

# BORRADORES DE ECONOMÍA



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mortgage spread volatility and  
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## 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 have not been investigated enough. We ask the questions: Which are the determinants of the mortgage interest rates at the micro level? What are the main determinants of mortgage interest rate spread and its volatility at the macro level? Is there room for macroprudential tools in the housing sector to improve financial stability in terms of credit growth? We analyze the mortgage interest rate using three datasets: the Data Register information from Colombia, an individual level social security dataset "PILA" and the data of country wide macroeconomic variables. Our findings are 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%. 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 1.02%. We found that a GARCH (1,1) model with output growth explains very well the spread volatility.

*JEL:* E12 G21 G17 C5 R380

**Keywords:** Multiplier accelerator, mortgage market, volatility forecasting, housing subsidies, econometric modelling.

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# Garantías, crecimiento del producto, volatilidad del diferencial hipotecario y subsidios en Colombia\*

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Las opiniones expresadas en este documento pertenecen únicamente a los autores y no representan aquellas del Banco de la República o su Junta Directiva. Los errores y omisiones en este trabajo son de responsabilidad de los autores

## Resumen

El sector de la vivienda es uno de los más relevantes en términos de estabilidad económica y financiera. Comprender su comportamiento puede prevenir burbujas y colapsos en la economía. Hay muchos estudios sobre los diferenciales de los bonos corporativos, pero los estudios sobre el diferencial de los tipos de interés hipotecarios y su volatilidad siguen siendo escasos. Del mismo modo, no se ha investigado lo suficiente el análisis de los subsidios al sector vivienda en diferentes dimensiones. Nos hacemos las preguntas: ¿Cuáles son los determinantes de las tasas de interés hipotecarias a nivel micro? ¿Cuáles son los principales determinantes del diferencial de tipos de interés hipotecarios y su volatilidad a nivel macro? ¿Hay margen para que las herramientas macroprudenciales en el sector inmobiliario mejoren la estabilidad financiera en términos de crecimiento del crédito? Analizamos la tasa de interés hipotecaria utilizando tres conjuntos de datos: la información del Registro de Datos de Colombia, un conjunto de datos de seguridad social a nivel individual "PILA" y los datos de variables macroeconómicas del país. Nuestros hallazgos son que la garantía es una variable importante que explica las tasas de interés hipotecarias, un aumento del 1% en la garantía disminuye la tasa de interés hipotecaria en 0.28%. El impacto de un cambio de focalización de los subsidios de vivienda en la asignación de los desembolsos de los beneficiarios respecto a las personas que no utilizan los subsidios es un aumento con una diferencia de 1.02%. Encontramos que un modelo GARCH (1,1) con crecimiento de la producción explica muy bien la volatilidad de los diferenciales.

*JEL:* E12 G21 G17 C5 R380

Palabras clave: Acelerador de multiplicadores, mercado hipotecario, pronóstico de volatilidad, subsidios a la vivienda, modelización econométrica.

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## 1. 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. The 2007-2009 crisis in the United States put forward this fact. 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. In both cases, the crises were preceded by housing prices bubbles. Housing market is very closely related to financial stability, therefore understanding its characteristics provide insights for macroprudential policy.

Moreover, housing has important levels of sector chaining backwards and forwards, which causes that the development in housing affects the performance of other sectors. 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, 2023). However, in recent years, especially during 2023, the sector has presented a downturn.

Our purpose in this document is threefold. First, establish 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, an individual level social security dataset, "PILA", a set of macroeconomic variables, and a variety of fixed effects. Second, 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. In the program called *Mi Casa Ya* 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 assignments according to the classification in the database of SISBÉN which has a more comprehensive definition of poverty. For example, the mothers

head of family and the displaced persons 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. Third, 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 developments 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 also 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.

There are some studies of the housing spread for advanced economies such as those by Liow and 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 and Zakrajsek (2012). Besides, to our knowledge, the housing interest rate spread has not been studied in Latin American countries. Regarding the literature of the effect of subsidies is scarce. However, Ramírez 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 effect. Our paper adds to this literature analyzing the change in the objective group of subsidies focalization on credit growth. In this way, answering the questions formulated above constitutes our main contribution to the empirical evidence on the spread and housing subsidies.

Furthermore, to answer these questions, we also base our analysis especially on the financial accelerator theory of Bernanke, Gertler and Gilchrist (1999) (BGG) and the most recent developments in the risk-taking theory of Adrian and Shin (2008, 2010). In our study, these theories are used for modelling the determinants of the housing interest rates, at the microeconomic level, and the housing spread based on output growth as a proxy variable for collateral, at the macroeconomic level. We also contribute to the empirical literature by

modeling the volatility spread based on its relationship with the level and the slope of the yield curve of the Colombian government bonds in a similar way presented by Liow and Addae-Dapaah (2010), and Gilchrist and Zakrajsek (2012).

