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# The pass-through of the monetary policy rate into lending rates in Mexico

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# THE PASS-THROUGH OF THE MONETARY POLICY RATE INTO LENDING RATES IN MEXICO

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By Alessandro Maravalle and Alberto Gonzalez Pandiella



Authorised for publication by Isabell Koske, Acting Director, Country Studies Branch, Economics Department.



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**ABSTRACT/RÉSUMÉ**

**The pass-through of the monetary policy rate into lending rates in Mexico**

This paper estimates the pass-through of monetary policy rates into five lending rates in Mexico using auto regressive distributed lags models (ARDLs) and taking into account several financial market characteristics. Results show that the pass-through of monetary policy into the average short-term lending rate is full and fast, as it takes around 3 months to be fully transmitted. However, the pass-through is heterogeneous across credit markets, being especially weak in the mortgage and automotive credit markets. A higher market concentration in the credit sector is associated with a higher level of the corresponding lending rate. Other financial market characteristics, such as the measure of bank profitability and the ratio of capital to bank assets, are also found to affect the long-run level of one or more lending rates. Higher competition in credit markets and reducing asymmetric information would improve the transmission of monetary policy and contribute to reduce the level of lending rates.

Key words: monetary policy, transmission mechanism, interest rate pass-through, bank lending rates.
JEL codes: E4, E52, G21.
This Working Paper relates to the 2022 Economic Survey of México
https://www.oecd.org/economy/mexico-economic-snapshot/.

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**La répercussion du taux de politique monétaire sur les taux débiteurs au Mexique**

Ce document estime la transmission des taux de la politique monétaire à cinq taux de prêt au Mexique en utilisant des modèles à retards distribués autorégressifs (ARDL) et en tenant compte de plusieurs caractéristiques du marché financier. Les résultats montrent que la transmission de la politique monétaire au taux moyen des prêts à court terme est complète et rapide, puisqu'il faut environ trois mois pour qu'elle soit complète. Cependant, la transmission est hétérogène entre les marchés du crédit, étant particulièrement faible sur les marchés du crédit hypothécaire et automobile. Une plus grande concentration du marché dans le secteur du crédit est associée à un niveau plus élevé du taux débiteur correspondant. D'autres caractéristiques des marchés financiers, telles que la mesure de la rentabilité des banques et le ratio capital/actifs bancaires, affectent également le niveau à long terme d'un ou de plusieurs taux débiteurs. Une concurrence accrue sur les marchés du crédit et la réduction de l'asymétrie d'information amélioreraient la transmission de la politique monétaire et contribueraient à réduire le niveau des taux débiteurs.

Mots clés: politique monétaire, transmission aux taux bancaires des modifications des taux directeurs, taux de prêts bancaires.
Codes: E4, E52, G21.
Ce document de travail est lié à l'Étude économique de l'OCDE de 2022 consacrée au Mexique
https://www.oecd.org/fr/economie/mexique-en-un-coup-d-oeil/.

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# The pass-through of the monetary policy rate into lending rates in Mexico

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## Introduction

The pass-through of monetary policy rates into bank lending rates (pass-through henceforth) is the first step of the interest rate channel of monetary policy transmission. The higher the proportion of a change in the monetary policy rate that is transmitted into lending rates (strength of the pass-through) and the faster lending rates adjust (speed of adjustment), the more relevant is the interest rate channel. By modifying the funding costs of banks, monetary policy affects aggregate demand as changes in cost and supply of bank credit affect consumption and investment decisions of bank credit-dependent borrowers. This paper estimates the impact of changes in the monetary policy rate into five bank lending rates over the last two decades in Mexico. How changes in these lending rates affect aggregate demand, however, goes beyond the scope of the analysis.

In the last two decades the relevance of the bank lending channel in the transmission of monetary policy in Mexico has gradually increased along with the interest rate channel and, to even a larger extent, the inflation expectation channel (Sidaoui and Ramos-Francia, 2008[1]; Banxico, 2016[2]). A credible inflation targeting commitment has helped diminish the level, volatility and persistence of inflation, thus reducing the risk of fiscal dominance and enhancing the ability of monetary policy to shape inflation expectations. During the same period, the exchange rate channel has instead progressively lost importance (Sidaoui and Ramos-Francia, 2008[1]; Banxico, 2016[2]).

