^b \neq \alpha_1^a \wedge \beta_1^b \neq \beta_1^a \tag{25}$$

3 Data and summary statistics

This section presents the source of data used in the empirical analysis and some stylized facts related to interest rates and the covariates.

3.1 Data

We construct our sample estimation using information provided by the Financial Market Commission (CMF for its acronym in Spanish) for the period from January 2004 to September 2019. This sample considers the period after the change in the monetary policy rate from real to nominal. This change in the monetary instrument had effects on financial markets as well as the conduct and effectiveness of monetary policy (Fuentes et al., 2003). Likewise, the estimates are made up to the event of the "social outbreak" in October 2019 and the subsequent Covid-19 crisis, given that the identification of the pass-through in this period requires greater adjustments due to the magnitude of the shocks, as it is a process that is still ongoing, and the effects of the policies implemented during the crisis.

We combine three sources of data: i) Bank's Deposits & Lending data (D31), ii) Bank's Deposits & Lending data (D34) and ii) Bank's Balance Sheet. The D31 and D34 database contains daily information regarding deposits, commercial, consumer and housing portfolio by banks. From the former, we consider the period from January 2004 to March 2013, and the latter includes the period from April 2013 to September 2019. Considering that commercial loans represent a high share of the total credit supply (around 60% of the portfolio, see Appendix A, Figure 7), this study focus its attention in such as segment. In addition, we use the short-term rates (30-89 days) for both deposits and commercial loans for two reasons. First, it allows us to minimize the effects of term premium and, second, short-term deposits represent a large part of the total deposits (Appendix B).

To isolate any seasonally effects that can arise intra-day or between weeks, we calculate the monthly deposits and commercial interest rate. This frequency also let us to match the second data source (Bank's Balance Sheet), which contains the covariates used in the estimates. The whole sample cover the most representative banks of the deposit and lending market, giving a total of 15 institutions[6].

3.1.1 Monetary policy rate

The Central Bank of Chile replaced its monetary policy instrument in August 2001, shifting from a monetary policy rate (MPR) linked to an indexed unit of account (UF, defined by the lagged CPI) to a nominal MPR denominated in pesos. Figure 3 shows that after 2001 (post nominalization) the evolution of the MPR began to be more stable over time. In spite of the reduction in the MPR volatility, which represents a challenge for the identification, our sample period covered the Global Financial Crisis (GFC), allowing us to capture the dynamics of the MPR in a crises period. In addition, during 2008, it is observed there was a considerable increase in the rate levels, reaching a threshold never seen after the nominalization. This increment was followed by a plummeted period (mid-2009), where deposit, commercial, and MPR rates reached historical lows.

3.1.2 Deposits and commercial rates

In order to have a historical overview regarding the dynamic of the MPR, deposit and commercial interest rate, our study makes an effort (in conjunction with the Statistics Division of Central Bank of Chile) to collect information since the 1990s. Figure 2 shows the average deposit interest rate follows closely the movements of the MPR in all period. At level institution, on the other hand, we see

[6] Treasury banks are excluded, as they are not part of the market being analyzed.

heterogeneity in the dynamic of their rates, indicating the spreads can be affected by non observable bank's risk premiums. Additionally, before the GFC, it is observed the p50-90 distribution is relatively lower compered to the post-crisis period, which can be influenced by changes in the market structure over time (Cecchetti, 1999; Gambacorta and Iannotti, 2007).

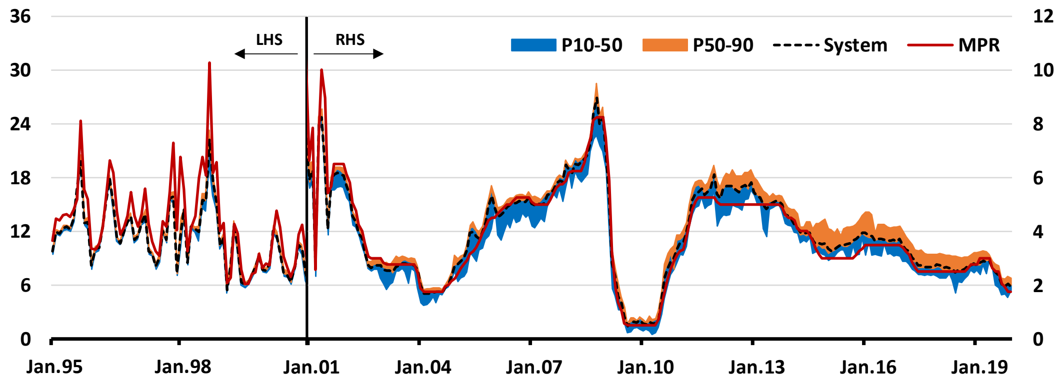

Figure 2. Annual nominal deposits rate 30-89 days vs MPR (percentage). This figure shows the evolution of the MPR, the average deposit interest rate, and its distribution. For the period prior to August 2001, the nominal MPR is aproximated by the interbank interest rate and liquidity facilities. *Source*: Own elaboration based on information from the CMF and CBCh.

Likewise, Figure 3 shows that the average commercial interest rate has a strong relationship with the MPR, and the dynamic of the distribution seems to consider additional non observable factors such as credit risk premiums.

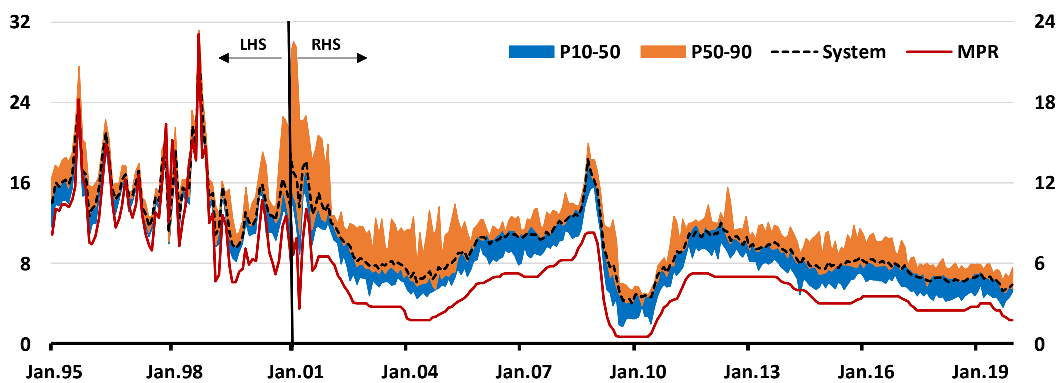

Figure 3. Annual nominal commercial rate 30-89 days vs MPR (percentage). This figure shows the evolution of the MPR, the average commercial interest rate, and its distribution. For the period prior to August 2001, the nominal MPR is aproximated by the interbank interest rate and liquidity facilities. *Source*: Own elaboration based on information from the CMF and CBCh.

3.2 Summary statistics

Tables I reports the summary statistics for the dependent variables and covariates considered in our estimated model. The division between large and medium-small banks is based on their level of total assets, as in Jara and Oda (2014), and the business cycles are divided according to Martínez et al. (2018). The Pre-Crisis includes the period from January 2004 to Feb.2007, Global Financial Crisis (GFC) from March 2007 to June 2011, and Post-Crisis from July 2011 to September 2019.

Table I
Summary Statistics

This table reports the summary statistics of variables considered in our estimated model. The sample includes a total of 15 individual banks between January 2004 and September 2019, representing an unbalanced panel database. The interest rates for *Deposits* and *Loans* correspond to the average *Term Deposits* and *Commercial loans* interest rates between 1 and 2 months. The *MPR* is the monthly average monetary policy rate. *Capital* is the average ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the average percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the average positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the average percentage of payments that are 90-days past the billing date. *VIX* is the average index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the average share of commercial loans over total assets. *Demand perception* corresponds to the average bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. In parenthesis is reported the standard deviation. Bank size is based on their assets share, which considers merges and acquisitions. Business cycles periods are divided according to Martínez et al. (2018). *Source*: Own elaboration based on CMF and CBCh.