Our main findings are as follows. First, using the microdata the mortgage interest rate is explained by the collateral, size, and maturity of the loans; wages, age, gender, and risk of the borrowers; and some macroeconomic variables. Particularly, a 1% increase in collateral causes an economically significant negative impact on the mortgage interest rate of 0.28%. Second, the effect of the modification in the policy of the subsidies of social interest housing was that the VIS disbursements increase more than the No-VIS with a difference of 1.02%. Third, for predicting the spread volatility, the GARCH (1, 1) with output growth model is preferred to an EGARCH (1, 1) with output growth, GARCH (1, 1), EGARCH (1, 1), TGARCH (1, 1) or PGARCH (1, 1) models. The forecasting capacity of the output growth goes in line with the relationship between collateral and GDP growth. Finally, the level and the slope of the yield curve of the government bonds on the predictability of the housing spread have a statistical significance very low.

We present robustness exercises to show that collateral has the expected sign and is significant independently from the specifications used in the regressions. We also present robust exercises for the effect of the change of the subsidies policy.

The paper proceeds as follows: Section 2 presents related literature. Section 3, the theoretical framework. Section 4, the stylized facts. Section 5 presents the econometric models and results for mortgage interest rate determination. In section 6 we present the change in subsidies policy effect. In section 7 we present the GARCH models specification and results. Section 8 presents our concluding remarks.

## 2. Related literature

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.

In line with the previous results, in an analysis for the United States during 1973-2010 with monthly firm data, Gilchrist and Zakrajsek (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 and find the expected relationship.

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 spreads 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 focusing 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 and 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, Gertler, and Gilchrist (1999) (BGG), Kiyotaki and Moore (1997), and Hall (2010), 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, Proudman, and Vlieghe (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 and 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, Tenjo and Zarate (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 of the effect of subsidies is scarce. However, Ramírez 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.

### 3. Theoretical framework

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 BGG (1999), Kiyotaki and Moore (1997), and Hall (2010), among others. Second, the more recent risk-taking theory, which explains the financial crises of 2007-2009, by Adrian and Shin (2008, 2010), and Jiménez et al. (2014).

According to BGG (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 and Shin (2008, 2010), as follows:

Denoting lending assets by  $A_l$ , other assets  $A_o$ , deposits  $D$  and equity  $E$ ,

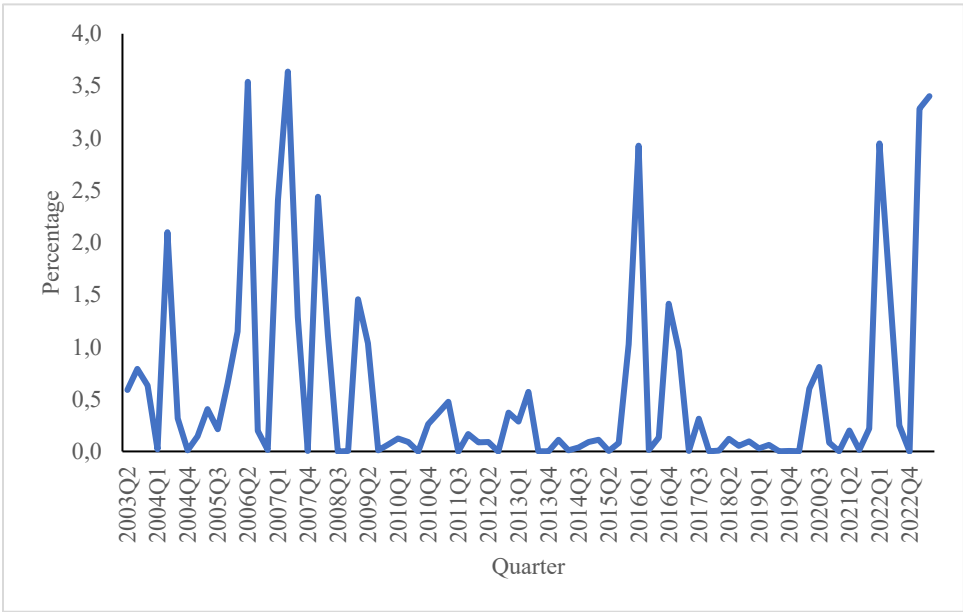
$$A_l + A_o = D + E$$

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.

4. Stylized facts

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 30-days deposits rate in line with the definition of spread of BGG. Graph 1 shows high spread volatility. This high volatility makes it difficult to forecast the spread, but with GARCH models it is possible to predict its volatility and assess the risk in the mortgage market.

