Cuadernos de Economía (2025) Volume 48, Issue 136, 24-35

Asociación Cuadernos de economía

Cuadernos de economía

www.cude.es

ARTÍCULO

Collateral, Output Growth, Mortgage Spread Volatility and Subsidies in Colombia

Martha López[1]*, Eduardo Sarmiento[2]

[1] Banco de la República, Cra 7 # 14-78, Bogotá-Colombia.
Email: mlopezpi@banrep.gov.co
[2] Escuela Colombiana de Ingeniería, ak 45 # 205-59, Bogotá-Colombia.
Email: eduardo.sarmientog@escuelaing.edu.co

Corresponding Author Email: mlopezpi@banrep.gov.co

Keywords:
Multiplier Accelerator, Mortgage Market, Volatility Forecasting, Housing Subsidies, Econometric Modelling.

Abstract: The housing sector is one of the most relevant in terms of economic and financial stability. Understanding its behavior can prevent bubbles and busts in the economy. There are many studies about the corporate bond's spreads, but the studies about mortgage interest rate spread and its volatility remain scarce. Similarly, the analysis of the subsidies on the housing sector on different dimensions has not been investigated enough. The main objectives of the paper are: i) to investigate the main determinants of mortgage interest rate spread and its volatility at the macro level, ii) the determinants of the mortgage interest rate at the micro level, and iii) contribute to the empirical literature on macroprudential policies in the housing sector to improve financial stability in terms of credit growth. We use GARCH models, panel data models and a difference-in-difference approaches, respectively. We found that a GARCH (1,1) model with output growth explains very well the spread volatility. We also found that collateral is an important variable that explains mortgage interest rates, an increase of 1% in collateral decreases the mortgage interest rate in 0.28%. Finally, the impact of a change of housing subsidies focalization on the assignation of the disbursements of the beneficiaries with respect to the individuals that do not use the subsidies is an increase with a difference of 1.014%. The main policy implications of these findings are that policy makers should take in account the evolution of output growth to reduce the volatility of mortgage spread; that for financial stability purposes, collateral is a variable that should be regulated and that a macroprudential policy in the housing market could be the change of the focalization of subsidies.

Author Correspondence: mlopezpi@banrep.gov.co

https://doi.org/10.32826/cude.v48i136.1003

Introduction

The housing market is one of the most dynamic and important sectors of the economy, not only in advanced economies but also in developing countries. In the 2007-2009 crisis in the United States was evident: "The U.S. financial crisis of 2008 followed a boom and bust cycle in the housing market that originated several years earlier and exposed vulnerabilities in the financial system" (Corporation, 2017). Among the shocks that triggered the crisis were the losses on subprime mortgage securities. The housing market is very closely related to financial and economic stability. In the United States, on December 1, 2008, the National Bureau of Economics Research (NBER) declared that the economy had entered a recession in December 2007. This was called the Great Recession for its severity after the Great Depression. In the United States the crisis was faced mainly with a Federal Reserve "Quantitative Easing" policy by acquiring new loans; purchases of mortgage-backed securities by the Treasury, and the establishment of insurances for the unsecured bank debt by the FDIC (Federal Deposit Insurance Corporation). These operations' main goal was to try to foster credit growth. The government also improved financial regulations to supervise the management of risk from new and large banks, among other policies.

Similarly, in Colombia, an emerging market economy, this sector was determinant in the depth of the 1997-1999 crisis after the liberalization of the financial account of the balance of payments López (2006). The crisis was preceded by a housing prices bubble. In this case, the triggers were mainly the increase in country risk premiums following the 1997 Asian crisis and that the Colombian monetary authority tried to pursue a fixed exchange rate regime during the financial distress, raising interest rates when output was falling. The role of a fixed exchange rate regime in amplifying emerging market crises has been suggested by Gertler et al. (2007). In its effort to avoid capital outflows, the Central Bank raised its interest rate, but the housing interest rates were tied to the Central Bank rate, so this increase led to a fall in the mortgage sector. The recession at the end of the 1990s was particularly long and severe; output fell 4.2% in 1999 and then took approximately five years to recover to its average growth rate. To face the crisis, the Central Bank let the exchange rate float; the private banks that used to provide only mortgage loans were allowed to diversify their investments as sources of funds; and the regulation of the financial system also was increased with new macroprudential policies such as Loan-to-Value limits in the mortgage sector.

Moreover, in general, the housing sector has important levels of chaining backwards and forwards whose performance affects other sectors. More recently, in Colombia, during the 2020-pandemic, the housing sector helped to mitigate its negative effects on output and employment. This was a consequence of an increase in the government budget assigned to housing subsidies in the period. While in 2016 the subsidies were CO$ 249.2 billion, in 2020 this budget was CO$ 726.3 billion and in 2021 it was over CO$ 1,000 billion (Rey Hernández, 2023). However, in recent years, especially during 2023, the sector has presented a downturn.

In advanced economies like the United States, the studies to disentangle many aspects regarding the mortgage sector have been important and particularly the analysis of the 2007-2009 financial crisis have been wide. In emerging markets economies like Colombia, the sector has not been studied enough and the understanding of aspects such as the volatility of the mortgage interest rate or its determinants and the analysis of the effect of macroprudential policies on the supply of credit remains scant (notably based on micro-level administrative datasets). Our paper tries to fill the gap.

Our purpose in this document is threefold. First, the spread between the housing market interest rate and the 3 months CDs interest rate is a key financial variable useful for investors to foresee the development of the housing sector and the possible investments in it. The determinants of the spread and its volatility constitute an important subject of analysis for its relationship with economic and financial stability, therefore, we use a battery of GARCH models for explaining the volatility of the spread at a macroeconomic level, as it is usual for financial variables, and answer the question about which model is best suited for it. Second, we stablish which are the determinants of the mortgage interest rate in Colombia during the period 2010Q1-2020Q4. For identification, we use granular information of the Data Register in Colombia, a dataset from the Integrated Social Security Form (PILA for its initials in Spanish), a set of macroeconomic variables, and a variety of fixed effects. Finally, in April 2023 the government introduced a modification in the way the subsidies of Social Interest Housing (VIS for its initials in Spanish) are implemented. We use the setting of the determination of lending interest rate to assess the impact of the policy reform in the supply of credit. In the program called "My House Now" between its creation in 2015 until March 2023, the subsidies were assigned according to the wages of the individuals. In April 2023, the focalization of the program changed to consider other variables about the borrower's vulnerability. For this, the government decided to base its assignations according to the classification in the database of SISBEN which has a more comprehensive definition of poverty. For example, the mothers head of family and the displaced persons by armed conflict have priority in the criteria for receiving the subsidy. Here, taking advantage of our granular dataset of the Data Register, the goal is to assess which was the effect of the policy on the growth of disbursements and sales of VIS housing compared to No-VIS during the period 2022Q1-2024Q1 using a difference-and-difference approach. Studies like ours, that analyze the aspects addressed above, would provide some tools for policymakers in choosing better economic policies. The paper proceeds as follows: Section 2 presents the literature review. Section 3 presents the theoretical framework and the institutional settings. Section 4 explains the estimation methods. Section 5 describes the data and statistics. Section 6 presents the empirical analysis of the results and findings, and section 7 concludes.

Literature Review

Gordon (2023) finds a negative correlation between the mortgage spread and output growth during 1990-2023 for the United States. During recessions mortgage spreads spikes for two reasons. "First, the yield curve inverts, which shortens the expected duration of mortgages. Second, since the yield curve is inverted, short-duration assets have higher yields (all else equal) than longer-duration assets." The yield curve is defined as the 10-year Treasury rate minus 2-year Treasury rate, and the mortgage spread as the 30-year mortgage rate relative to the 10-year Treasury rate. When there is a recession the 10-year Treasury rate is expected to fall, for which the

duration of mortgages is reduced expecting to refinance them at lower rates in the future, which increases the spread. We contribute to this evidence by estimating the mortgage spread volatility depending on these variables but in the context of a developing economy.