	Bank size		**Business cycles**			
	Medium-Small	Large	Pre-Crisis	GFC	Post-Crisis	Total
MPR (%)			3.53	3.93	3.66	3.71
			(1.38)	(2.61)	(1.01)	(1.67)
VIX			13.55	25.73	16.19	18.28
			(2.04)	(11.06)	(5.00)	(8.32)
Commercial interest rate (%)	6.13	6.79	6.67	7.15	6.17	6.54
	(2.07)	(2.26)	(1.87)	(3.06)	(1.62)	(2.21)
Deposits interest rate (%)	4.14	3.81	3.65	4.05	3.88	3.88
	(1.78)	(1.69)	(1.38)	(2.59)	(1.15)	(1.71)
Capital (%)	7.96	7.58	6.97	7.15	7.92	7.68
	(2.64)	(2.20)	(2.24)	(2.59)	(2.22)	(2.33)
Share Term-Deposits (%)	45.36	37.50	44.88	43.76	37.71	39.57
	(7.88)	(5.32)	(6.48)	(5.73)	(6.53)	(7.01)
Share Demand-Deposits (%)	10.23	19.11	13.30	15.06	17.70	16.77
	(2.94)	(3.88)	(3.71)	(4.83)	(5.38)	(5.36)
Excess of liquidity (%)	3.73	1.25	5.53	2.66	1.23	1.90
	(4.80)	(3.15)	(6.78)	(4.38)	(2.66)	(3.82)
Short funding	0.24	0.70	0.31	0.49	0.64	0.58
	(0.42)	(0.46)	(0.46)	(0.50)	(0.48)	(0.49)
Past-due Index (%)	0.91	1.19	1.41	1.10	1.07	1.11
	(0.78)	(0.57)	(0.64)	(0.69)	(0.63)	(0.65)
Commercial loan/Assets (%)	47.03	39.76	42.74	42.86	41.20	41.67
	(11.15)	(6.37)	(10.80)	(9.25)	(7.94)	(8.54)
Demand perception	0.19	0.00	0.45	0.37	-0.18	0.13
	(0.97)	(1.01)	(0.79)	(1.02)	(0.96)	(0.99)
Number of banks	11	6	15	14	12	15
Number of months			38	52	99	189
Observations	1,500	811	541	666	1,104	2,311

As shown in Table I, during the GFC the MPR, the deposit and commercial interest rates have on average a level and a standard deviation greater than the pre and post crisis periods, a characteristic expected considering the global uncertainty. Similarly, the VIX index has a higher average and standard deviation during the crisis period. These risks would further increase the spreads on the dynamics of the MPR. The capital hold by banks have risen over time, but its dispersion augmented during the GFC. Likewise, the share of demand-deposits has increased in the most recent period, as well as the the short funding. Conversely, the share of term-deposits, excess of liquidity, past-due index, and demand perception show a reduction over the years. These characteristics should have an effect both on the risk premium that investors demand from the bank, and on the margin that banks charge to debtors. Additionally, it is important to note that the number of observation differ between period mainly because of the numbers of months included and, in a lesser extent, the enter or exit of institutions from the banking system.

Regarding the differences between banks size, large institutions have, on average, a higher commercial rate and lower deposits rate than medium-small institutions. This stylized fact could be attributed to the difference in the bank's market power. Additionally, large banks have lesser ratio of capital over total assets than medium-small ones, which indicates large banks have higher level of leverage. Further, medium-small banks depend more on demand deposits than large banks, which is contrary on term-deposits. This greater dependence on short-term financing for medium-small banks means that they have to offer a higher interest rate to investors and adjust it more quickly to changes in the capital market. Lastly, it follows that large banks have, on average, lesser excess of liquidity, share of commercial loans portfolio, and demand perception.

4 Results

In this section, we estimates the effects of the MPR on the short-term deposits (maturity between 30 to 89 days) and commercial loans interest rates. We considered the sample period of the current nominal MPR denominated in Chilean pesos after its implementation in September 2001. In order to avoid the adjustment dynamics during the first years of the policy, the estimates for the most recent period start in January 2004. This restriction also allows us to include data from the Senior Loan Officers Survey (SLOS), which starts in mid-2003. In addition, the sample ends in September 2019, as it let us to eliminate any idiosyncratic factors linked to the Chilean social outbreak and the Covid-19 pandemic.

4.1 Convergence and asymmetry

First of all, panel unit root tests (Dickey-Fuller, Phillips-Perron and Im-Pesaran-Shin) cannot reject the stationarity of the deposit and loan interest rate series. Therefore, it is appropriate to use use level estimates compared to panel cointegration models.

Table II shows the estimation of the transmission of monetary policy on deposits and commercial loans interest rates after the introduction of the nominal MPR. Regarding deposit rates, we cannot reject the hypothesis that they adjust to an equilibrium level[7] (the test gives a p-value of 0.6). Therefore,

[7]Unrestricted results are presented in Appendix C.

banks fully incorporate MPR changes, but gradually. Furthermore, we cannot reject the hypothesis that these rates adjust at different speeds when the MPR decreases or increases (the test shows a p-value of 0.5). Thus, we can conclude there is a convergence in the deposit rates, which is asymmetric to the tightening and easing of the MPR. In other words, when the MPR increases (decreases) by 1pp, deposits rates increase (decrease) by 50bp (54bp). This finding suggests banks could have some market power to reduce their costs more quickly when MPR fall, and increase them more slowly when MPR rises. Additionally, we find that grater level of both capital and liquidity hold by banks have a positive effect on reducing the cost of funding. On the other hand, the more dependent on term-deposits the banks are, the higher is the spread they pay.

Table II
Bank Rates' Asymmetric Convergence Estimation (BRACE): Jan.2004-Sep.2019

This table examines the effect of the monetary policy on both *Term-Deposits* (Panel A) and *Commercial loans* (Panel B) interest rates between 1 and 2 months. Observations are taken monthly for 15 individual banks between January 2004 and September 2019. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of term deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Term-Deposits	Upwards	Downwards	**Panel B: Commercial Loans**	Upwards	Downwards
Term-Deposits (-1)	0.5036***	0.4628***	Commercial Loans (-1)	0.4833***	0.7078***
	(0.0633)	(0.0505)		(0.0565)	(0.0311)
MPR	0.4964***	0.5372***	MPR	0.5167***	0.2922***
	(0.0633)	(0.0505)		(0.0565)	(0.0311)
Capital	−0.0273***	−0.0141***	Past-due index	0.2234***	−0.0377
	(0.0076)	(0.0048)		(0.0584)	(0.0429)
Share Term-Deposits	0.0091***	0.0101***	VIX	0.0130**	0.0035
	(0.0019)	(0.0025)		(0.0058)	(0.0049)
Share Demand-Deposits	0.0067	−0.0030	Commercial loan/Assets	−0.0216***	−0.0114**
	(0.0044)	(0.0047)		(0.0049)	(0.0049)
Excess of liquidity	−0.0020	−0.0134***	Demand perception	−0.0266	0.0230
	(0.0029)	(0.0031)		(0.0299)	(0.0281)
Short funding	−0.0321	0.0048			
	(0.0256)	(0.0339)			
Observations	1,382	929	Observations	794	1,517
FE	Yes		FE	Yes	
Dummies 2009q1-q2	Yes		Dummies 2009q1-q2	No	
R-squared	0.701		R-squared	0.811	
Convergence (p-value)	0.621		Convergence (p-value)	0.452	
Asymetry (p-value)	0.530		Asymetry (p-value)	1.000	
			Dependence (p-value)	0.546	

Related to commercial rates, Table II shows that idiosyncratic shocks of the deposits rates have an effect on the levels of loan rates (the dependence test gives a p-value of 0.56). Likewise, the convergence and asymmetry are also satisfied. Thus, an increase (decrease) by 1pp in the MPR generates an increase (decrease) by 52bp (29bp) in the commercial rate. Additionally, credit risk indicators, such as past-due index and the VIX, explain part of the spread of commercial loans, but only when there is an easing MPR stance. An important issue related to the estimates over commercial rates is it could be biased because of the exclusion of demand factors. Changes in demand factors have effects on credit growth (Jara et al., 2017) and might impact on the level of the target rate. Hence, we incorporate the banks' demand perception, reported in the SLOS conducted by the Central Bank of Chile[8] as a control. However, the results indicate that demand factors are not statistically significant to determine the credit spread in this sample.

As we described above, the effect of MPR changes on commercial rates is higher when it goes upwards than downwards; while, for deposits, it has a greater effect on decreases than increases. Figure 4 shows the adjustment of the interest rates due to changes in the MPR given that the rates are in equilibrium. In this exercise the changes in the MPR are permanent, so the interest rates transit to a new equilibrium. Hence, the adjustment of the deposits interest rates is faster when it converges to a lower objective rate compared to the dynamic of the commercial loan rates. The deposits rates are almost fully adjusted to the new MPR in about 5 months, while the loan rate does so in 12 months. That means banks are likely to maintain higher margins as much as they can. However, when the MPR increases, the transmission is almost complete in 6 and 5 months for deposits and loans, respectively. Although the speed to increase deposit rates decreases slightly, the pass-through to commercial credit rates increases significantly compared to when the MPR decreases. In other words, the margins for the banks do not increase significantly, even if the adjustment is gradual.