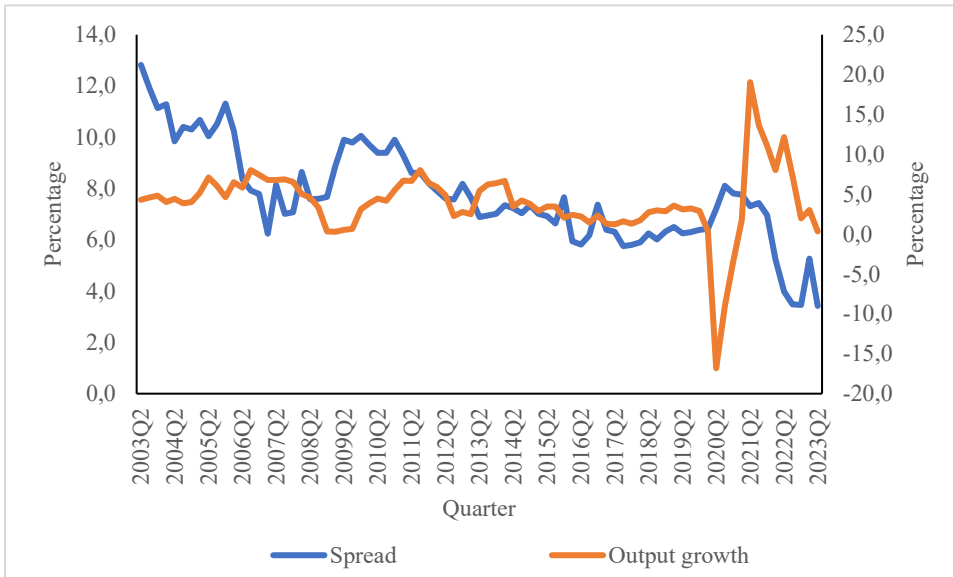
**Graph 1. Spread volatility in Colombia**  
**2003Q2 - 2023Q2**



Graph 2 presents the evolution of output and spread during the analyzed period. 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, for most of the time when output increases the spread falls during the period.

**Graph 2. GDP growth and spread in Colombia**

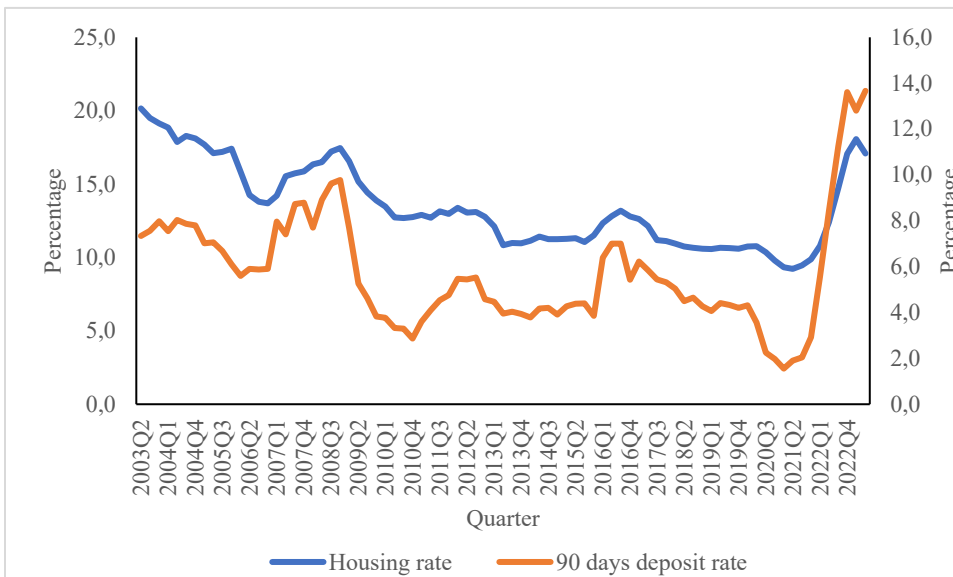
2003Q2- 2023Q2



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 evident positive correlation as presented in Graph 3.

**Graph 3. Interest rates in Colombia**

2003Q2- 2023Q2



## 5. Econometric models and results for the mortgage interest rate determination using microdata

In this section we present the estimations of the explanatory variables of the mortgage interest rate based on microdata.

### 5.1. Data and descriptive statistics

In this subsection we present the main determinants of the mortgage interest rate based on 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, “PILA” (*Planilla Integrada de Liquidación de Aportes*), 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.

In Table 1 we present the definition of the variables and descriptive statistics. 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 analyzed in the following section. 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 wages mean is 14.5 (which corresponds to CO\$ 1,982,759) with a standard deviation of 0.9. The borrower 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 standard deviation of 0.5.

**Table 1**  
**Descriptive statistics**

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

## 5.2. Empirical strategy

To assess the importance of collateral on mortgage interest rates we estimate the following regression at the loan level:

$$(1) R_{ibt} = \alpha_1 + \beta_1 \text{Collateral}_{ibt} + \beta_2 X_{ibt} + \beta_3 Y_{ibt} + \delta_{It} + \delta_{bt} + \delta_r + \delta_{Ib} + \epsilon_{ibt}$$

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  $\text{Collateral}_{ibt}$ , 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,  $\delta_{It}$ , and region fixed effects  $\delta_r$ . These fixed effects along with the borrower characteristics allow us to control for the demand of credit and isolate the supply of credit in

a similar way as (Khwaja and Mian, 2008)<sup>1</sup>. We also saturate the model with bank\*time fixed effects,  $\delta_{bt}$ , to control for the credit channel of monetary policy and with industry\*bank fixed effects,  $\delta_{ib}$ , to control for the time varying bank-industry relationship of the borrowers with the bank. Finally,  $\epsilon_{ibt}$  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.