There are some studies of the housing spread for advanced economies such as those by Liow & Addae-Dapaah (2010). However, most of the studies about interest rates spreads are based on corporate bonds like the ones of Kim et al. (2021) and Gilchrist & Zakrajšek (2012). This is the first paper to provide evidence on mortgage spread and housing supply of credit in an emerging market economy.

In line with the previous results, in an analysis for the United States during 1973-2010 with monthly firm data, Gilchrist et al. (2012) find that an increase in the level and the slope of the Treasury term structure of interest rates narrows the credit spread for corporate callable bonds, meanwhile the increase in the volatility of the long-term Treasury yields increases the credit spread of the corporate callable bond debt with respect to Treasury yield of the same maturity. They find a negative correlation between the spread of corporate bonds with respect to treasury securities and output growth. The positive magnitude of the effect of the default over the spread is smaller for callable bonds. They describe the spread as divided into two determinants, a forecastable part and a non-forecastable which they name the excess bond premium. When the latest increases in 100 base points, GDP growth falls in 1.5 percentage points. We contribute to this literature in the context of the mortgage market.

Batten et al. (2014) consider a GARCH regression of the incidence of the change of the level and the slope on the callable bonds spread, with monthly data from Canada during September of 1976 to July of 2001. The spread is defined as the difference between the corporate bond yields and a 5-year government bond yield. The level is the long-term 5-year government yield and the slope the difference between the 5-year long-term government yield and the three-month treasury yield. The incidence of the change of the level and the change of the slope over the change of the spread are both negative and significant for callable bonds. The relationship with the level results when the long-term government bond interests are high and the callable bonds are not expected to exercise their option, reducing the yield for the call provision. When government bond interests are low the opposite occurs, the corporate yield call provision is raised. We contribute to this literature by using the slope and the level of government bond to explain the volatility of mortgage spread.

Kim et al. (2021) provide evidence, with data for the United States, of the volatility of the interest of corporate callable and noncallable bonds with respect to treasury bonds of the same maturity estimating the first with a T-GARCH model and the second with a Q-GARCH model. Volatility increases with equity volatility, higher interest payments coupon rates, volatility of one month maturity rates and weak bond risk ratings. The slope of the difference between the rates of 10-year and a 1-year rates, the level of one month treasury rates and time-to-maturity increases noncallable bonds spread volatility and decreases callable bonds volatility. Finally, liquidity reduces noncallable bonds volatility spread and increases callable bonds volatility spread. Our paper is in the same spirit but focuses on mortgages interest spread.

Vargas et al. (2010) find that for monthly data of Colombia during August of 2003 and September of 2009 an increase of the policy rate in 100 base points raises the spread of the mortgage rate and the 10-year treasury rate with a lag of 3 to 5 months and the highest incidence is of 50-60 base points. Carranza & Navarro (2010) consider microeconomic data of Colombia between the first quarter of 1997 and the second quarter of 2004 for the mortgage market, in this study, the probability of default decreases with the house prices, and increases with the value of the mortgage and the maturity of the credit. Our finding using microdata adds to this evidence.

The mortgage spread is very closely related to the evolution of output growth. As described by the financial accelerator theory of Bernanke et al. (1999) (BGG), Kiyotaki & Moore (1997), and Hall (2011), among others, the spread in the credit market depends on the evolution of the equity prices which affect net worth and output. When equity prices increase, net worth and output also rise, and leverage of entrepreneurs falls reducing the spread between the lending interest rate and the policy rate. Similarly, for the mortgage market in the United Kingdom, in a calibrated model of the spirit of the one of BGG, Aoki et al. (2004) describe how housing net worth is affected by housing prices which at the same time determines housing leverage, mortgage spread, investment and output. The financial accelerator theory predicts that the business cycle is deeper given that the initial increase in investment and output in turn fuels housing prices and net worth causing a fall in leverage of households reducing the spread between the mortgage interest rate and the policy rate. In the case of Colombia, López (2006) estimates a DSGE model with a financial accelerator framework and finds that the mortgage spread depends on leverage. We contribute to this strand of literature by estimating the relationship between mortgage interest rates and collateral with microdata and between the GDP growth and the volatility of the mortgage spread at the macroeconomic level.

Similarly, Adrian & Shin (2010) highlight the importance of the behavior of large banks and broker dealers in the recent financial crises from 2007-2009. As these institutions manage their leverage in a procyclical way, in an expansion when asset prices increase their balance sheet is higher and they raise leverage and credit supply, increasing output growth, which in turn increases asset prices, amplifying the boom. In contractions they deleverage their balance sheets. Mortgage-Backed Securities were among the key assets explaining the financial crises in the United States, as is well known in the risk-taking theory. We contribute to this literature in the context of a developing country with a bank-based financial system. In Colombia, using Data Register information, López et al. (2011) also present evidence of this risk-taking channel for the corporate loans. In the case studied here, when housing interest rates are low for a long period of time (and their prices are high) banks take more risk by increasing the supply of housing loans and output growth increases, which in turn raises housing prices again reinforcing the boom (collateral increases and the housing interest rates spread falls).

Abreu et al. (2024) provide evidence of the effectiveness of the introduction of new limits to the loan-to-value in Portugal in February of 2018 on the reduction of indebtedness of the constrained households and the increase in their interest rates. They used Data Register information for their analysis. We contribute to this strand of literature by using microdata from the Data Register for a developing country like Colombia. Regarding the literature about the effect of subsidies on credit, it is scarce. However, Ramírez Sierra et al. (2024) analyze the effect of subsidies on housing prices in Mexico during 2008-2019 using administrative records and find that they have a significant and positive effect. Our paper adds to this literature analyzing the

change in the objective group of subsidies focalization on credit growth.

Theoretical Framework and Institutional Settings

Financial Accelerator Model

We use two main strands of literature to explain the relationship between supply of credit, output growth and interest rates spread. First, the framework of the financial accelerator theory formulated by Bernanke et al. (1999), Kiyotaki et al. (1997), and Hall (2011), among others. Second, the more recent risk-taking theory, which explains the financial crises of 2007-2009, by Adrian & Shin (2008); Adrian et al. (2010), and Jiménez et al. (2014).
According to Bernanke et al. (1999)

$$q_{t-1}K_t = B_t + N_t$$

$$\frac{(1+i_t^l)}{(1+i_t^d)} = f\left(1 - \frac{N_t}{q_{t-1}K_t}\right) = f\left(\frac{B_t}{q_{t-1}K_t}\right), f' > 0$$

Where q_{t-1} is the housing price, K_t is the housing capital stock, B_t is the amount of housing investment financed with loans, N_t is the amount of housing investment financed with net-worth and $\frac{(1+i_t^l)}{(1+i_t^d)}$ is the mortgage interest rate spread between the lending and the deposit rates. According to this theory, when collateral increases, the mortgage interest rate falls and similarly when the net-worth increases, the mortgage interest rate falls. The spread of mortgage interest rate is a positive function of household's leverage, $\frac{B_t}{q_{t-1}K_t}$, and negative function of collateral, $\frac{q_{t-1}K_t}{B_t}$. As a result, the credit supply increases when housing prices and net worth increase. To increase the credit supply, the banks raise their leverage, according to Adrian et al. (2008, 2010), as follows:
Denoting lending assets by A_l, other assets A_o, deposits D and equity E,

$$A_l + A_o = D + E$$

The bank's lending assets increase in response to a rise in asset prices, with a bigger proportion of equity used for lending, which also increases by expanding the banks leverage through more deposits. Banks' balance sheets become stronger when housing prices increase and leverage initially falls, however they raise lending through more leverage, which increases output and raises more housing prices, reinforcing the expansion cycle. The opposite occurs when housing prices fall.