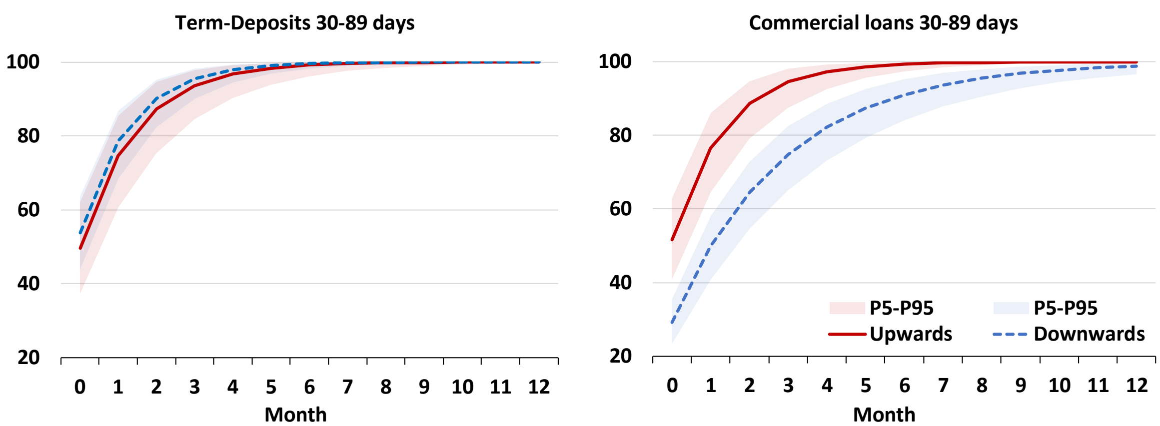

Figure 4. Convergence of the interest rates due to changes in the MPR (percentage). This figure represents the accumulative percentage of the new level of the MPR per month since the change. *Source*: Own elaboration.

[8]The survey reports the perception of the loan demand since the first quarter of 2003. The answers are ordered in five levels, from extremely weaker demand to extremely stronger demand. Following Jara et al. (2017), we categorize the answers with a scale between -1.5 to 1.5, where 0 represents no change in the demand.

A key point to highlight is that the parameters of convergence α and β are not necessarily stable in time and might be state-dependent (Weise, 1999). Since the dynamics of the interest rate may differ according to the cycle, we estimate the elasticities in the period before, during, and after the global financial crisis, in order to capture changes in the transmission of the monetary policy. To do so, we divided the sample following the periods suggested by Martinez et. al (2018), which are: Pre-Crisis (Jan.04-Feb.07), Global Financial Crisis (Mar.07-Jun.11) and Post-Crisis (Jul.11-Sep.19). We excluded the observations after September 2019 in order to isolate any effect related to the Chilean Social Uprising and the Pandemic Period.

As Table III shows, the transmission of monetary policy on deposits rates was stronger during the global financial crisis. As a matter of fact, in such a period, the MPR elasticity is greater than one when there was an easing stance. This phenomenon is probably because the MPR sharply fell due to the crisis (Figure 2), banks expected a further decrease in the MPR, and the demand for deposits increased. This meant that banks overreacted to the movements of the MPR[9]. For commercial loans, on the other hand, during the GFC the results shows that the persistence of commercial rates increased, principally when the MPR decreased[10]. That means that monetary policy effectively reduced the funding cost of banks, but had less effects on credit due to the less willingness to lend. Additionally, we see that the transmission of monetary policy to commercial rates is greater in the recent period, particularly if we focus on the results associated with a downward movement of the MPR.

Lastly, it is important to note that the asymmetric responses to a tightening or easing MPR stance have been reduced in the most recent period. Table III shows that prior to the crisis and during the GFC, the hypothesis of asymmetry cannot be rejected. That is, increases and decreases in the MPR generate asymmetric effects in the deposit and commercial rates. However, after the GFC, this asymmetry has diminished, which is supported by rejecting the asymmetry test for both commercial and deposit interest rates. A plausible reason for this phenomenon is that changes in the structure of the financial market can make the monetary policy pass-through vary over time (Cecchetti, 1999; Gambacorta and Iannotti, 2007).

[9] We also control for the implementation of liquidity facilities (FLAP) over this period, but the conclusions remain.

[10] Notice that the increase in the spread due to the higher credit risk is included by the past-due index.

Table III
BRACE by Financial Fragility Periods

This table examines the transmission of monetary policy over the phases of the cycle. The fragility periods are defined based on Martinez et. al (2018). Observations are taken monthly for 15 individual banks between January 2004 and September 2019. The dependent variables are *Term-Deposits* (Panel A) and *Commercial loans* (Panel B) interest rates between 1 and 2 months. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of term deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Term-Deposits

	Pre-Crisis (Jan.04-Feb.07)		GFC (Mar.07-Jun.11)		Post-Crisis (Jul.11-Sep.19)	
	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards
Term-Deposits (-1)	0.5774***	0.4457***	0.0963	0.0568	0.6403***	0.6454***
	(0.1391)	(0.0700)	(0.0666)	(0.0588)	(0.1423)	(0.0738)
MPR	0.4226***	0.5543***	0.9037***	0.9432***	0.3597**	0.3546***
	(0.1391)	(0.0700)	(0.0666)	(0.0588)	(0.1423)	(0.0738)
Capital	−0.1305***	−0.1350***	−0.0197**	−0.0121*	−0.0204*	−0.0132
	(0.0225)	(0.0268)	(0.0079)	(0.0072)	(0.0117)	(0.0095)
Share Term-Deposits	0.0018	0.0050	0.0061	0.0035	0.0042	0.0134***
	(0.0035)	(0.0050)	(0.0048)	(0.0054)	(0.0036)	(0.0036)
Share Demand-Deposits	0.0414***	0.0435***	0.0373***	0.0313***	−0.0041	−0.0031
	(0.0121)	(0.0131)	(0.0080)	(0.0102)	(0.0123)	(0.0094)
Excess of liquidity	0.0103*	−0.0023	−0.0067	−0.0042	0.0138	−0.0065
	(0.0056)	(0.0079)	(0.0060)	(0.0070)	(0.0097)	(0.0090)
Short funding	−0.0490	−0.1184	0.0355	0.0706	0.0192	−0.0094
	(0.0500)	(0.0854)	(0.0463)	(0.0623)	(0.0598)	(0.0377)
Observations	389	152	451	215	353	751
FE	Yes		Yes		Yes	
Dummies 2009q1-q2	No		Yes		No	
R-squared	0.705		0.689		0.816	
Convergence (p-value)	0.172		0.037		0.403	
Asymetry (p-value)	0.635		0.679		0.041	

Panel B: Commercial Loans

	Pre-Crisis (Jan.04-Feb.07)		GFC (Mar.07-Jun.11)		Post-Crisis (Jul.11-Sep.19)	
	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards
Commercial Loans (-1)	0.3826***	0.7098***	0.4305***	0.7513***	0.4198***	0.3339***
	(0.1165)	(0.0666)	(0.1019)	(0.0559)	(0.0798)	(0.0753)
MPR	0.6174***	0.2902***	0.5695***	0.2487***	0.5802***	0.6661***
	(0.1165)	(0.0666)	(0.1019)	(0.0559)	(0.0798)	(0.0753)
Past-due index	0.3131***	−0.1993	0.1476	−0.0608	0.0253	0.2602**
	(0.1094)	(0.1282)	(0.0978)	(0.1159)	(0.1211)	(0.1053)
VIX	0.0235	0.0483	0.0294***	−0.0066	−0.0233***	0.0108**
	(0.0190)	(0.0379)	(0.0085)	(0.0072)	(0.0067)	(0.0052)
Commercial loan/Assets	−0.0081	−0.0187*	0.0036	0.0051	−0.0423***	−0.0241**
	(0.0108)	(0.0113)	(0.0099)	(0.0110)	(0.0143)	(0.0110)
Demand perception	0.0219	−0.0215	−0.1056**	0.0119	0.1246**	0.0572*
	(0.0535)	(0.0635)	(0.0496)	(0.0671)	(0.0535)	(0.0311)
Observations	207	334	280	386	370	734
FE	Yes		Yes		Yes	
Dummies 2009q1-q2	No		No		No	
R-squared	0.822		0.826		0.759	
Convergence (p-value)	0.001		0.397		0.977	
Asymetry (p-value)	1.000		0.999		0.090	
Dependence (p-value)	0.791		0.000		0.153	

4.2 Bank size and market segmentation

In this section, we study heterogeneous effects by bank size, in order to understand how a monetary policy shock impacts the transmission and adjustment of the interest rate depending on market segmentation. Table IV shows the results of an increase and decrease in monetary policy on deposits and commercial rates, controlling for bank fixed effects and divided into large and medium-small banks. Regarding deposits rate, we find that the hypothesis of convergence and asymmetry in large banks cannot be rejected, however, this is not true for medium-small banks. The latter imply that for medium-small banks changes in the MPR also have an impact in their equilibrium spreads. This can be due to the incentive of smaller banks to increase their market shares depending on the dynamic of monetary policy. Thus, a positive change by 1pp in the MPR generates a 51bp increase in deposit rates for large banks and 52bp for medium-small banks. On the other hand, a 1pp decline in the MPR generates a 62bp and 52bp decrease in the deposit rate for large and medium-sized banks, respectively. Therefore, we see that larger banks adjust their deposits rates faster to falls than to increases in the MPR, while in medium-sized banks this asymmetry is almost imperceptible.