### 5.3. Results

The results are presented in Table 2. 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. 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.

### 5.4. Robustness

We perform robustness checks to validate the findings in Table 2. 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 3 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 the baseline regression. In column 3 we add macroeconomic controls including lagged annual GDP growth, annual inflation rate

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<sup>1</sup> Jimenez et al. (2012, 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.

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 (1) results, presented in a desegregated form in Table 2, 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 for the demand of credit and the credit channel.

**Table 2. Estimation results 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

Note: 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 y \*p<0.1. Standard error in parentheses.

**Table 3. Mortgage interest rate - Robustness: Progressively saturated models**

Variable	Mortgage interest rate				
	(1)	(2)	(3)	(4)	(5)
Collateral	-0.574*** (0.0656)	-0.545*** (0.0650)	-0.496*** (0.0585)	-0.301*** (0.0431)	-0.283*** (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

Note: 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 y \* p < 0.1. Standard error in parenthesis.

## 6. Subsidies *Mi Casa Ya*

### 6.1. Institutional settings: Subsidies *Mi Casa Ya* to the housing sector in Colombia

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 *Fondo Nacional de Vivienda (Fonvivienda)* 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 *Vivienda Gratuita* aimed at the vulnerable population was created by Law 1537 of 2012, and the program of *Vivienda de Interés Prioritario para Ahorradores (VIPA)* 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 *Mi Casa Ya* 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, *Mi Casa Ya* is only aimed at *Vivienda de Interés Social VIS* (social interest housing) and not *Vivienda de Interés Prioritaria VIP* (priority interest housing). Subsequently, the *Mi Casa Ya* program is extended to three components *Mi Casa Ya - Cuota Inicial*, *Mi Casa Ya - Ahorradores* and *Mi Casa Ya - Subsidio a la Tasa de Interés*.

*Mi Casa Ya - Ahorradores* 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 *Mi Casa Ya - Ahorradores* list.

*Mi Casa Ya – Cuota Inicial* 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 *Mi Casa Ya - Subsidio a la Tasa de Interés* 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-Vivienda de Interés Social No VIS* (no- social interest housing) coverage is up to 2.5 p.p. of the credit.

During the second period 2014 - 2018, the *Vivienda Gratuita* 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.

By 2018, the *Mi Casa Ya* and *Vivienda Gratuita* programs were continued, and the programs *Semillero de Propietarios* and *Casa Digna Vida Digna* were launched.

In the first, the Government contributes a part of the rent and results in savings which are then used by the beneficiary to buy new housing with alternatives such as *Mi Casa Ya*.

The second seeks to reduce the housing deficit through 4 components: land titling, intra-household connections, finishes and structure, and transformation of neighborhoods.

In the first year of government, the subsidies of *Mi Casa Ya* 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.

During 2023-2024, with Decree 490 of 4 of April of 2023, the Government makes modifications to the *Mi Casa Ya* program. The focalization of the program was changed. Households that acquire social interest housing and are classified between groups A1 and C8 of *SISBÉN 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 *SISBÉN IV*, are assigned a subsidy up to the amount equivalent to 20 smmlv.

In addition, the Government, through the *Fondo de Reserva para la Estabilización de la Cartera Hipotecaria* (Fund for the Mortgage Bank of the Republic), offers rate coverage that facilitates 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 *Fonvivienda*. 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 *Mi Casa Ya*, in this document we evaluate the impact of the reform on sales, approximated by housing disbursements using microdata.

6.2. Data and summary statistics

Graph 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.