Subsidies "My House Now" (Mi Casa Ya)

We use the institutional setting of the subsidies "My House Now" in Colombia to assess the impact on the supply of credit of the change in the targeting group of beneficiaries of the subsidies with the reform of 2023Q2. Article 51 of the constitution of 1991 establishes the right to decent housing. This encourages governments to participate in solving the national housing deficit. Decree 555 of 2003 created the Housing National Fund to finance urban housing subsidies. The Government has implemented different housing programs that have varied over the course of the different presidential four-year terms. The program of Free Housing aimed at the vulnerable population was created by Law 1537 of 2012, and the program of Priority Housing for Savers (VIPA for its initials in Spanish) that established a housing subsidy for households with incomes below 2 smmlv (current legal minimum monthly wage) was created by the Decree 1432 of 2013. The housing program with the greatest impact has been "My House Now" which is implemented with Decree 428 of 2015. This is initially aimed at households between 2 and 4 smmlv. The subsidy for households between 2 and 3 smmlv is up to 20 smmlv, and for households between 3 and 4 smmlv it is up to 12 smmlv. Beneficiaries of the program can also access the interest rate coverage program. Initially, "My House Now" is only aimed at Social Interest Housing (VIS for its initials in Spanish) and not Priority Interest Housing (VIP for its initials in Spanish). Subsequently, the "My House Now" program was extended to three components My House Now - Downpayment, My House Now - Savers and My House Now - Subsidy to the Interest Rate. My House Now - Savers includes households with incomes between 1 and 2 smmlv. For those with incomes up to 1.6 smmlv the subsidy is 30 smmlv and for those with incomes more than 1.6 smmlv and up to 2 smmlv the subsidy is 25 smmlv. New homes purchased must be up to 70 smmlv and must be on the My House Now - Saver's list.
My House Now – Downpayment includes households with incomes between 2 and 4 smmlv. The value of the new property is between 70 smmlv and 135 smmlv, and the subsidy is up to 20 smmlv. In My House Now - Subsidy to the Interest Rate the household income must add up to 8 smmlv. For VIS and VIP housing, the interest coverage is up to 5 p.p. of the credit. For No-VIS coverage is up to 2.5 p.p. of the credit. During the second period 2014 - 2018, the Free Housing program was also implemented. Although housing is one of the main flags of the Government, it was surpassed in amounts of subsidies by the next Government. In the first year of government, the subsidies of "My House Now" rose to 32,330, surpassing those of 2015 (1,801), 2016 (7,162) and 2017 (14,846), with subsidies of up to 30 smmlv. These were complemented by interest rate coverage of 4 p.p. for VIS homes and 5 p.p. for VIP homes. The amount of housing subsidies hiked during the pandemic; during 2019-2022 presidency, the subsidies went from 33,000 to 66,000. In 2023, they fell to 52,000.
Since 2023, with Decree 490 of 4 of April of 2023, the Government makes modifications to the "My House Now" program. The focalization of the program was changed. Households that acquire social interest housing and are classified between groups A1 and C8 of SISBEN IV, are assigned a subsidy for an amount equivalent to 30 smmlv. Households that acquire social interest housing and are classified between groups C9 and D20 of SISBEN IV, are assigned a subsidy up to the amount equivalent to 20 smmlv. In addition, the Government, through the Fund for the Mortgage Bank of the Republic, offers rate coverage that makes easier the financing of new VIS and VIP interest housing. Coverage for No-VIS had been eliminated since 2022. Those households that access the concurrence of subsidies, that is, that have the subsidy of their compensation fund, can receive an additional subsidy by the Housing National Fund. Unlike previous programs, new homes can also be rural. Among the priority individuals to receive the subsidies are the victims of the armed conflict, poor head of family women, informal workers women and communitarian mothers. After more than 1 year of the introduction of a new policy of focalization of "My House Now" in this document we evaluate the impact of the reform on sales, approximated by housing disbursements using microdata.

Methodology

Estimation Methods on Spread Volatility at the Macroeconomic Level

Similarly to Kim et al. (2021) we use the empirical strategy of the GARCH models for assessing the volatility of the

difference of the mortgage spread in Colombia explained by the output growth at the country level. In this subsection we present the models for the difference of the spread with and without the output growth as explanatory variables, for GARCH, TGARCH, EGARCH and PGARCH specifications. These kinds of models are widely used in empirical literature to assess the volatility of financial variables. The models considered are as follows:

Bollerslev (1986) **GARCH Model**

$$y_t = X_t'B + \epsilon_t$$

The distribution of the disturbance's conditional on the information at time *t-1*, ψ_{t-1}, is assumed to be:

$$\epsilon_t|\psi_{t-1} \sim N(0, \sigma_t^2)$$

Where the conditional variance is:

(1) $\sigma_t^2 = \alpha_0 + \alpha_1\epsilon_{t-1}^2 + \alpha_2\epsilon_{t-2}^2 + \cdots + \alpha_q\epsilon_{t-q}^2 + \delta_1\sigma_{t-1}^2 + \delta_2\sigma_{t-2}^2 + \cdots + \delta_p\sigma_{t-p}^2$

The GARCH model has the following restrictions:

$$\alpha_0 > 0, \alpha_i \geq 0, \delta_j \geq 0$$

The above determines that the conditional variance is not negative. The variance is a stationary process that converges:

$$\sum_{i,j}^{\max(q,p)} (\alpha_i + \delta_j) < 1$$

EGARCH (exponential GARCH)

Nelson (1991) suggests an exponential GARCH with the following conditional variance:

(2) $ln\sigma_t^2 = \alpha_0 + \alpha_1 \frac{|\varepsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} + \alpha_2 \frac{|\varepsilon_{t-2}|}{\sqrt{\sigma_{t-2}^2}} + \cdots + \alpha_q \frac{|\varepsilon_{t-q}|}{\sqrt{\sigma_{t-q}^2}} + \delta_1 ln\sigma_{t-1}^2 + \delta_2 ln\sigma_{t-2}^2 + \cdots + \delta_p ln\sigma_{t-p}^2$

The EGARCH model has the following restrictions:

$$\alpha_0 > 0, \alpha_i \geq 0, \delta_j \geq 0$$

TGARCH (threshold GARCH)

In this case the conditional variance corresponds to:

(3) $\sigma_t^2 = \alpha_0 + \alpha_1\epsilon_{t-1}^2 + \alpha_2\epsilon_{t-2}^2 + \cdots + \alpha_q\epsilon_{t-q}^2 + \delta_1\sigma_{t-1}^2 + \delta_2\sigma_{t-2}^2 + \cdots + \delta_p\sigma_{t-p}^2 + \gamma_1\epsilon_{t-1}^2\Gamma_1 + \gamma_2\epsilon_{t-2}^2\Gamma_2 + \cdots + \gamma_q\epsilon_{t-q}^2\Gamma_q$

With:

$\Gamma_l = 1 \; if \; \varepsilon_t < 0$

$\Gamma_l = 0 \; otherwise$

For positive Γ_l, the incidence of negative news shocks over volatility is positive.

PGARCH (power GARCH)

The conditional variance of the power GARCH is:

(4) $\sqrt{\sigma_t^2}^{\lambda} = \alpha_0 + \alpha_1|\varepsilon_{t-1}|^{\lambda} + \alpha_2|\varepsilon_{t-2}|^{\lambda} + \cdots + \alpha_q|\varepsilon_{t-q}|^{\lambda} + \delta_1\sqrt{\sigma_{t-1}^2}^{\lambda} + \delta_2\sqrt{\sigma_{t-2}^2}^{\lambda} + \cdots + \delta_p\sqrt{\sigma_{t-p}^2}^{\lambda}$

Where $\lambda > 0$

Estimation Method on Mortgage Interest Rate Determination Using Micro Data

In a similar way to Gordon (2023), Gilchrist et al. (2012) and Batten et al. (2014) we analyze the determinants of interest rates, but in the context of the housing market. The importance of collateral on mortgage interest rates is considered using microdata, and estimate the following panel regression at the loan level between 2010Q1 and 2020Q:

(5) $R_{ibt} = \alpha_1 + \beta_1 Collateral_{ibt} + \beta_2 X_{ibt} + \beta_3 Y_{ibt} + \delta_{It} + \delta_{bt} + \delta_r + \delta_{Ib} + \epsilon_{ibt}$

The dependent variable R_{ibt} corresponds to the mortgage interest rate that the bank b charges to borrower i in quarter t. It depends on our main variable of interest, loan $Collateral_{ibt}$, other loan characteristics X_{ibt}, and borrower characteristics Y_{ibt}. We also saturate the model with industry*time fixed effects of the 4-digit ISIC industry of the firm for which the borrower works, δ_{It}, and region fixed effects δ_r. These fixed effects along with the borrower characteristics allow us to control by the demand of credit and isolate the supply of credit in a similar way as (Khwaja & Mian, 2008)[1]. We also saturate the model with bank*time fixed effects, δ_{bt}, to control for the credit channel of monetary policy and with industry*bank fixed effects, δ_{Ib}, to control for the time varying bank-industry relationship of the borrowers with the bank. Finally, ϵ_{ibt} is an error term. We cluster the standard errors at the four-digit ISIC industry of the firm of the borrower, a convention held throughout the paper. In robustness exercises we also control for observed macroeconomic variables. Here, the methodology follows closely Jiménez et al. (2014) and Fabiani et al. (2022).