Additionally, the results show that higher levels of capital reduce the cost of funding for both types of institutions, but with a greater magnitude for large banks. Meanwhile, a higher share of demand deposits in banks' liabilities generates an increase in the cost of funding for large and medium-small banks. Similarly, the greater the share of term deposits in total liabilities and the greater the short funding, the higher the level of deposit rates in large banks.

In regard to commercial interest rates, the results show the hypothesis of convergence and asymmetry cannot be rejected for large banks, whereas for medium-small banks only the hypothesis of asymmetry cannot be rejected. Thus, a 1pp increase in the MPR generates a 58bp increment in commercial rates for large banks and a 55bp increase for medium-small banks. Conversely, a 1pp decrease in the MPR generates a 27bp and 41bp decline in the deposit rate for large and medium-small banks, respectively. Therefore, we find that both large and medium-small banks adjust their commercial rates faster to increases than to decreases in the MPR.

Additionally, Table IV shows that, for medium-small banks, higher levels of credit risk (past-due index), uncertainty (VIX) have a positive effect on commercial rates. Nonetheless, the credit risk has a negative effect when the rates decreases for large banks, contrary to what is observed in theory. This can be due to the risk taking behaviour during expansion periods. Likewise, a greater share of commercial loans in the total of assets generates a negative effect for both type of banks. On the other hand, demand perception have a significant positive effect on commercial rate, but only in a MPR easing for medium-small banks. Results for large banks show that demand perception has no effect on commercial rates.

Table IV
BRACE by Bank Size

This table examines how the bank size affect the interest rate convergence to its equilibrium level. Observations are taken monthly for 15 individual banks between January 2004 and September 2019. The dependent variables are *Time Deposits* (Panel A) and *Commercial loans* (Panel B) interest rates between 1 and 2 months. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of term deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Term-Deposits

	Large banks		Medium-Small	
	Upwards	Downwards	Upwards	Downwards
Term-Deposits (-1)	0.4859***	0.3821***	0.4842***	0.4780***
	(0.0714)	(0.0600)	(0.1277)	(0.0774)
MPR	0.5141***	0.6179***	0.5158***	0.5220***
	(0.0714)	(0.0600)	(0.1277)	(0.0774)
Capital	−0.0438***	−0.0505***	−0.0141*	−0.0100**
	(0.0120)	(0.0141)	(0.0077)	(0.0047)
Share Term-Deposits	0.0193***	0.0183***	−0.0008	0.0010
	(0.0032)	(0.0049)	(0.0018)	(0.0021)
Share Demand-Deposits	0.0259***	0.0122	0.0176**	0.0199**
	(0.0062)	(0.0083)	(0.0079)	(0.0094)
Excess of liquidity	0.0066	−0.0039	0.0020	−0.0012
	(0.0047)	(0.0049)	(0.0032)	(0.0044)
Short funding	−0.0625*	0.0421	0.0016	−0.0242
	(0.0340)	(0.0496)	(0.0352)	(0.0328)
Observations	457	354	933	567
FE	Yes		Yes	
Dummies 2009q1-q2	Yes		Yes	
R-squared	0.706		0.620	
Convergence (p-value)	0.469		0.000	
Asymetry (p-value)	0.776		0.044	

Panel B: Commercial Loans

	Large banks		Medium-Small	
	Upwards	Downwards	Upwards	Downwards
Commercial Loans (-1)	0.4206***	0.7341***	0.4540***	0.5911***
	(0.0844)	(0.0415)	(0.0539)	(0.0374)
MPR	0.5794***	0.2659***	0.5460***	0.4089***
	(0.0844)	(0.0415)	(0.0539)	(0.0374)
Past-due index	0.1664	−0.1739**	0.1283***	0.1098**
	(0.1083)	(0.0788)	(0.0440)	(0.0482)
VIX	0.0100	0.0004	0.0223***	0.0086*
	(0.0082)	(0.0064)	(0.0074)	(0.0044)
Commercial loan/Assets	−0.0435***	0.0032	−0.0142***	−0.0087**
	(0.0128)	(0.0158)	(0.0041)	(0.0041)
Demand perception	−0.0246	−0.0001	−0.0060	0.0492**
	(0.0428)	(0.0428)	(0.0224)	(0.0244)
Observations	263	548	591	909
FE	Yes		Yes	
Dummies 2009q1-q2	No		No	
R-squared	0.811		0.794	
Convergence (p-value)	0.832		0.009	
Asymetry (p-value)	1.000		0.942	
Dependence (p-value)	0.244		0.001	

Given the above, we find that, in the short term, both larger and medium-small banks increase their spread (mark-up) when they face a tightening or easing monetary policy. In particular, as can be seen in Figure 5, an increase (decrease) by 1pp leads a positive impact of 7bp (31bp) in the spread for large banks, while for medium-small banks the effect is about 3bp (11bp).

These heterogeneous results can be explained by several reasons. First, the client portfolio of smaller banks has a greater amount of structural credit risk compared to larger banks, which could cause their interest rates to react differently when there are changes in the MPR. Second, the asymmetry can be related to the *switching cost* hypothesis. This means that customers are less likely to switch financial products, or institutions, in search of a higher profit, when they face a higher cost of moving (Hefferman, 1997). Thus, the profile of deposit holders can influence the convergence parameters between large and medium-smalle banks. Third, for the local case, the higher speed of adjustment of the cost of liabilities may be due to the presence of a secondary deposit market, which would be more relevant for smaller banks given their greater dependence on this source of funding. Thus, if there is a change in the MPR, they will be more likely to adjust faster the deposit interest rate in the primary market, in order to eliminate any arbitrage opportunity. Lastly, the industrial organization of the sector also can influence asymmetric adjustment of bank rates. For instance, Gambacorta and Iannotti (2007) point out that, if there is a monetary tightening, institutions with market power could raise their loan interest rate by more and faster than their deposit interest rate; and vice versa, in the case of an easy monetary policy. A similar conclusion for deposit interest rate can be found in Drechsler et al. (2017), who state that market power influences the transmission of the monetary policy.

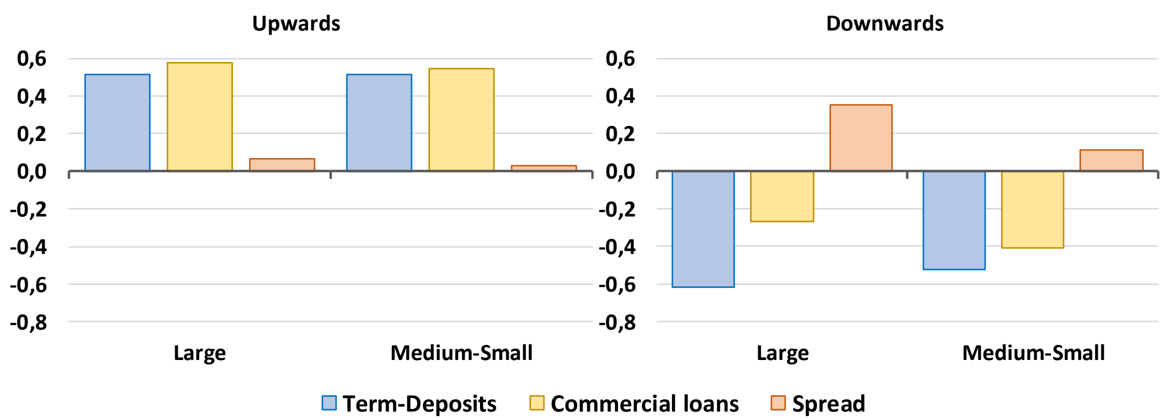

Figure 5. Direct effect due to a 1pp change in the MPR (percentage points). This figure represents the effect of 1pp point change in the MPR over the deposits and commercial interest rate by bank size. *Source*: Own elaboration.