**Graph 4. Housing VIS, No-VIS credit growth, 2022Q2-2024Q1**

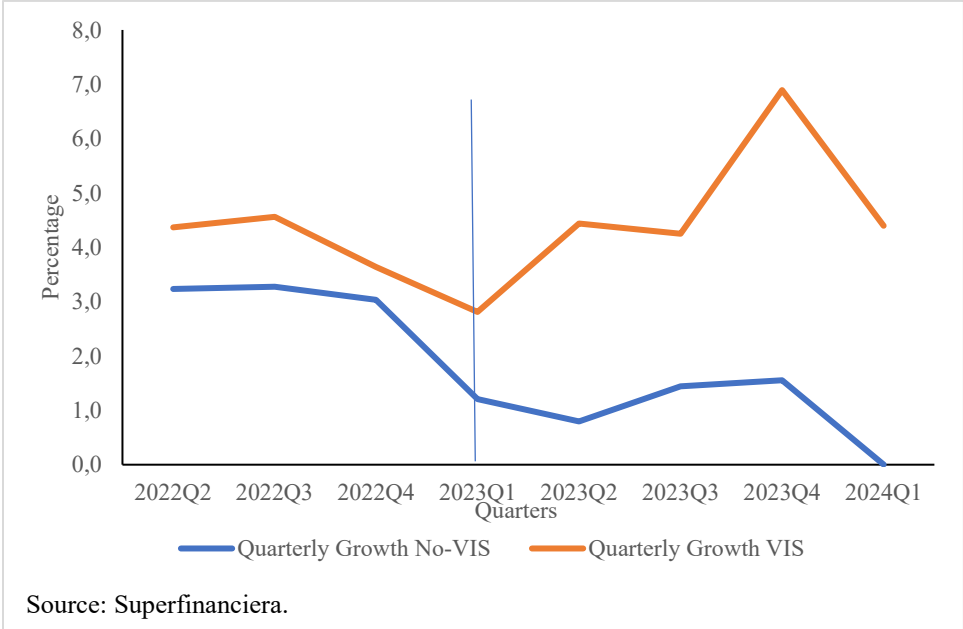


Table 4 presents the descriptive statistics of the variables for the housing sector divided into individuals with housing subsidies (VIS) and those without (No-VIS). We present the

summary for the same variables that we considered in the previous section which are related to the supply of credit. 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 as long as the demand of credit depends of factors related to the evolution of financial conditions of borrowers. The number of total 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 (\$66,986,389) than for No-VIS individuals (\$156,724,493). The average wage of borrowers that receive the subsidy is \$860,246, while for those that do not receive it is \$1,763,680. The mean of borrower's risk for VIS individuals is higher than for No-VIS individuals, respectively with 0,10 and 0.08.

**Table 4. Descriptive statistics housing policy**

Variable	Description	N	Mean	Std. Dev.	Min.	Max.
<b>VIS</b>						
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	Wages	305,640	860,246	865,269	250	2.73e+07
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
<b>No VIS</b>						
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	Wages	480,116	1,763,680	2,243,276	0	7.64e+07
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

### 6.3. Empirical strategy

We investigate the effect of *Mi Casa Ya* policy reform of April 2023 on VIS versus No-VIS disbursements with Data Register, PILA, and macroeconomic information from 2022Q1 to 2024Q1. We use a diff-in-diff approximation with the following regression:

$$(2) D_{ibt} = \beta_1 + \beta_2 VIS_{ibt} * Post_t + \beta_3 X_{ibt-1} + \beta_4 X_{ibt-1} * Post_t + \beta_5 Y_{ibt-1} + \beta_6 Y_{ibt-1} * Post_t + \delta_I + \delta_{It} + \delta_{rt} + \delta_{bt} + \delta_{Ib} + \epsilon_{ibt}$$

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  $X_{ibt}$ , and borrower characteristics by  $Y_{ibt}$ . To control for loan and borrower characteristics that might be driving the differences in outcomes of pre vs post VIS shock, we horse-race  $POST * X_{ibt}$ , and  $POST * Y_{ibt}$ . We also saturate the model with 4-digit ISIC industry fixed effects  $\delta_I$ , industry\*time fixed effects  $\delta_{It}$ , and region\*time fixed effects  $\delta_{rt}$  to control for the unobserved demand of credit; bank\*time fixed effects  $\delta_{bt}$ , to control for the credit channel of monetary policy; and industry\*bank fixed effects  $\delta_{Ib}$  to control for the variation in industry of bank-borrower relationships. Finally,  $\epsilon_{ibt}$  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.

**Table 5. Subsidy housing policy**

Dependent variable	Ln (Disbursement)
Post*VIS	0.02*** (0.0044)
Collateral	-0.468*** (0.0073)
Post*Collateral	-0.009*** (0.0037)
Maturity	0.005*** (0.0005)
Post*Maturity	-0.0003 (0.0003)
Wages	7.79e-10 (2.18e-09)
Post*Wages	-0.79e-10 (2.43e-09)
Borrower risk	-0.066*** (0.0070)
Post*Borrower risk	-0.034*** (0.0110)
Gender	0.044*** (0.0051)
Post*Gender	-0.010*** (0.0035)
Age	0.0001 (0.0004)
Post*Age	-0.001*** (0.0002)
Intercept	19.187*** (0.0194)
N	775,317
R-squared	0.64

Note: Regression of interest rate on collateral, maturity, wages, gender, age and borrower risk using quarterly data from 2022Q1 to 2024Q1, with 4-digit ISIC industry fixed effect, 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 y \*p<0.1. Standard error in parentheses.

Our main coefficient of interest is  $\beta_2$  which corresponds to the impact of the subsidy policy on disbursements. Considering Graph 4 the expected sign is positive after controlling for the demand of credit and the bank-lending channel.

#### 6.4. Results

Our main results are depicted in Table 5. Our main coefficient of interest is  $\beta_2$  and is positive and significant with value of 0.02. After the implementation of the policy, the VIS disbursements increase more than the No-VIS with a difference of 1.02%.