This paper estimates auto regressive distributed lags models (ARDLs) to measure the pass-through of monetary policy rates into the following lending rates: i) the average bank lending rate, which is the average bank rate that usually meets the short- and medium-term financing needs of the private sector; ii) the mortgage rate; iii) the credit card rate, iv) the payroll loan rate and v) the automotive loan rate. The analysis takes into account macrofinancial characteristics that may affect how banks adjust credit supply and lending rates after a change in the monetary policy, including the borrowers' credit risk, the banks' leverage and profitability, alternatives to lending to the private sector such as investing in government bonds, the degree of market concentration, the size of the banking sector and the overall country risk level.

The main result is that changes in the monetary policy rate are fully transmitted to the average bank lending rate, in line with results in (Nguyen, 2018[3]) and (Medina Cas, Carrion-Menendez and Frantischek, 2011[4]), but pass-through is incomplete in other segments of the bank credit market. Thus, between half and two thirds of a change in the monetary policy rate is transmitted into the mortgage, the credit card or the automotive loan rate. This proportion drops to one fifth for the payroll loan rate. As to the speed of adjustment, all bank lending rates tend to react quickly, usually within three months from the change in the monetary policy rate. The only exception is the mortgage rate that takes between nine months and one

[1]Alessandro Maravalle and Alberto Gonzalez Pandiella are members of the OECD Economics Department. The authors would like to thank Isabell Koske, Vincent Koen, Aida Caldera Sánchez, Srdan Tatomir, Balázs Egert (from the OECD Economics Department) and Etienne Lepers (from the OECD DAF Department) for useful comments and suggestions. The authors are also grateful to Roland Tusz and Véronique Gindrey for statistical assistance, and Karimatou Diallo for editorial assistance.

year to adjust. Results are also in line with (Banxico, 2022[5]) that finds that the pass-through of monetary policy changes into bank lending rates is full for short term rates but decreases with the loan maturity.

Higher market concentration is associated with a higher level of the lending rate in any segment of the bank credit market. Higher competition would then help reduce the long-run level of lending rates and improve the transmission of monetary policy into the mortgage and consumer credit markets. The degree of country risk, the measure of bank profitability, the ratio of capital to bank assets or the term spread, are also found to have a long-run impact on one or more bank lending rates. In particular, a higher profitability in the banking sector is associated to a lower level of bank lending rates. This may point to issues of asymmetric information in the banking sector (moral hazard and adverse selection) with banks engaging into some credit rationing and modifying credit supply rather than changing lending rates to reduce credit risk and preserve profitability. Reducing asymmetric information could help ease access to finance by firms and households and improve financial inclusion.

These results are in line with the literature on the pass-through in emerging market economies that finds that the pass-through is stronger in countries with more competitive banking sectors and more developed financial sectors. Reducing the size of the informal sector in Mexico, which represents a barrier to financial deepening and financial inclusion (Maravalle and Gonzaléz Pandiella, 2022[6]), would further increase the relevance of the interest rate and bank lending channels in the transmission mechanism of monetary policy.

The paper is organised as follows. Section 1 provides an introduction. Section 2 presents a brief description of the main channels of transmission of monetary policy and an overview of the literature. Section 3 outlines the main elements of the bank credit market in Mexico. Section 4 describes data and methodology used in the analyses and section 5 presents the results.

## The role of interest rate pass-through in the monetary policy transmission mechanism

The interest rate pass-through captures how changes in a reference rate (e.g. official interest or money market rates) transmit to bank rates (lending corporate and consumer rates or bank deposit rates) and is the first part of the interest rate channel of monetary policy, one of the main transmission channels through which monetary policy affects the real economy (Figure 1). The faster and the higher the pass-through, the larger the impact of monetary policy decisions on bank lending rates, and thus on investment and consumption decisions. The impact of changes in bank lending rates on the aggregate demand is the second part of the interest rate channel.