5 Benchmark models and Robustness check

In this section we compare our results with alternative benchmark models, as well as other author's findings for Chile. We also performed a robustness analysis under different samples and specification scenarios.

5.1 Benchmark models

A typical practice to estimate the MPR pass-through as a panel regression of the MPR on the level of interest rates, without imposing any condition, as convergence or dependency of the commercial rate on the deposit rate. Additionally, in order to capture possible differences in the direction of monetary policy, positive and negative changes in the MPR are separated. Results in Table V confirm the presence of an asymmetric[11] convergence[12] in commercial and deposit rates, when there is a positive or negative change in the MPR. Despite the fact that the conclusions are maintained on the asymmetric effect on deposit rates, the orders of magnitude differ mainly in the increases of the MPR. Meanwhile, no convergence of commercial rates is observed during a MPR tightening, with a lower level of pass-through. In this sense, the results of the BRACE model present results that are more intuitive and consistent with the theory. Additionally, the results show that, on average, higher capital and liquidity held by banks generate a decrease in deposit rate, while a higher share of term-deposits has a positive impact. Similarly, greater credit risk and demand perception imply a positive effect on commercial rates. Conversely, a higher ratio of commercial loans over total assets negatively impacts such a rate.

Another benchmark model relies on a first-difference estimation, which aims to solve the problem of stationarity of the series. However, as we mention before, panel unit root tests cannot reject the stationarity of the series. The results in Table IV show that this model is not compatible with a dynamic convergence. In other words, given a particular change in the MPR with everything else remaining constant, the deposit and commercial interest rates converge to a level with a different spread respect to the MPR. Additionally, the sensitivity to changes in the MPR is higher than one and the coefficient of the lag is negative, probably due to the over-differentiation of the series in the estimation. This configuration suggests that there is an overreaction to the monetary policy that dilutes in the following months. In spite of that, the results also show that lesser capital and higher share of both term and demand deposits generate positive effects on the deposit interest rate. Meanwhile, a fewer share of commercial loans over total assets, or a higher uncertainty (VIX) and demand perception, produce a positive effect on the commercial rates.

On the other hand, Table VI shows other findings regarding the monetary policy pass-through for Chile, but they differ in terms of time sample and estimation methodology. For instance, using a model in difference, Pedersen (2016) estimates that the transmission from the MPR to the commercial interest rate (1-3 months) is 116 and 162bp when there is a easing and tightening monetary policy stance, respectively. This means commercial rate for 1-3 moths overreact to changes in the monetary policy. A closer finding to our main results can be found in Luttini and Pedersen (2015), who shows that the first lag in the MPR has a positive and statistically positive effect on the commercial interest rate (1-3 months). Similarly, using a weekly frequency estimation, Becerra et al. (2009) and Becerra et al. (2010) show that the transmission of the monetary policy for commercial interest rate (30-89 days) is about 55-89bp and 35-45bp, respectively. On the other hand, for the period prior to the nominalization, Berstein and Fuentes (2003) find that the MPR (through the interbank rate) has a positive effect (71-75bp) on the lending rate (30-89 days). Likewise, Espinosa-Vega and Rebucci (2003) estimate that the interbank rate has a pass-through nearly 63bp in the short-term lending interest rate. Lastly, it is relevant to highlight that all of these studies only focus their attention to the direct impact of the MPR, but they do not consider the convergence analysis as we propose.

[11]Coefficients of negative and positive changes are different.

[12]Coefficients of the lag and MPR add up to one.

Table V
Panel Estimations of Interest Rates

This table presents the results of alternative specifications in levels and using the first difference. Observations are taken monthly for 15 individual banks between January 2004 and September 2019. The dependent variables are *Time Deposits* (Panel A) and *Commercial loans* (Panel B) interest rates between 1 and 2 months. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. The sample is divided into observations with negative and positive changes of the MPR. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Term-Deposits

	Level			First difference		
	Total	Negative	Positive	Total	Negative	Positive
Term-Deposits (-1)	0.5757***	0.4653***	0.5420***	−0.1083***	−0.2062***	0.1320***
	(0.0150)	(0.0313)	(0.0304)	(0.0175)	(0.0316)	(0.0300)
MPR	0.4326***	0.5544***	0.4552***	0.9518***	0.7319***	1.0561***
	(0.0152)	(0.0296)	(0.0295)	(0.0278)	(0.0479)	(0.0641)
Capital	−0.0142***	−0.0039	−0.0171**	−0.0552***	−0.0580**	−0.1301***
	(0.0038)	(0.0061)	(0.0070)	(0.0094)	(0.0248)	(0.0195)
Share Term-Deposits	0.0059***	−0.0043*	0.0048*	0.0115***	0.0277***	0.0171***
	(0.0013)	(0.0024)	(0.0027)	(0.0031)	(0.0086)	(0.0050)
Share Demand-Deposits	0.0023	−0.0113*	0.0144***	0.0133***	0.0240**	0.0031
	(0.0026)	(0.0058)	(0.0049)	(0.0048)	(0.0120)	(0.0091)
Excess of liquidity	−0.0034*	−0.0206***	−0.0011	0.0087**	0.0168*	−0.0084
	(0.0019)	(0.0049)	(0.0031)	(0.0037)	(0.0093)	(0.0063)
Short funding	−0.0202	0.0028	−0.0870***	−0.0125	0.0132	−0.0867***
	(0.0160)	(0.0293)	(0.0305)	(0.0174)	(0.0409)	(0.0302)
Observations	2,298	405	721	2,297	405	721
FE	Yes	Yes	Yes	Yes	Yes	Yes
Dummies 2009q1-q2	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.981	0.986	0.978	0.648	0.869	0.365

Panel B: Commercial Loans

	Level			First difference		
	Total	Negative	Positive	Total	Negative	Positive
Commercial Loans (-1)	0.6442***	0.6234***	0.7018***	−0.3475***	−0.3188***	−0.2874***
	(0.0143)	(0.0430)	(0.0245)	(0.0188)	(0.0458)	(0.0354)
MPR	0.3679***	0.3185***	0.2905***	1.0806***	1.1316***	0.9824***
	(0.0154)	(0.0414)	(0.0275)	(0.0469)	(0.0743)	(0.1789)
Past-due index	0.0603*	−0.0523	0.1831***	−0.1408	0.0554	−0.4492
	(0.0323)	(0.0841)	(0.0584)	(0.1325)	(0.3789)	(0.2915)
VIX	0.0026	−0.0103**	0.0370***	0.0322***	0.0058	0.0518***
	(0.0019)	(0.0050)	(0.0036)	(0.0035)	(0.0140)	(0.0052)
Commercial loan/Assets	−0.0127***	−0.0020	−0.0102	−0.0338***	0.0060	−0.0316*
	(0.0045)	(0.0112)	(0.0081)	(0.0103)	(0.0337)	(0.0167)
Demand perception	0.0477***	0.0044	0.0537*	0.0985***	0.0257	0.1353***
	(0.0144)	(0.0369)	(0.0278)	(0.0223)	(0.0461)	(0.0417)
Observations	2,310	409	722	2,309	409	722
FE	Yes	Yes	Yes	Yes	Yes	Yes
Dummies 2009q1-q2	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.905	0.889	0.915	0.274	0.398	0.234

Table VI
Previous research of MPR pass-through in Chile

This table presents the results of different studies regarding the monetary policy pass-through to nominal interest rates. *Source:* Own elaboration.

Article	Interest rate	Sample period	Estimates (bp)	Description
Pedersen (2016)	Commercial interest rate (1-3 months)	Jan.02-Jul.14 & 162-116	116-162	Model in difference. Distinction between positive and negative variations in the MPR. Monthly frequency estimation.
Luttini and Pedersen (2015)	Commercial interest rate (1-3 months)	Jan.08-Feb.14	79	Constant Mark-up. Consider the deviation from the long-term relationship. Monthly frequency estimation.
Becerra et al. (2009, 2010)	Commercial interest rate (30-89 days)	Mar.05-Jul.09 May.05-Mar.09	55-89 35-45	Weekly frequency estimation.
Berstein and Fuentes (2003)	Lending rate (30-89 days)	1996-2001	71-75	Interbank rate pass-through plus the change in the MPR (indexed).
Espinosa-Vega and Rebucci (2003)	Lending rate (1-30 days)	Apr.93-Sep.02	63	Short and long term pass-through. It considers deviations from its long-term equilibrium. Monthly frequency estimation.