With respect to the socio-economic variables, which were part of the policy, the incidence of wages before and after were not significantly different. 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.

#### 6.5 Robustness

##### 6.5.1 Alternative model specifications

Table 6 presents the  $\beta_2$  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.

**Table 6. Disbursements - Robustness: Progressively saturated models**

Variable	Ln (Disbursement)				
	(1)	(2)	(3)	(4)	(5)
Post*VIS	0.059*** (0.0047)	0.051*** (0.0048)	0.049*** (0.0046)	0.048*** (0.0047)	0.015*** (0.0044)
Observations	776,031	776,030	776,030	775,515	775,317
R-squared	0.4375	0.5180	0.5186	0.5204	0.6314
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

Note: 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 y \*p<0.1. Standard error in parentheses.

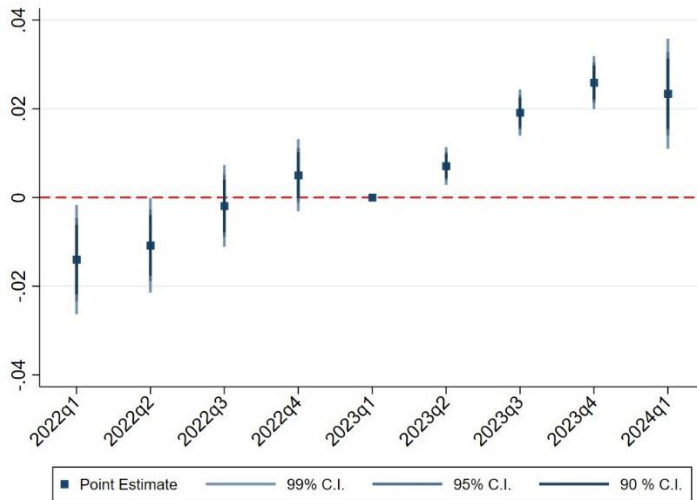
### 6.5.2. Parallel trends

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:

$$(3) D_{ibt} = \sum_{t \neq 2023Q1} (\beta_t VIS_t + \alpha_t X_{ibt-1} + \gamma_t Y_{ibt-1}) + \delta_l + \delta_b + \delta_{lt} + \delta_{rt} + \delta_{lb} + \epsilon_{ibt}$$

Graph 5 depicts the time variant coefficient of the treatment effect (relative to a baseline, fixed at zero, for 2023Q1), obtained from the estimation of regression (3). A validation of the parallel trend's assumption requires that coefficients be about zero before the impact in 2023Q1 and positive after. Indeed graph 5 suggests that before the change in subsidy policy the coefficients are statistically zero, specially between 2022q2 and 2023q1, and after the implementation of the policy, the coefficients are markedly positive, around 0.02, specially between 2023q3 and 2024q1.

**Graph 5. Parallel trends assumption**



This graph 5 shows the time variant coefficient  $\beta_t$  resulting from the following regression:

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

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  $\delta_l$ , bank fixed effects  $\delta_b$ , industry\*time fixed effects  $\delta_{lt}$ , region\*time fixed effects  $\delta_{rt}$ , and industry\*bank fixed effects  $\delta_{lb}$ . Finally,  $\epsilon_{ibt}$  is an error term. We cluster the standard errors at the four-digit ISIC industry level.

## 7. GARCH models

In the section 5 we presented the evidence of the determinants of the mortgage interest rate based on microdata information from the Data Register of Colombia. 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 BGG (1999).

First, we provide some evidence of the relationship between the mortgage interest rate and the output growth at the regional level. When output grows, households' net-worth and collateral increases and interest rates decrease. The estimation at the regional level gives a macroeconomic estimation with some degree of cross-sectional variation. Second, we present the GARCH models in a more aggregate data at the country level.

### 7.1. Mortgage interest rate and the output growth at the regional level

Table 7 presents the estimation, at the regional level of 23 Departments of mortgage interest rate against output growth and borrower risk with region and time fixed effects to control for the demand of credit. The results show that there is a negative and significant relationship between the mortgage interest rate and output growth as expected by the financial accelerator theory. The relation with borrower risk is positive.

**Table 7. Estimation results at the regional level**

Dependent variable	Interest rate
Output growth	-0.014*** (0.0055)
Borrower risk	0.634 (0.4329)
Intercept	10.846*** (0.1979)
N obs	299
R-squared	0.8727

Note: Regression of interest rate on output growth, and borrower risk, with region and time fixed effects. The sample is from 2011 to 2023 for 23 states including Bogota D.C. Robust standard errors. \*\*\* p < 0.01, \*\* p < 0.05 y \* p < 0.1. Standard error in parentheses.

## 7.2. GARCH models

Next, we present the econometric evidence using the GARCH models for 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 variable, for GARCH, TGARCH, EGARCH and PGARCH specifications.