Estimation Method on "My House Now" Policy

To investigate the effect of "My House Now" policy reform of April 2023 on VIS versus No-VIS disbursements we use a diff-in-diff approximation with the following regression for the period 2022Q1-2024Q1:

(6) $D_{ibt} = \beta_1 + \beta_2 VIS_{ibt} * Post_t + \beta_3 X_{ibt-1} + \beta_4 X_{ibt-1} * Post_t + \beta_5 Y_{ibt-1} + + \beta_6 Y_{ibt-1} * Post_t + \delta_I + \delta_{It} + \delta_{rt} + \delta_{bt} + \delta_{Ib} + \epsilon_{ibt}$

The dependent variable corresponds to the Ln of disbursements D_{ibt}. VIS corresponds to a dummy variable that takes the value of 1 for the individual with subsidy and No-VIS corresponds to 0. The variable Post is a dummy that takes the value of 0 between 2022Q1 and 2022Q4 and the value of 1 between 2023Q1 and 2024Q1. Loan characteristics are represented by X_{ibt-1}, and borrower characteristics by Y_{ibt-1}. To control for loan and borrower characteristics that might be driving the differences in outcomes of pre vs post VIS shock, we horse-race POST*X_{ibt-1}, and POST*Y_{ibt-1}. We also saturate the model with 4-digit ISIC industry fixed effects δ_I, industry*time fixed effects δ_{It}, and region*time fixed effects δ_{rt} to control for the unobserved demand of credit; bank*time fixed effects δ_{bt}, to control for the credit channel of monetary policy; and industry*bank fixed effects δ_{Ib} to control for the variation in industry of bank-borrower relationships. Finally, ϵ_{ibt} is an error term. We cluster the standard errors at the four-digit ISIC industry level, a convention held throughout the paper. In robustness exercises we also present horse-racing with macroeconomic variables. This methodology also follows closely Jiménez et al. (2014) and Fabiani et al. (2022)

Data and Descriptive Statistics

As many financial markets series, the interest rate mortgage spread is quite volatile in Colombia. Here, the mortgage spread is defined as the difference between the mortgage lending rate and the 90-days deposits rate in line with the definition of spread of BGG. Figure 1 shows high spread volatility. This high volatility makes it difficult to forecast

[1] Jiménez et al. (2012); Jiménez et al. (2014) for Spain used data on applications to control for credit demand besides the firm fixed effects. We do not have access to this information in the case of Colombia.

the spread, but with GARCH models it is possible to predict its volatility and assess the risk in the mortgage market.

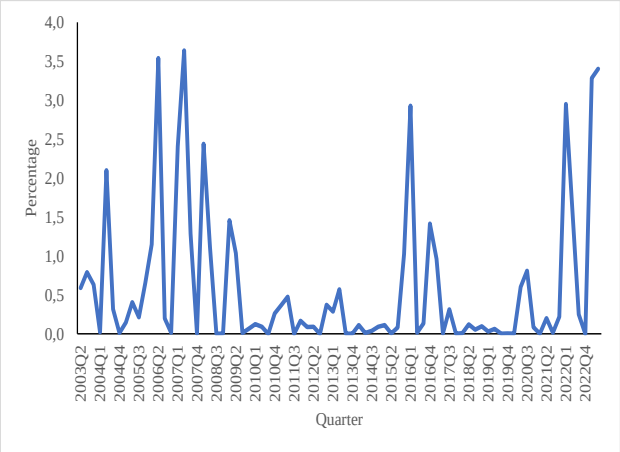


Figure 1: Mortgage Spread Volatility in Colombia, 2003q2 - 2023q2.

Figure 2 presents the evolution of output and spread during the period analyzed. The output growth and the spread show an opposite relationship during the period 2003Q2 - 2023Q2, as predicted by the theory. The years of lower output growth, 2009 and 2020 are the ones with highest spread increasing from 7.7% in 2008Q4 to 10.1% in 2009Q4 and increasing from 6.4% in 2019Q4 to 8.1% in 2020Q3. Likewise, most of the time when output increases the spread falls during the period.

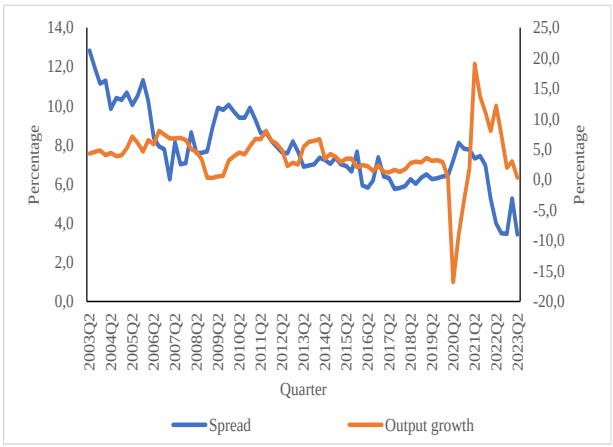


Figure 2: GDP Growth and Mortgage Spread in Colombia, 2003Q2- 2023Q2.

An important fact is that the two rates that compose the spread, the housing rate, and the deposit rate, move during the whole period with an evident positive correlation as presented in Figure 3.

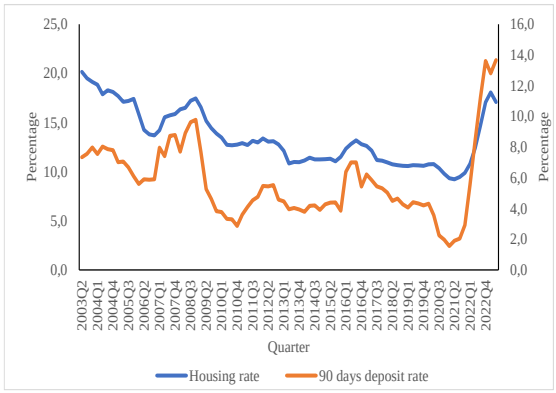


Figure 3: Interest Rates in Colombia, 2003Q2- 2023Q2.

For the analysis of the mortgage interest rate determination and the impact of the reform in the policy of Social Interest Housing (VIS) using microdata, we use the matching of three data sets. First, the Data Register from Colombia, that records loan level information about size, days past due, initial date of the loan, lending banks, interest rate of the loans, collateral, and maturity of the loans. Second, an individual level social security dataset, Integrated Social Security Form (PILA for its initials in Spanish), from which we draw borrowers' information of wages, age, gender, location of the borrower and 4-digit ISIC industry level of the firm for which the borrower works. Finally, a set of data of country wide macroeconomic variables such as annual growth of GDP, annual inflation rate and the lagged monetary policy rate.

In Table 1 we present the definition of the variables and descriptive statistics for the analysis of the determination of mortgage interest rate. The data corresponds to a panel of disbursements from 2010Q1 to 2020Q4. The number of loans is 2,533,213 which is a sample of the individuals whose information is available in PILA in 2010 and that corresponds to approximately 70% of the total lending in 2020. The information does not include social interest housing, which will be described in Table 2 and subsection 6.4. The mortgage interest rate has a mean of 11%, with a minimum of 6% and maximum of 32.5%. Collateral has a mean of 1.8. The size of the loan has a mean of 18.5 (which corresponds to CO$ 111,551,843) with a standard deviation of 0.62. The average maturity of the loans is 16 years, with a maximum of 30 years. The borrower's wages mean is 14.5 (which corresponds to CO$ 1,982,759) with a standard deviation of 0.9. The borrower's age mean is 42 years with a standard deviation of 9 years. Gender has a mean of 0.57 (a little more than half of the people in the sample are men) and standard deviation of 0.5. Borrower risk has a mean of 0.53 (which is the percentage of loans in default during the whole sample, 0.01 each quarter) with a standard deviation of 0.5.