5.2 Robustness check

5.2.1 Tolerance

As we described in section 2.1.2 (equation 11) there are two regimes that define the convergence of the bank's interest rate. This means the bank converges upwards if the difference ($d_{i,t+1}$) between the target rate ($r^*_{i,t+1} = m_t + b'_{i,t}\rho$) and its current value ($r_{i,t}$) is positive and downwards otherwise. However, there could be a third regime when $d_{i,t+1}$ is not statistically different from zero, making the convergence undefined. That is, the incentives to move toward the optimum rate may vanish as banks are not far enough from their own objective. Hence, to tackle this scenario, we focus our estimation in the sample that meets the condition that $d_{i,t+1}$ is far from zero.

For each period t, we assume there is a normal distribution of $d_{i,t+1}$ with zero mean and variance σ_t^2. Thus, we define the invariant tolerance $\tau \in [0, 1]$ as the share of the sample that is close to zero. Figure 6 shows an example where the parameter τ defines the percentage of the distribution that is excluded from the estimates (shadow area).

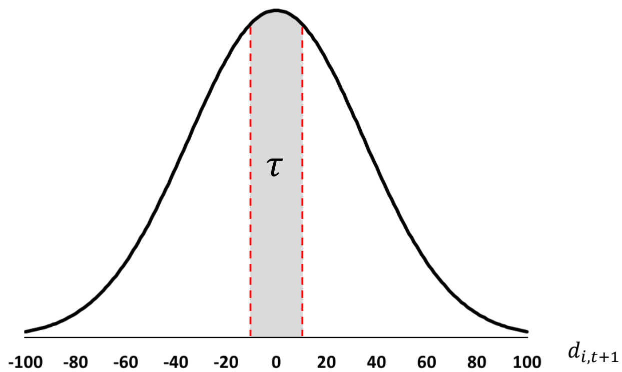

Figure 6. Distribution of $d_{i,t+1}$ and tolerance τ. This figure represents an hypothetical distribution of the difference between the target interest rate and current interest rate ofr bank i in the period t. The shadow region represents the sample's share that is not included in the estimates.
Source: Own elaboration.

We relax the precision of the thresholds of each regimen by considering different values for the tolerance $\tau = \{5\%, 10\%, 20\%\}$. Table VII shows that the results remain stable, i.e., transmission of monetary policy over deposits as well as commercial interest rates is asymmetric. For deposits interest rates the pass-through is faster when there is an easing monetary policy, while for commercial interest rates it is higher when there is a tightening monetary policy stance. In addition, we find that the rest of the covariates maintain their magnitude and significance for both deposits and commercial rates, making our results robust for different samples.

Table VII
BRACE by Deviation from the Target Interest Rate

This table examines how the transmission of the monetary policy varies according to the deviation of the banks current interest rate respect to its equilibrium. The tolerance corresponds to the percentage of observations closest to the target. Observations are taken monthly for 15 individual banks between January 2004 and September 2019. The dependent variables are *Time Deposits* (Panel A) and *Commercial loans* (Panel B) interest rates between 1 and 2 months. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of term deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Term-Deposits

	Tolerance 5%		Tolerance 10%		Tolerance 20%	
	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards
Term-Deposits (-1)	0.4663^{***}	0.4277^{***}	0.4497^{***}	0.4005^{***}	0.4447^{***}	0.3293^{***}
	(0.0678)	(0.0522)	(0.0727)	(0.0541)	(0.0825)	(0.0574)
MPR	0.5337^{***}	0.5723^{***}	0.5503^{***}	0.5995^{***}	0.5553^{***}	0.6707^{***}
	(0.0678)	(0.0522)	(0.0727)	(0.0541)	(0.0825)	(0.0574)
Capital	-0.0289^{***}	-0.0157^{***}	-0.0298^{***}	-0.0178^{***}	-0.0322^{***}	-0.0175^{***}
	(0.0080)	(0.0051)	(0.0085)	(0.0053)	(0.0095)	(0.0056)
Share Term-Deposits	0.0097^{***}	0.0111^{***}	0.0102^{***}	0.0097^{***}	0.0102^{***}	0.0113^{***}
	(0.0020)	(0.0027)	(0.0020)	(0.0028)	(0.0022)	(0.0034)
Share Demand-Deposits	0.0071^{*}	-0.0034	0.0084^{*}	-0.0051	0.0089^{*}	-0.0056
	(0.0043)	(0.0049)	(0.0044)	(0.0051)	(0.0048)	(0.0059)
Excess of liquidity	-0.0023	-0.0140^{***}	-0.0007	-0.0137^{***}	-0.0010	-0.0160^{***}
	(0.0030)	(0.0033)	(0.0029)	(0.0034)	(0.0031)	(0.0040)
Short funding	-0.0288	0.0140	-0.0224	0.0189	-0.0197	0.0343
	(0.0255)	(0.0360)	(0.0244)	(0.0380)	(0.0277)	(0.0451)
Observations	1,298	847	1,195	754	998	587
FE	Yes		Yes		Yes	
Dummies 2009q1-q2	Yes		Yes		Yes	
R-squared	0.704		0.706		0.707	
Convergence (p-value)	0.412		0.351		0.318	
Asymetry (p-value)	0.487		0.517		0.799	

Panel B: Commercial Loans

	Tolerance 5%		Tolerance 10%		Tolerance 20%	
	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards
Commercial Loans (-1)	0.4575^{***}	0.7048^{***}	0.4562^{***}	0.7105^{***}	0.4766^{***}	0.7399^{***}
	(0.0607)	(0.0329)	(0.0639)	(0.0340)	(0.0720)	(0.0367)
MPR	0.5425^{***}	0.2952^{***}	0.5438^{***}	0.2895^{***}	0.5234^{***}	0.2601^{***}
	(0.0607)	(0.0329)	(0.0639)	(0.0340)	(0.0720)	(0.0367)
Past-due index	0.2432^{***}	-0.0358	0.2592^{***}	-0.0430	0.2352^{***}	-0.0353
	(0.0611)	(0.0437)	(0.0652)	(0.0444)	(0.0738)	(0.0464)
VIX	0.0145^{**}	0.0034	0.0149^{**}	0.0029	0.0150^{**}	-0.0000
	(0.0059)	(0.0052)	(0.0061)	(0.0052)	(0.0067)	(0.0053)
Commercial loan/Assets	-0.0217^{***}	-0.0112^{**}	-0.0212^{***}	-0.0104^{**}	-0.0226^{***}	-0.0109^{**}
	(0.0049)	(0.0050)	(0.0051)	(0.0050)	(0.0055)	(0.0053)
Demand perception	-0.0113	0.0240	-0.0175	0.0277	-0.0097	0.0215
	(0.0315)	(0.0297)	(0.0336)	(0.0309)	(0.0380)	(0.0311)
Observations	736	1,449	665	1,370	522	1,211
FE	Yes		Yes		Yes	
Dummies 2009q1-q2	No		No		No	
R-squared	0.813		0.812		0.812	
Convergence (p-value)	0.118		0.239		0.068	
Asymetry (p-value)	1.000		1.000		1.000	
Dependence (p-value)	0.554		0.572		0.584	

5.2.2 One-step Asymmetric Estimation

An alternative model that allows us to analyze the transmission of monetary policy to commercial interest rate is by controlling both for factors that determine the deposit spread and the credit spread. In other words, we carry out a one-step asymmetric estimation, where variables such as capital, liquidity, share of deposits and short-term funding are included as controls in the regression for the commercial rate.