### 7.2.1. GARCH

Bollerslev (1986) suggests the following GARCH model:

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

The distribution of the disturbance's conditional on the information at time  $t$ ,  $\psi_t$ , is assumed to be:

$$\epsilon_t | \psi_t \sim N(0, \sigma_t^2)$$

Where the conditional variance is:

$$(4) \quad \sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \alpha_2 \epsilon_{t-2}^2 + \dots + \alpha_q \epsilon_{t-q}^2 + \delta_1 \sigma_{t-1}^2 + \delta_2 \sigma_{t-2}^2 + \dots + \delta_p \sigma_{t-p}^2$$

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:

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

### 7.2.2. EGARCH (exponential GARCH)

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

$$(5) \quad \ln \sigma_t^2 = \alpha_0 + \alpha_1 \frac{|\epsilon_{t-1}|}{\sqrt{\sigma_{t-1}^2}} + \alpha_2 \frac{|\epsilon_{t-2}|}{\sqrt{\sigma_{t-2}^2}} + \dots + \alpha_q \frac{|\epsilon_{t-q}|}{\sqrt{\sigma_{t-q}^2}} \\ + \delta_1 \ln \sigma_{t-1}^2 + \delta_2 \ln \sigma_{t-2}^2 + \dots + \delta_p \ln \sigma_{t-p}^2$$

The EGARCH model has the following restrictions:

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

### 7.2.3 TGARCH (threshold GARCH)

In this case the conditional variance corresponds to:

$$(6) \quad \sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \alpha_2 \epsilon_{t-2}^2 + \dots + \alpha_q \epsilon_{t-q}^2 + \delta_1 \sigma_{t-1}^2 + \delta_2 \sigma_{t-2}^2 + \dots + \delta_p \sigma_{t-p}^2 \\ + \gamma_1 \epsilon_{t-1}^2 \Gamma_1 + \gamma_2 \epsilon_{t-2}^2 \Gamma_2 + \dots + \gamma_q \epsilon_{t-q}^2 \Gamma_q$$

With:

$$\Gamma_l = 1 \text{ if } \epsilon_t < 0$$

$$\Gamma_l = 0 \text{ otherwise}$$

For positive  $\Gamma_l$ , the incidence of negative news shocks over volatility is positive.

### 7.2.4. PGARCH (power GARCH)

The conditional variance of the power GARCH is:

$$(7) \quad \sqrt{\sigma_t^2}^\lambda = \alpha_0 + \alpha_1 |\epsilon_{t-1}|^\lambda + \alpha_2 |\epsilon_{t-2}|^\lambda + \dots + \alpha_q |\epsilon_{t-q}|^\lambda \\ + \delta_1 \sqrt{\sigma_{t-1}^2}^\lambda + \delta_2 \sqrt{\sigma_{t-2}^2}^\lambda + \dots + \delta_p \sqrt{\sigma_{t-p}^2}^\lambda$$

Where  $\lambda > 0$

### 7.3. Model selection and estimations of GARCH models

In Table 8 we present the Akaike information criterion (AIC) results of the regressions, which are used for the 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.<sup>2</sup>

**Table 8. 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	-83.1600	-88.4684	-87.5243	-86.1036	-83.1600	-84.0341
AIC	2.2639	2.1925	2.2846	2.2742	2.20400	2.2259

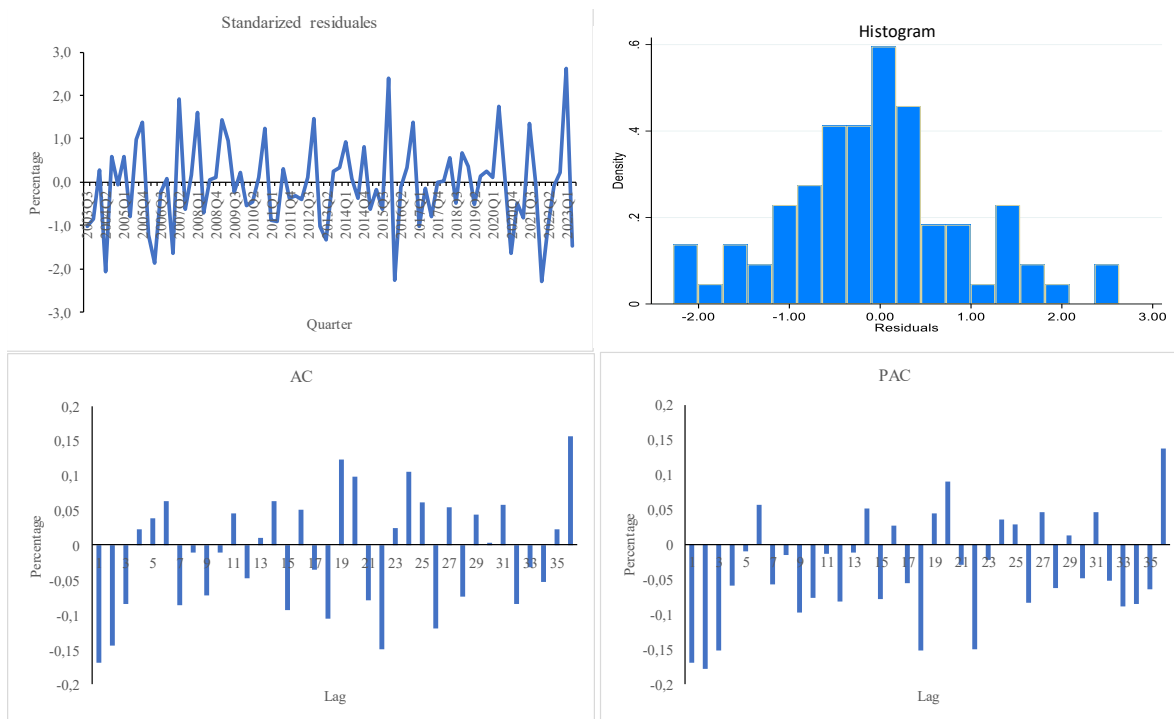
We selected a GARCH (1,1) with independent variable lagged output growth, and the results of the regression are shown in column (1) of Table 9.