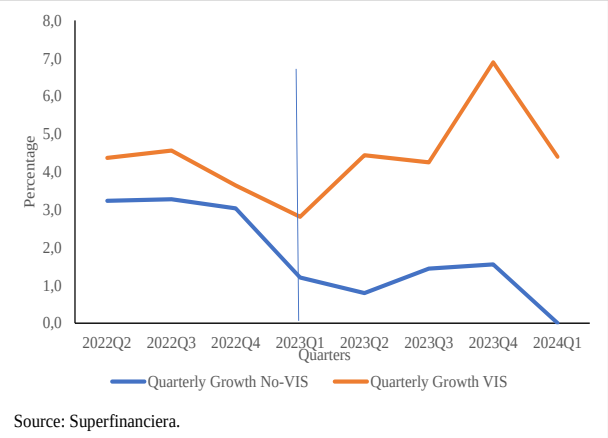
Table 1: Descriptive Statistics for Determination of Mortgage Interest Rates.

Variable	Description	N	Mean	Std. Dev.	Min.	Max.
Interest rate	Mortgage interest rate (%)	2,533,213	10.97	2.00	6	32.45
Collateral	Ln (Guarantee value/ Loan balance)	2,533,213	0.60	0.22	0.18	1.10
Loan size	Ln (Disbursements)	2,533,213	18.53	0.62	9.39	22.63
Maturity	Maturity of loan in years	2,533,213	15.71	4.27	0	30
Wages	Ln (Wages)	2,533,213	14.51	0.90	12.43	19.40
Age	Age	2,533,213	42.40	9.12	20	80
Gender	Male = 1, Female = 0	2,533,213	0.57	0.50	0	1
Borrower risk	90 pass due days = 1, otherwise = 0	2,533,213	0.53	0.50	0	1

Notes: The data corresponds to a panel of disbursements from 2010Q1 to 2020Q4. The number of loans is a sample of the individuals whose information is available in PILA in 2010 and that corresponds to approximately 70% of the total lending in 2020.

The data for the analysis of the change in the focalization of the subsidies of Social Interest Housing is presented in Figure 4 and Table 2. Figure 4 presents the credit growth quarter to quarter of the VIS (social interest housing) with respect to No-VIS, before and after the introduction of the April 2023 reform that changed the focalization of the subsidies. Before the reform, there is a common falling trend between the two groups and after the policy No-VIS credit continued falling, while VIS lending started to increase. This is suggestive evidence of the positive result of the policy with respect to VIS credit growth and housing sales.

Table 2 presents the descriptive statistics of the variables for the housing sector divided into individuals with housing subsidies (VIS) and those without (No-VIS). We present the summary for the same variables that we considered in Table 1. In this context, the financial accelerator theory presented in section 3, is captured by the controls and fixed effects that we include regarding borrower characteristics because the demand of credit depends on factors related to the evolution of financial conditions of borrowers. The total number of loans is 785,757, of which 305,640 corresponds to VIS (38.9%) and 480,116 corresponds to No-VIS (61.1%). The average lending rate is slightly higher for No-VIS loans. The average size of the loans is much smaller for VIS individuals (CO$ 66,986,389) than for No-VIS individuals (CO$ 156,724,493). The average wage of borrowers that receive the subsidy is CO$ 700,816, while for those that do not receive it is CO$ 1,167,062. The borrower's risk for VIS individuals has a mean higher than for No-VIS individuals, respectively with 0.10 and 0.08.



Source: Superfinanciera.

Figure 4: Housing VIS, Non-VIS credit growth, 2022Q2-2024Q1.

Table 2: Descriptive Statistics Housing Subsidies Policy.

Variable VIS	Description	N	Mean	Std. Dev.	Min.	Max.
Interest rate	Mortgage interest rate (%)	305,640	11.28	3.14	6	40
Collateral	Ln (Guarantee value/ Loan balance)	305,640	0.57	0.23	0.18	1.09
Loan size	Ln (Disbursement)	305,640	18.02	0.39	13.46	20.71
Maturity	Maturity of loan in years	305,640	19.62	5.70	0.92	42.92
Wages	Ln (Wages)	305,640	13.46	0.65	0	17.12
Age	Age	305,640	44.34	8.56	30	80
Gender	Male = 1, Female = 0	305,640	0.49	0.49	0	1
Borrower risk	90 pass due days = 1, otherwise = 0	305,640	0.10	0.31	0	1
Non-VIS						
Interest rate	Mortgage interest rate (%)	480,116	11.60	3.48	6	43
Collateral	Ln (Guarantee value/Loan balance)	480,116	0.56	0.22	0.18	1.10
Loan size	Ln (Disbursement)	480,116	18.87	0.65	11.97	22.61
Maturity	Maturity of loan in years	480,116	18.54	4.92	0.01	31
Wages	Ln (Wages)	480,116	13.97	0.88	0	18.15
Age	Age	480,116	46.6	8.77	32	80
Gender	Male = 1, Female = 0	480,116	0.54	0.49	0	1
Borrower risk	90 pass due days = 1, otherwise = 0	480,116	0.08	0.27	0	1

Notes: The data corresponds to a panel of disbursements from 2022Q1 to 2024Q1. The number of loans is a sample of the individuals whose information is available in PILA in 2010 and that corresponds to approximately 70% of the total lending in 2024.

Empirical Findings

GARCH Regression Analysis

In this subsection we present macroeconomic evidence of the volatility of the mortgage interest rate spread. As mentioned previously in the theoretical framework of Section 3, net worth of the households is related to the spread through collateral. When net worth increases the spread decreases. In a macroeconomic environment, net worth is related to output growth. When net worth increases investment in housing and output growth increases, causing a subsequent fall in the spread, as suggested by Bernanke et al. (1999). In Table 3 we present the Akaike information criterion (AIC) results of the regressions, which are used for model selection. In columns (1) to (4) are presented the estimation of the models without considering the output growth, and in columns (5) and (6) the models with output growth. As we can observe, the models estimated with output growth are the ones that have the best fit according to the AIC. This means that as the financial accelerator theory predicts output growth is an important variable to predict spread volatility. Among the models the GARCH (1,1), with output growth is the best one, which presents the lowest AIC.[2] We selected a GARCH (1,1) with independent variable lagged output growth, and the results of the regression are shown in column (1) of Table 4. Figure 5 presents the diagnostics for the selected GARCH model for the volatility of the difference of the mortgage spread in Colombia. The standard residuals present constant conditional volatility. The histogram of the standardized residuals suggests a normal distribution. The autocorrelation, AC and the partial autocorrelation, PAC, suggest no AR or MA components for the models and we incorporated this into all the regressions[3].

[2] Using the AIC we also determined the order of each GARCH.

[3] Diagnostics for the other models are provided upon request.

Table 3: Model selection.

	GARCH (1,1)	EGARCH (1,1)	TGARCH (1,1)	PGARCH (1,2)	GARCH (1,1) GDP growth	EGARCH (1,1) GDP growth
	(1)	(2)	(3)	(4)	(5)	(6)
Log likelihood	-87.6897	-88.4684	-87.5243	-86.1036	-83.1600	-84.0341
AIC	2.2639	2.2832	2.2846	2.2742	2.20400	2.2259

Notes: This table presents the Log Likelihood and Akaike for 6 competing GARCH models. We selected the one with the lowest Akaike and highest Log Likelihood.