Table VIII
One-step asymmetric estimation

This table examines the direct effect of both variables that determine commercial and deposits spread over the commercial interest rate. Observations are taken monthly for 15 individual banks between January 2004 and September 2019. The dependent variable is the *Commercial interest rate* interest rates between 1 and 2 months. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of term deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Commercial Loans

	(1)		(2)		(3)	
	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards
Commercial Loans (-1)	0.4748***	0.6701***	0.4431***	0.6837***	0.3976***	0.6837***
	(0.0573)	(0.0356)	(0.0617)	(0.0388)	(0.0580)	(0.0360)
MPR	0.5252***	0.3299***	0.5569***	0.3163***	0.6024***	0.3163***
	(0.0573)	(0.0356)	(0.0617)	(0.0388)	(0.0580)	(0.0360)
Capital	0.0023	−0.0051			−0.0023	−0.0061
	(0.0127)	(0.0146)			(0.0121)	(0.0133)
Share Term-Deposits	0.0029	0.0053			0.0179***	0.0094*
	(0.0053)	(0.0059)			(0.0061)	(0.0057)
Share Demand-Deposits	0.0212**	0.0165			0.0070	0.0193*
	(0.0101)	(0.0126)			(0.0106)	(0.0114)
Excess of liquidity	0.0100	−0.0008			−0.0177**	−0.0125*
	(0.0065)	(0.0066)			(0.0072)	(0.0074)
Short funding	−0.2566***	−0.1240			−0.2452***	−0.1182
	(0.0802)	(0.0815)			(0.0799)	(0.0799)
Past-due index			0.2042***	−0.0472	0.2643***	−0.0592
			(0.0606)	(0.0441)	(0.0615)	(0.0434)
VIX			0.0164**	0.0388	0.0205***	−0.0013
			(0.0075)	(0.2172)	(0.0064)	(0.0069)
Commercial loan/Assets			−0.0137***	−0.0119**	−0.0268***	−0.0139**
			(0.0048)	(0.0048)	(0.0065)	(0.0063)
Demand perception			0.0354	0.0439	0.0110	0.0442
			(0.0311)	(0.0321)	(0.0298)	(0.0311)
Observations	811	1,500	794	1,517	815	1,496
FE	Yes		Yes		Yes	
Dummies 2009q1-q2	Yes		No		Yes	
R-squared	0.763		0.759		0.774	
Convergence (p-value)	0.161		0.038		0.140	
Asymetry (p-value)	0.992		1.000		1.000	

Table VIII shows the results under different specifications, in which the asymmetric effect of a tightening or easing MPR stance remains. Moreover, pass-through estimations are in the same level of magnitude as the results presented on Table II. However, although the regression manages to capture the essence of this study (asymmetry), the results of Table VIII do not allow us to isolate the effects between the credit and deposits spread, which is achieved by the BRACE.

5.2.3 Commercial Interest Rate Post-Crisis

The availability of data regarding economic sector, credit size, and information by firm size from 2011, allows us to incorporate more controls into the commercial rate estimates for the post-crisis period, but at the cost of losing 7 years of information.

Column (1) of Table IX shows the main result for the period Jul.2011 - Sep.2019. Column (2) incorporates the variable average loan size as a control, which has a negative impact on the commercial interest rate as we expected. Column (3) includes the commercial loan share by economic sector, and it is observed that the primary, financial, manufacturing, electricity-gas-water and construction-transport sectors are associated with lower interest rates on average. Finally, in column (4), we add information related to firm size, and we find that larger firms have lower levels of commercial rates on average. In general terms, it is observed that the asymmetry test cannot be rejected when the new controls are incorporated, however, the convergence hypothesis is rejected in the new specifications.

Table IX
Commercial Interest Rate Post-Crisis

This table examines the effect of the commercial loans composition over the spread. Observations are taken monthly for 12 individual banks in a sample period between July 2011 and September 2019. The dependent variable is *Commercial interest rates* between 1 and 2 months. *MPR* correspond to the monthly average monetary policy rate. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. *Average loan size* is the average amount of the loan expressed in thousands of UF (Chilean inflation indexed currency unit). The column (3) includes the percentage of bank's loans corresponding to each sector, and column (4) incorporates the commercial loans share for big companies. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of time deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Commercial Loans	(1)		(2)		(3)		(4)	
	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards	Upwards	Downwards
Commercial Loans (-1)	0.4198***	0.3339***	0.3541***	0.3328***	0.3044***	0.3752***	0.3986***	0.3474***
	(0.0798)	(0.0753)	(0.0809)	(0.0828)	(0.0663)	(0.0719)	(0.0684)	(0.0722)
MPR	0.5802***	0.6661***	0.6459***	0.6672***	0.6956***	0.6248***	0.6014***	0.6526***
	(0.0798)	(0.0753)	(0.0809)	(0.0828)	(0.0663)	(0.0719)	(0.0684)	(0.0722)
Past-due index	0.0253	0.2602**	0.0749	0.2964***	0.2659***	0.0930	0.2798***	0.0544
	(0.1211)	(0.1053)	(0.1096)	(0.1041)	(0.0977)	(0.0854)	(0.0920)	(0.0817)
VIX	−0.0233***	0.0108**	−0.0227***	0.0108**	−0.0082	0.0092*	−0.0040	0.0086
	(0.0067)	(0.0052)	(0.0064)	(0.0052)	(0.0053)	(0.0055)	(0.0046)	(0.0060)
Commercial loan/Assets	−0.0423***	−0.0241**	−0.0555***	−0.0296***	−0.0364***	−0.0087	−0.0347***	−0.0080
	(0.0143)	(0.0110)	(0.0115)	(0.0094)	(0.0100)	(0.0083)	(0.0093)	(0.0079)
Demand perception	0.1246**	0.0572*	0.0858**	0.0565*	−0.0053	0.0487*	−0.0018	0.0583**
	(0.0535)	(0.0311)	(0.0385)	(0.0311)	(0.0290)	(0.0260)	(0.0283)	(0.0259)
Average loan size			−0.0376***	−0.0214***	−0.0400***	−0.0106***	−0.0352***	−0.0102***
			(0.0071)	(0.0057)	(0.0067)	(0.0040)	(0.0061)	(0.0039)
Primary sector					−0.0502*	0.0323**	−0.0165	0.0605***
					(0.0296)	(0.0163)	(0.0311)	(0.0151)
Financial services					−0.0529*	0.0004	−0.0336	0.0105
					(0.0301)	(0.0166)	(0.0309)	(0.0148)
Manufacturing					−0.0550*	0.0059	−0.0373	0.0160
					(0.0296)	(0.0157)	(0.0307)	(0.0139)
Electricity, gas & water					−0.0637**	−0.0058	−0.0496	0.0045
					(0.0309)	(0.0167)	(0.0320)	(0.0151)
Construction & transport					−0.0302	0.0416***	−0.0182	0.0465***
					(0.0292)	(0.0154)	(0.0303)	(0.0134)
Real State					−0.0441	0.0139	−0.0295	0.0239*
					(0.0296)	(0.0154)	(0.0306)	(0.0136)
Whole sale & retail trade					−0.0385	0.0132	−0.0209	0.0187
					(0.0298)	(0.0161)	(0.0309)	(0.0140)
Share big companies							−0.6225	−2.0654***
							(0.4163)	(0.3775)
Observations	370	734	349	700	392	657	399	648
FE	Yes		Yes		Yes		Yes	
Dummies 2009q1-q2	No		No		No		No	
R-squared	0.759		0.791		0.841		0.849	
Convergence (p-value)	0.977		0.082		0.009		0.009	
Asymetry (p-value)	0.090		0.796		0.743		0.973	
Dependence (p-value)	0.153		0.180		0.420		0.402	

6 Conclusions

We study the transmission of monetary policy changes through the banking deposits and credit channels in the Chilean economy. Our main contributions are the adaptation and application of a partial adjustment model to the estimation of the monetary policy pass-through to deposits and commercial credit interest rates. The proposed methodology represents an alternative to the currently available literature that considers a static model of interest rates, models the aggregate financial system, or does not consider the asymmetry in the response to monetary policy shocks. Thus, we exploit the heterogeneity of banks as an identification strategy, using a panel data estimation from January 2004 to September 2019.

We find that there is persistence of bank interest rates, which is consistent with previous evidence. In addition, the empirical evidence also indicates that the convergence hypothesis is accepted for both deposits and commercial rates. Moreover, we find that there is a relevant role of information contained in banks' heterogeneity. For instance, the percentage of banks that are in a regime of higher equilibrium level changes over time and does not necessarily coincide with the periods of increases in the MPR. This variability allows the identification of asymmetric elasticities. Thus, we observe that the adjustment of interest rates towards its objective is asymmetric with respect to the increases and decreases of the equilibrium level, while the MPR has a full effect on the equilibrium rates. In particular, the sensitivity to the MPR is different for deposits and commercial rates. The adjustment of deposits rates to changes in the MPR is faster in a monetary policy easing, while the commercial rates adjust more rapidly to the tightening.

Furthermore, the heterogeneous effects by bank size show that, in the short term, both larger and medium-small banks increase their spread (mark-up) when they face a tightening or easing monetary policy. In particular, both increases and decrease of the MPR leads to a positive impact on the spread, but higher for large than for medium-small banks. In this context, it can be observed that banks have incentives to maintain a greater margins when they face decreases in their target rates and, to a lesser extent, in the increases.