Graph 6 present 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 in all the regressions<sup>3</sup>.

<sup>2</sup> Using the AIC we also determined the order of each GARCH.

<sup>3</sup> Diagnostics for the other models are provided upon request.

**Graph 6. 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  $\epsilon_{t-1}^2$  and the  $\sigma_{t-1}^2$  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 and Zakrajsek (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 9. GARCH (1,1) with output growth, and level and slope of treasury bonds**

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

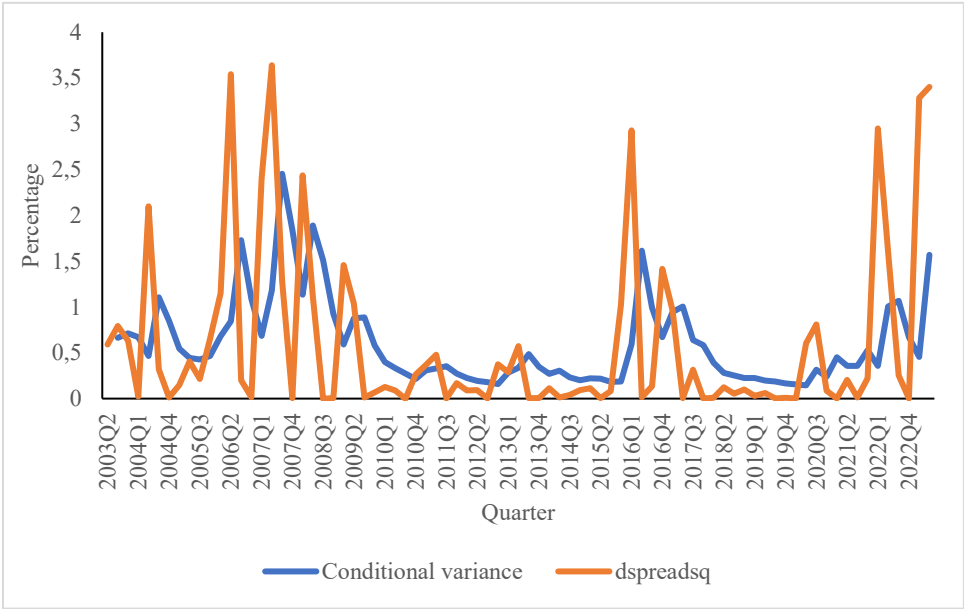
\*\*\* p<0.01, \*\*p<0.05 y \*p<0.1. Standard error in parentheses.

In column (2) of Table 9 we present, following Batten et al. (2014) and Gilchrist and Zakrajsek (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 9 is shown 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 sum less than one. Output growth has the expected sign and is statistically significant. The difference of 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.

**Graph 7 Conditional variance of GARCH (1, 1)-GDPG  
2003Q2- 2023Q2**



In Graph 7 is shown the relation 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.

## 8. Concluding remarks

In this paper we analyze the determinants of the mortgage interest rate at the microlevel data and select the best GARCH to model the spread volatility of the mortgage interest at the macroeconomic level. Our main findings are that, as predicted by the financial accelerator theory of BGG (1999) and the risk-taking theory of Adrian and Shin (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 size of the loans, their maturity, the borrowers wage, age, risk, and gender, present the expected relationship with the spread at a micro level. The selected GARCH model was a GARCH (1,1) with output growth. The level and the slope of the treasury bonds also present the correct signs although they are not statistically significant. From a macroprudential point of view, the evidence presented here suggests that limits to leverage ratios of household's indebtedness are important tools for avoiding financial instability. In addition, we analyzed the effect of a change in the policy of the focalization of housing subsidies of *Mi Casa Ya* 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 1.02%.

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