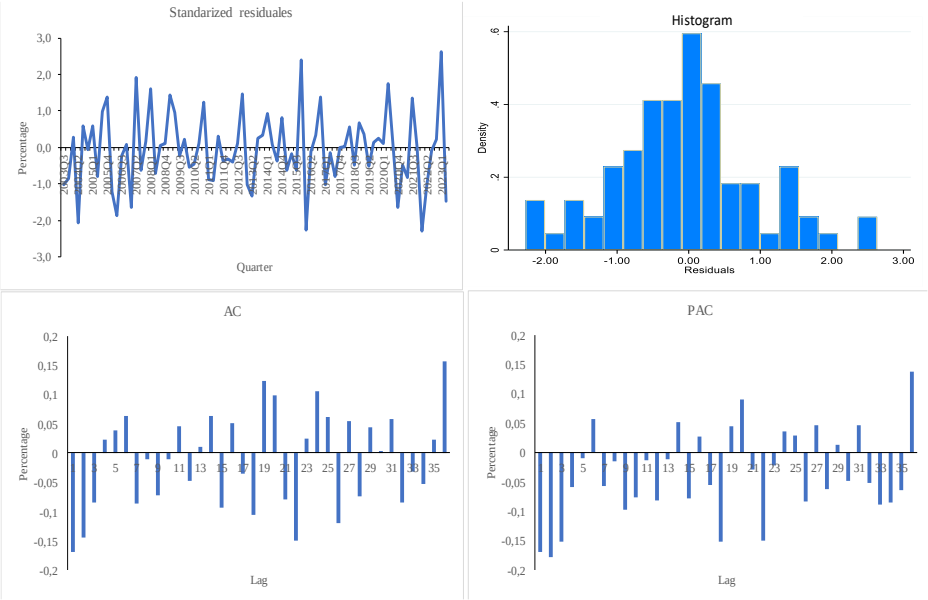


Figure 5: Diagnostics for GARCH11 with Output Growth.

The model selected by the AIC shows no autocorrelation or heteroskedasticity, and the product growth has a significant negative incidence over the difference of the spread as predicted by the financial accelerator theory and the risk-taking theory presented above. The coefficients of the ϵ_{t-1}^2 and the σ_{t-1}^2 are positive, significant and sum less than one. The intercept in the variance equation of the regression is also positive, which implies that the conditional variance is non-negative.

These results are also in line with the evidence presented by Gilchrist et al. (2012) for the case of the corporate bonds in the United States because in their study when the default risk decreases (here proxied by GDP growth) the spread of corporate bonds with respect to treasury bonds is also reduced. In the same way, our results are close to the ones of Gordon (2023) who finds a negative relationship between the mortgage spread and product growth for the United States.

Table 4: GARCH (1,1) With Output Growth, And Level and Slope of Treasury Bonds.

Dependent variable: Dspread		
	(1)	(2)
Output growth (-1)	-0.043***	-0.043**
	(0.0106)	(0.0156)
Dlevel(-1)		0.026
		(0.1097)
Dslope(-1)		0.0454
		(0.1167)
Intercept	0.125	0.127
	(0.0824)	(0.0852)
Variance equation		
ϵ_{t-1}^2	0.399*	0.400*
	(0.2045)	(0.2206)
σ_{t-1}^2	0.575***	0.575***
	(0.1569)	(0.1948)
Intercept	0.055	0.054
	(0.0379)	(0.0450)
N	80	80
R-squared	0.042	0.045
Sample	2003Q3 2023Q2	2003Q3 2023Q2

Notes: The regression in the first column shows the incidence of output growth over the difference of the spread in a GARCH (1, 1) model. The second column includes the level of the one-year government bonds and the slope of the 10-year government bonds yield curve. ***p<0.01, **p<0.05 and *p<0.1. Standard error in parentheses.

In column (2) of Table 4 we present, following Batten et al. (2014) and Gilchrist et al. (2012), the relation of the spread with the level and the slope of the government bonds. This relation among the three variables depends on their implicit definition. Since the spread considered in this study is the difference between the mortgage interest and

the 3-month deposit interest rate, it is expected that the change of the level of the one-year government bonds yield will cause a negative incidence over the change of the spread, because the long-term interest rate doesn't change in the same proportion as the short-term interest rate. On the other hand, the incidence of the change of the slope between long term and short-term government bonds over the change of the spread is expected to be positive, since the long-term government yield relates positively with a long-term mortgage interest.

As before, the incidence of output growth over the spread is expected to be negative. In column (2) of Table 4 shows a GARCH regression of the difference of the spread with respect to the difference of the level, the difference of the slope and lagged product growth (the sample starts in 2003Q3 because of the availability of the data). The coefficient of the GARCH components sums less than one. Output growth has the expected sign and is statistically significant. The difference between the level and the slope are statistically insignificant. The equation of the GARCH (1, 1) with output growth has the correct statistical properties to calculate the volatility of the difference of the mortgage spread. In Figure 6 we show the relationship between the conditional variance predicted by the model and the observed spread volatility. The model captures very well the peaks and falls of the spread during the period.

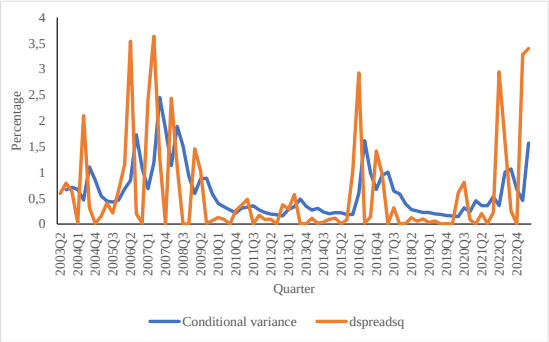


Figure 6: Conditional Variance of GARCH (1, 1)-GDPG, 2003Q2- 2023Q2.

Panel Regression Analysis on Interest Rate Determination Using Microdata

The results on interest rate determination for equation 5 are presented in Table 5. As expected, the coefficient of collateral is negative and significant. A 1% increase in collateral translates into a fall of about 0.28% in the interest rate. In addition, when the size of the loan increases the banks charge lower interest rates. Similarly, the longer the maturity the lower the interest rates. With respect to borrower characteristics, higher wages are related to lower interest rates, as expected. Interest rates are lower for males and younger borrowers. When borrower risk increases interest rates fall, which is a counterintuitive result.

Table 5: Estimation Results of Interest Rates Determination Using Microdata.

Dependent variable	Interest rate
Collateral	-0.283***
	(0.0465)
Loan size	-0.427***
	(0.0164)
Maturity	-0.073***
	(0.006)
Wages	-0.127***
	(0.0113)
Gender	-0.027***
	(0.0047)
Age	0.007***
	(0.0007)
Borrower risk	-0.138***
	(0.0342)
Intercept	21.888***
	(0.2683)
N	2,499,607
R-squared	0.456

Notes: Regression of interest rate on collateral, size, maturity, wages, gender, age and borrower risk using quarterly data from 2010 to 2020, with time fixed effects of the 4-digit ISIC industry of the firm for which the borrower works, region fixed effects, bank time fixed effects, and with industry-bank fixed effects, and robust standard errors clustered at the 4-digit SIC industry level. ***p<0.01, **p<0.05 and *p<0.1. Standard error in parentheses.

Robustness Test Panel Regression Analysis on Interest Rate Determination

Table 6: Mortgage Interest Rate - Robustness: Progressively Saturated Models.

Variable	Mortgage interest rate				
	(1)	(2)	(3)	(4)	(5)
Collateral	-0.574***	-0.545***	-0.496***	-0.301***	-0.283***
	(0.0656)	(0.0650)	(0.0585)	(0.0431)	(0.4651)
Observations	2,503,665	2,503,186	2,503,072	2,499,859	2,499,607
R-squared	0.1373	0.1404	0.1704	0.4289	0.4558
Loan controls	YES	YES	YES	YES	YES
Borrower controls	NO	YES	YES	YES	YES
Macro controls	NO	NO	YES	NO	NO
Industry*time FE	NO	NO	NO	YES	YES
Bank*time FE	NO	NO	NO	YES	YES
Region FE	NO	NO	NO	NO	YES
Industry*bank FE	NO	NO	NO	NO	YES

Notes: Regressions using quarterly data from 2010Q1 to 2020Q4. Loan controls include collateral, maturity and size; Borrower controls include wages, risk, gender and age; Macro controls include lagged values of GDP yearly growth rate, yearly inflation rate and of the lagged monetary policy rate. Robust standard errors clustered at the 4-digit ISIC industry level. ***p <0.01, **p<0.05 and *p<0.1. Standard error in parenthesis.