It is important to highlight that the asymmetric response to a MPR tightening or easing have been reduced in the most recent period, which can be attributed to changes in financial market structure. Moreover, the heterogeneous effects between large and medium-small banks may be explained by reasons such as structural credit risk portfolio, the *switching cost* hypothesis, the existence of a secondary deposit market, and the industrial organization. The results are robust to different econometric specifications and sample estimations, and they are consistent with other local findings.

Finally, the setting presented in this paper would allow us to estimate the effects of changes in monetary policy stance into credit dynamics and also the effect of changes in other types of regulation in the banking credit channel. Also, the methodology can be used to determine the effects of monetary policy for each type of debtor by using more disaggregated data. In this way, it is possible to analyze the heterogeneous impact on each sector, mainly during periods of financial fragility. However, we leave these issues for future work.

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Appendix

A Credit supply by portfolio

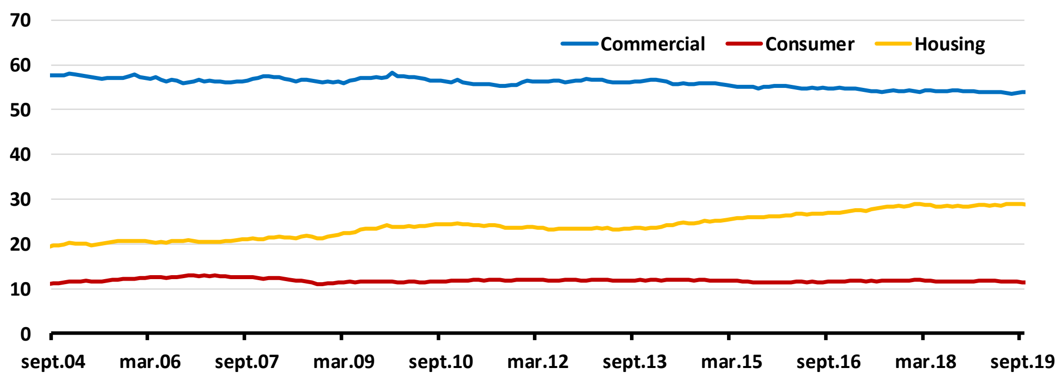

Figure 7. Credit supply by portfolio (percentage of total credit supply). This figure shows the evolution of the credit supply by portfolio. Commercial loans does not consider credits for exports neither imports (COMEX). *Source*: Own elaboration based on information from the CMF.

B Commercial loans and term-deposits by maturity

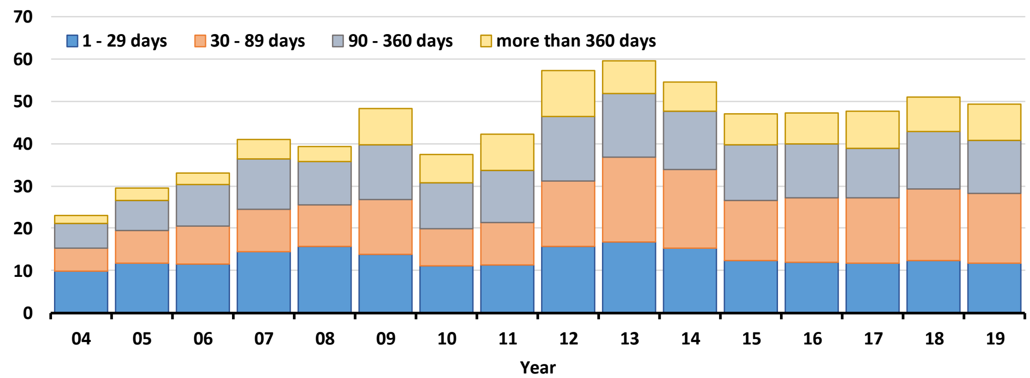

Figure 8. Annual amount of nominal commercial loans by maturity (billions USD). This figure represents the amount of commercial loan for different maturities. It only considers the amount associated to nominal fixed interest rate. *Source*: Own elaboration based on information from the CMF.

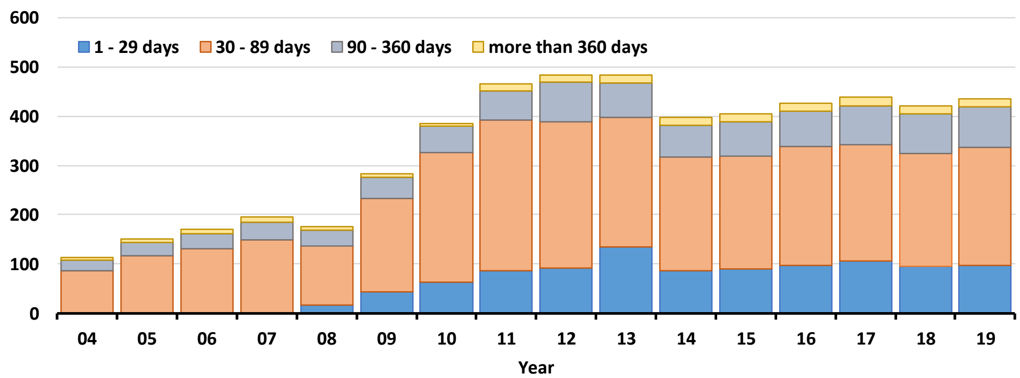

Figure 9. Annual amount of nominal term-deposits by maturity (billions USD). This figure represents the amount of deposits for different maturities. It only considers the amount associated to nominal fixed interest rate. *Source*: Own elaboration based on information from the CMF.

C Unrestricted Estimation

Table X
BRACE: Unrestricted Estimation (Jan.2004-Sep.2019)

This table examines the unrestricted effect of the monetary policy on both *Term-Deposits* (Panel A) and *Commercial loans* (Panel B) interest rates between 1 and 2 months. Observations are taken monthly for 15 individual banks between January 2004 and September 2019. *MPR* correspond to the monthly average monetary policy rate. *Capital* is the ratio of bank's capital over total assets. *Share Term-Deposits* and *Share Demand-Deposits* correspond to the percentage of term deposits and demand deposits over total assets, respectively. *Excess of liquidity* is the positive difference between liquid assets and demand deposits. *Short funding* is a *dummy* that takes value 1 if the demand deposits is higher than liquid assets, and takes value 0 otherwise. *Past-due index* is the percentage of payments that are 90-days past the billing date. *VIX* is an index that represents the expected volatility of the market based on the options of the S&P 500 index. *Commercial loan/Assets* represents the share of commercial loans over total assets. *Demand perception* corresponds to the bank's answer to the Senior Loan Officers Survey, conducted by the Central Bank of Chile, regarding its perception of the demand strength in a scale between -1.5 to 1.5, where -1.5 is significantly weak and 1.5 is significantly strong. Dickey-Fuller, Phillip-Perron and Im-Pesaran-Shin test for panel data reject the presence of unit root. Observations for Panels A and B are weighted by its corresponding bank's share of term deposits and commercial loans, respectively. Standard errors (in parentheses) are clustered by bank. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Term-Deposits	Upwards	Downwards
Term-Deposits (-1)	0.5134***	0.4618***
	(0.0651)	(0.0501)
MPR	0.4929***	0.5419***
	(0.0635)	(0.0515)
Capital	−0.0272***	−0.0141***
	(0.0075)	(0.0049)
Share Term-Deposits	0.0085***	0.0097***
	(0.0021)	(0.0029)
Share Demand-Deposits	0.0077	−0.0024
	(0.0044)	(0.0048)
Excess of liquidity	−0.0014	−0.0129***
	(0.0030)	(0.0030)
Short funding	−0.0379	0.0025
	(0.0264)	(0.0349)
Observations	1,382	929
FE	Yes	
Dummies 2009q1-q2	Yes	
R-squared	0.981	
Convergence (p-value)	0.621	
Asymetry (p-value)	0.530	

Panel B: Commercial Loans	Upwards	Downwards
Commercial Loans (-1)	0.4890***	0.7224***
	(0.0548)	(0.0331)
MPR	0.5319***	0.2818***
	(0.0569)	(0.0403)
Past-due index	0.2478***	−0.0341
	(0.0603)	(0.0441)
VIX	0.0114**	0.0043
	(0.0056)	(0.0054)
Commercial loan/Assets	−0.0245***	−0.0118**
	(0.0051)	(0.0049)
Demand perception	−0.0206	0.0186
	(0.0311)	(0.0291)
Observations	794	1,517
FE	Yes	
Dummies 2009q1-q2	No	
R-squared	0.917	
Convergence (p-value)	0.452	
Asymetry (p-value)	1.000	
Dependence (p-value)	0.546	

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