Following (Rousseas, 1985[7]), the pass-through of monetary policy changes on bank lending rate can be described as follows:

$$lr = F(mc) = \underset{(markup)}{\mu_t} + \underset{(passthrough)}{\beta} * \underset{(marginal\ cost\ of\ funding)}{mc}$$

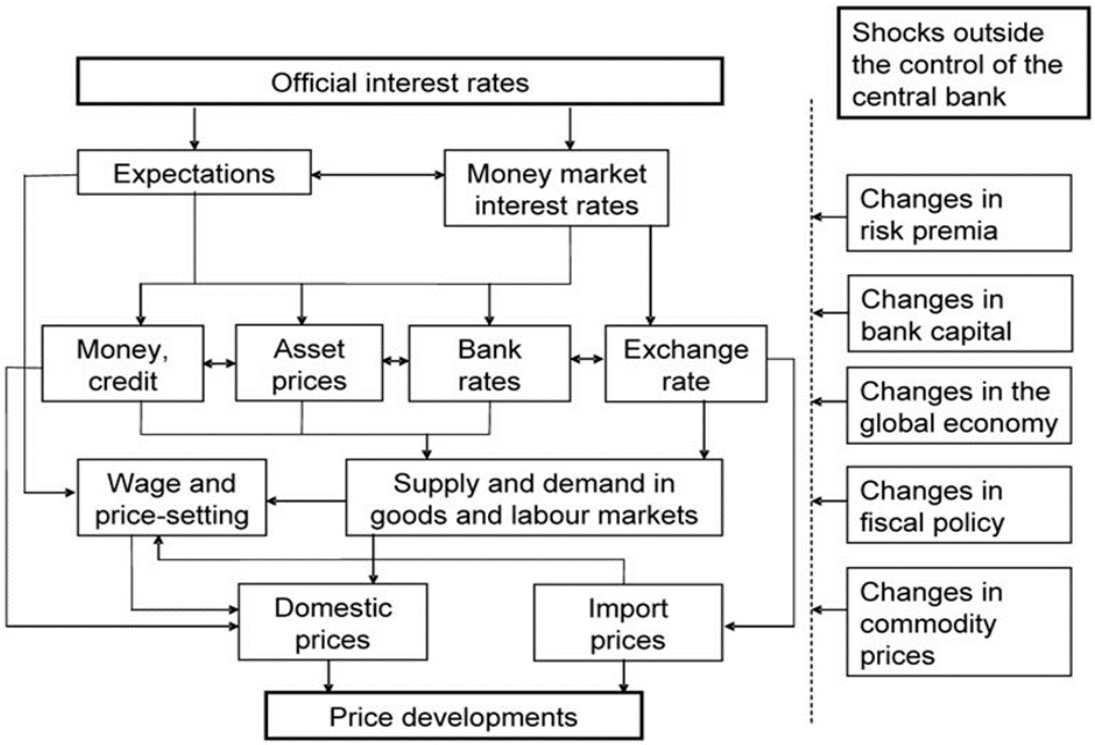
Where the bank lending rate (*lr*) is assumed to be a function of the bank marginal cost of funding (mc), which is approximated by the reference rate (official or money market interest rate). In its simplest version, the function is linear and the lending rate is determined by a markup or spread ($\mu$) over the reference rate and the product of the pass-through (β) by the marginal cost. Changes in the monetary policy rate affect the marginal cost of funding and the lending rate via the pass-through (β). In general, the markup may vary over time and be affected by macrofinancial conditions (e.g. bank market structure, bank conditions).

Monetary policy decisions transmit into the real economy also through other channels (Égert and MacDonald, 2009[8]). Monetary policy changes impact expectations of future short-term official interest rates and thus long-term interest rates and future inflation. A central bank that is credible in its commitment to maintaining price stability is able to anchor inflation expectations at its inflation target rate, thus affecting price formation (inflation expectation channel). Rising domestic interest rates also tend to provoke capital

inflows and the appreciation of the domestic currency (exchange rate channel). The loss in price competitiveness, as domestic goods become more expensive than imported goods, reduces aggregate domestic demand and inflation, as imports become more affordable.

### Figure 1. The interest rate channel is important for the transmission of monetary policy to the real economy

Main transmission mechanisms of monetary policy decisions




Source: ECB.