We perform robustness checks to validate the findings in Table 6. This is, the influence of collateral on the mortgage interest rate is negative and significant, and this result is not sensitive to alternative model specifications. In Table 6 we show coefficients under progressively saturated models. In column 1, we employ just loan controls, which are a minimal set of controls. Next, we augment the model by introducing borrower characteristics, column 2, and the coefficient on collateral

remains like baseline regression. In column 3 we add macroeconomic controls including lagged annual GDP growth, annual inflation rate and lagged monetary policy interest rate. Then, we introduce industry*time and bank*time fixed effects in column 4. Afterwards, we add region and industry*bank fixed effects, and our baseline equation (5) results, presented in a desegregated form in Table 5, is reproduced in column (5). An important observation of our results is that when we introduce industry*time and bank*time fixed effects, the R-squared jumps from 17% to 43% from column (3) to (4). This highlights the importance of controlling the demand for credit and the credit channel.

Difference-in-Difference Analysis on the Effect "My House Now" Policy Reform

Our main results for equation (6) are depicted in Table 7. Our main coefficient of interest is β_2 and it is positive and significant with value of 0.014. After the implementation of the policy, the VIS disbursements increased more than the No-VIS with a difference of 1.014%. With respect to the socio-economic variables, which were part of the policy, the incidence of wages during the whole period was positive and significant, but after the policy the incidence was negative and significant, which shows that after the policy wages lost importance. With respect to gender, after the policy the females credit increased with respect to males comparing with before the policy, as expected. For age, the post-policy coefficient is negative, which implies that older individuals receive less credit. Finally, banks were more stringent with respect to borrower risk after the policy.

Robustness on the Difference-in-Difference analysis of the effect "My House Now" policy Reform

First, we performed alternative model specifications. Table 8 presents the β_2 coefficient for different specifications of the model starting with only the horse-racing with loan controls, adding horse-racing with borrower controls, the horse-racing with macroeconomic controls, and different fixed effects. The coefficient is positive and significant and the most saturated specification corresponding to our baseline model is column (5). As we progressively saturate the model the R-squared increases. Particularly when bank*time fixed effects are included, R-squared jumps from 0.52% to 0.63%. There is some literature on product bundling, so this possibility means some of the heterogeneity in rates caused by bank fixed effects could be explained by customer-bank relationships. Perhaps banks in which a client has an existing current/saving account, for example, provide better terms with respect to mortgages. Next, we further inspect the validity of the parallel trend assumption as our analysis corresponds to a diff-in-diff. In practice, we estimate the following equation:

(7) $$D_{ibt} = \sum_{t \neq 2023Q1}(\beta_t VIS_t + \alpha_t X_{ibt-1} + \gamma_t Y_{ibt-1}) + \delta_I + \delta_b + \delta_{It} + \delta_{rt} + \delta_{Ib} + \epsilon_{ibt}$$

Table 7: Effect of Subsidy Housing Policy on Credit Supply.

Dependent variable	Ln (Disbursement)
Post*VIS	0.014***
	(0.0034)
Collateral	-0.460***
	(0.0078)
Post*Collateral	-0.010***
	(0.0038)
Maturity	0.005***
	(0.0006)
Post*Maturity	-0.0003
	(0.0003)
Wages	0.167***
	(0.0116)
Post*Wages	-0.024***
	(0.0038)
Borrower risk	-0.012***
	(0.0033)
Post*Borrower risk	-0.088***
	(0.0095)
Gender	0.049***
	(0.0051)
Post*Gender	-0.009***
	(0.0035)
Age	0.0004
	(0.0005)
Post*Age	-0.001***
	(0.0002)
Intercept	17.080***
	(0.1560)
N	774,084
R-squared	0.63

Notes: Regression of disbursements on collateral, maturity, wages, gender, age and borrower risk using quarterly data from 2022Q1 to 2024Q1, with 4-digit ISIC industry fixed effects, industry*time fixed effects, region*time fixed effects, bank*time fixed effects, and industry*bank fixed effects. Robust standard errors clustered at the 4-digit ISIC industry level. ***p<0.01, **p<0.05 and *p<0.1. Standard error in parentheses.

Figure 7 depicts the time variant coefficient of the treatment effect (relative to a baseline, fixed at zero, for 2023Q1), obtained from the estimation of regression (7). A validation of the parallel trend's assumption requires that coefficients be about zero before the impact in 2023Q1 and positive after. Indeed Figure 7 suggests that before the change in subsidy policy the coefficients are statistically zero, especially between 2022Q2 and 2023Q1, and after the implementation of the policy, the coefficients are markedly positive, especially between 2023Q3 and 2024Q1.

Table 8: Disbursements - Robustness: Progressively Saturated Models

Variable	Ln (Disbursement)				
	(1)	(2)	(3)	(4)	(5)
Post*VIS	0.059***	0.040***	0.039***	0.039***	0.014***
	(0.0047)	(0.0045)	(0.0045)	(0.0045)	(0.0034)
Observations	776,031	774,770	774,770	774,283	774,084
R-squared	0.4375	0.5143	0.5148	0.5167	0.6326
Loan controls*POST	YES	YES	YES	YES	YES
Industry FE	YES	YES	YES	NO	YES
Borrower controls*POST	NO	YES	YES	YES	YES
Macro controls*POST	NO	NO	YES	NO	NO
Industry*time FE	NO	NO	NO	YES	YES
Bank*time FE	NO	NO	NO	NO	YES
Region*time FE	NO	NO	NO	NO	YES
Industry*bank FE	NO	NO	NO	NO	YES

Notes: Regressions using quarterly data from 2022Q1 to 2024Q1. Loan controls include collateral, maturity and size; Borrower controls include wages, risk, gender and age; Macro controls include lagged values of GDP yearly growth rate, yearly inflation rate and of the lagged monetary policy rate. Robust standard errors clustered at the 4-digit ISIC industry level. ***p<0.01, **p<0.05 and *p<0.1. Standard error in parentheses.

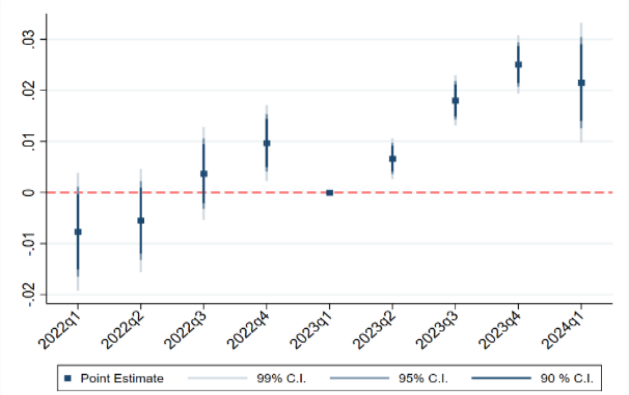


Figure 7: Parallel Trends Assumption.
Notes: This figure shows the time variant coefficient β_t resulting from the following regression:

$$D_{ibt} = \sum_{t \neq 2023Q1} (\beta_t VIS_t + \alpha_t X_{ibt-1} + \gamma_t Y_{ibt-1}) + \delta_I + \delta_b + \delta_{It} + \delta_{rt} + \delta_{Ib} + \epsilon_{ibt}$$

The dependent variable corresponds to the ln of loan disbursements. VIS corresponds to a dummy variable that takes the value of 1 for the individual with subsidy and No-VIS corresponds to 0. Loan characteristics are represented by X_{ibt}, and include maturity and collateral. Borrower characteristics by Y_{ibt}, include wages, gender, age and borrower risk. We also saturate the model with 4-digit ISIC industry fixed effects δ_I, bank fixed effects δ_b, industry*time fixed effects δ_{It}, region*time fixed effects δ_{rt}, and industry*bank fixed effects δ_{Ib}. Finally, ϵ_{ibt} is an error term. We cluster the standard errors at the four-digit ISIC industry level

Conclusion

In this paper we selected the best GARCH model for the spread volatility of the mortgage interest at the macroeconomic level, analyzed the determinants of the mortgage interest rate at the microlevel data and estimated the effect of a housing policy reform on the supply of credit in Colombia. Our main findings are that, as predicted by the financial accelerator theory of Bernanke et al. (1999) and the risk-taking theory of Adrian et al. (2010), collateral drives the behavior of mortgage interest rate spreads and its relationship with the output growth is an important factor to consider when modeling the volatility of this spread. The selected GARCH model was a GARCH (1,1) with output growth, in line with the findings of Gordon (2023). The level and the slope of the treasury bonds are not statistically significant, contrary to the findings of Batten et al. (2014) for the case of callable corporate bonds in Canada. Moreover, collateral, the size of the loans, their maturity, the borrowers wage, age, risk, and gender, present the expected relationship with the mortgage interest rate at a micro level. Finally, with respect to the effect of a change in the policy of the focalization of housing subsidies of "My House Now" in April of 2023, the result is that after the implementation of the policy, the VIS disbursements increase more than the No-VIS with a difference of 1.014%.
The main policy implications of these findings are that policy makers should take in account the evolution of output growth to reduce the volatility of mortgage spread; that for financial stability purposes, collateral is a variable that should be regulated and that a macroprudential policy in the housing market could be the change of the focalization of subsidies. A research aspect for future studies could be the analysis of the subsidies for a longer period of time when the data is available.

Acknowledgments

We are grateful for the comments of Peter Ireland, Paul Soto and Juan Esteban Carranza.

Funding Sources

This research did not receive any specific grant from funding agencies in the public, commercial or non-profit sectors.

References

Abreu, D., Félix, S., Oliveira, V., & Silva, F. (2024). The impact of a macroprudential borrower-based measure on households' leverage and housing choices. *Journal of Housing Economics, 64*, 101995. doi: https://doi.org/10.1016/j.jhe.2024.101995

Adrian, T., & Shin, H. S. (2008). Financial intermediaries, financial stability, and monetary policy. *FRB of New York staff report*, (346), 39. doi: http://dx.doi.org/10.2139/ssrn.1266714

Adrian, T., & Shin, H. S. (2010). Liquidity and leverage. *Journal of financial intermediation, 19*(3), 418-437. doi: https://doi.org/10.1016/j.jfi.2008.12.002

Aoki, K., Proudman, J., & Vlieghe, G. (2004). House prices, consumption, and monetary policy: a financial

accelerator approach. *Journal of financial intermediation, 13*(4), 414-435. doi: https://doi.org/10.1016/j.jfi.2004.06.003

Batten, J. A., Jacoby, G., & Liao, R. C. (2014). Corporate yield spreads and real interest rates. *International Review of Financial Analysis, 34*, 89-100. doi: https://doi.org/10.1016/j.irfa.2014.05.009

Bernanke, B. S., Gertler, M., & Gilchrist, S. (1999). Chapter 21 The financial accelerator in a quantitative business cycle framework. In J. B. Taylor & M. Woodford (Eds.), *Handbook of Macroeconomics* (1sted ed., Vol. 1, pp. 1341-1393). Elsevier. doi: https://doi.org/10.1016/S1574-0048(99)10034-X

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of econometrics, 31*(3), 307-327. doi: https://doi.org/10.1016/0304-4076(86)90063-1

Carranza, J. E., & Navarro, S. (2010). Estimating dynamic models with aggregate shocks and an application to mortgage default in Colombia. *Universidad Icesi Department of Economics Research Paper,* (24), 46. doi: http://doi.org/10.2139/ssrn.1628279

Corporation, F. D. I. (2017). Origins of the crisis. In F. D. I. Corporation (Ed.), *Crisis and response: An FDIC history, 2008-2013* (1st ed ed., pp. 3-32). FDIC. Retrieved from https://www.fdic.gov/publications/crisis-and-response-fdic-history-2008-2013

Fabiani, A., Piñeros, M. L., Peydró, J.-L., & Soto, P. E. (2022). Capital controls, domestic macroprudential policy and the bank lending channel of monetary policy. *Journal of International Economics, 139*, 103677. doi: https://doi.org/10.1016/j.jinteco.2022.103677

Gertler, M., Gilchrist, S., & Natalucci, F. M. (2007). External constraints on monetary policy and the financial accelerator. *Journal of Money, credit and Banking, 39*(2-3), 295-330. doi: https://doi.org/10.1111/j.0022-2879.2007.00027.x

Gilchrist, S., & Zakrajšek, E. (2012). Credit spreads and business cycle fluctuations. *American economic review, 102*(4), 1692-1720. doi: https://doi.org/10.1257/aer.102.4.1692

Gordon, G. (2023). Mortgage Spreads and the Yield Curve. *Richmond Fed Economic Brief, 23*(27). Retrieved from https://www.richmondfed.org/publications/research/economic_brief/2023/eb_23-27

Hall, R. E. (2011). The high sensitivity of economic activity to financial frictions. *The Economic Journal, 121*(552), 351-378. doi: https://doi.org/10.1111/j.1468-0297.2011.02421.x

Jiménez, G., Ongena, S., Peydró, J.-L., & Saurina, J. (2012). Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review, 102*(5), 2301-2326. doi: https://doi.org/10.1257/aer.102.5.2301

Jiménez, G., Ongena, S., Peydró, J. L., & Saurina, J. (2014). Hazardous times for monetary policy: What do twenty-three million bank loans say about the effects of monetary policy on credit risk-taking? *Econometrica, 82*(2), 463-505. doi: https://doi.org/10.3982/ECTA10104

Khwaja, A. I., & Mian, A. (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *American Economic Review, 98*(4), 1413-1442. doi: https://doi.org/10.1257/aer.98.4.1413

Kim, J.-M., Kim, D. H., & Jung, H. (2021). Estimating yield spreads volatility using GARCH-type models. *The North American Journal of Economics and Finance, 57*, 101396. doi: https://doi.org/10.1016/j.najef.2021.101396

Kiyotaki, N., & Moore, J. (1997). Credit cycles. *Journal of political economy, 105*(2), 211-248. doi: https://doi.org/10.1086/262072

Liow, K. H., & Addae-Dapaah, K. (2010). Idiosyncratic risk, market risk and correlation dynamics in the US real estate investment trusts. *Journal of Housing Economics, 19*(3), 205-218. doi: https://doi.org/10.1016/j.jhe.2010.06.001

López, M. (2006). House prices and monetary policy in Colombia. *Revista ESPE, 24*(50), 212-241. Retrieved from https://ideas.repec.org/a/col/000107/007498.html

López, M., Tenjo, F., & Zárate, H. (2011). The risk-taking channel and monetary transmission mechanism in Colombia. *Ensayos sobre política económica, 29*(SPE64), 212-234. Retrieved from https://ideas.repec.org/a/col/000107/009446.html

Nelson, D. B. (1991). Conditional heteroskedasticity in asset returns: A new approach. *Econometrica: Journal of the econometric society*, 347-370. doi: https://doi.org/10.2307/2938260

Ramírez Sierra, G. D., González Martínez, A. A., Monroy Cruz, M. Á., & Zapata Barrientos, L. G. (2024). The impact of subsidies on house prices in Mexico's mortgage market for low-income households 2008–2019. *Journal of Housing Economics, 63*, 101970. doi: https://doi.org/10.1016/j.jhe.2023.101970

Rey Hernández, M. (2023). Efecto de los subsidios de vivienda del programa" Mi Casa Ya" sobre el mercado de vivienda de interés social en Colombia (2015-2021). *Universidad de los Andes*, 1-36. Retrieved from http://hdl.handle.net/1992/67509

Vargas, H., Hamann, F., & González, A. (2010). Efectos de la política monetaria sobre las tasas de interés de los créditos hipotecarios en Colombia. *Desarrollo y sociedad, 1*(66), 45-64. doi: https://doi.org/10.13043/dys.66.2