By modifying the cost of capital, monetary policy decisions affect asset prices (stock market and real estate prices) and, in turn, consumption and investment decisions via the wealth effect and the impact on the price of loan collaterals. For example, an increase in the interest rate by the monetary authority would reduce consumption by lowering asset prices and wealth, and also investment as borrowers would get less loans for the loss in the value of the assets used as collaterals (balance sheet channel). Higher interest rates also increase the risk of borrowers being unable to pay back their loans and banks may cut back on the amount of funds they lend to households and firms (bank lending channel).Through changes in asset prices, interest rates also affect banks' incentive to bear risk related to the provision of loans (risk-taking channel). For example, lower interest rates boosting asset and collateral values lead both borrowers and banks to accept higher risks, if the increase in value is considered sustainable. Also, lower interest rates make riskier assets more attractive as agents search for higher yields.

The two main approaches to estimate the pass-through are the monetary approach (Becker, Osborn and Yildrim, 2012[9]) and the cost of funds approach (Hofmann, 2004[10]). The former uses the main monetary policy (or monetary market) rate as the reference rate, while the latter estimates the pass-through of monetary policy into the full term structure of interest rates by assigning to each lending rate a market rate of comparable maturity.

Estimates of the pass-through focused on either a single country or a multi-country approach. Multi-country estimates are based on static (Ozdemir and Altinoz, 2012[11]) and dynamic panel models (Medina Cas,

Carrion-Menendez and Frantischek, 2011[4]) or panel structural vector auto regression model (PSVAR) (Mishra et al., 2014[12]). Panel models are preferable when cross sectional dependence is relevant, such as when common factors are important (e.g. US monetary policy) or with dataset with a large country sample size but a limited time coverage. Single country analysis is usually preferred in the presence of data availability issues or when cross sectional dependence is not relevant. Single country estimates are predominant in the literature on interest rate pass-through (Jiří, 2021[13]).

To estimate the pass-through the single-country approach uses vector auto regressive (VAR) models (Cottarelli and Kourelis, 1994[14]), single equation error correction models (ECM), which captures both long-term and short-term dynamics in presence of cointegration relationships, or auto regressive distributed lag (ARDL) models (Gregor and Melecký, 2018[15]). The latter is the most flexible modelling approach as it provides consistent estimations in the presence of variables integrated of order 0 and 1 or cointegrated.

Few studies estimated the pass-through in Mexico and those available focused on the average bank lending rate only. In particular, (Medina Cas, Carrion-Menendez and Frantischek, 2011[4]) and (Nguyen, 2018[3]) both find complete pass-through using, respectively, an auto regressive distributed lags model and a dynamic panel model. The current study extend the estimate of the pass-through to other four specific credit markets (the mortgage market , the credit card market , the automotive loan market and the payroll loan market) that account for around 33% of all bank credits (see section 3) and cover short-medium (credit card and payroll rates) and medium-long (automotive and mortgage rates) loan rates. In addition, following (Gregor and Melecký, 2018[15]) the analysis includes macrofinancial factors that may affect the long run level of lending rates and the pass-through of monetary policy.

The literature highlights that several characteristics of a country's financial structure may affect the monetary policy pass-through (Andries and Billon, 2016[16]), including the degree of market power in the banking sector, the size and the health of the financial system, the strength of financial regulation and the degree of independence of the central bank. A more developed financial system strengthens the lending transmission mechanism, as the presence of alternative sources of capital increase the demand elasticity for bank loans. Financial shallowness, instead, leads to higher excess liquidity in banks, discouraging the development of an active interbank market and reducing the effectiveness of monetary policy transmission.

Banks' market power may reduce the pass-through as low competition in the banking sector reduces available substitutes for bank loans and deposits, making their demand more inelastic. Banks with high market power may then keep their lending rates fixed in case of a reduction in the policy rate to increase profitability. A banking system characterised by high non-performing loan rates, low bank profitability or capitalisation, decreases the interest rate pass-through of monetary policy. In a downturn, with increasing risk aversion and information costs, banks may prefer build up liquidity or increase margins rather than extending credit in response to an expansionary monetary policy (injection of central bank liquidity or lower policy interest rates), especially if they are financially weak.

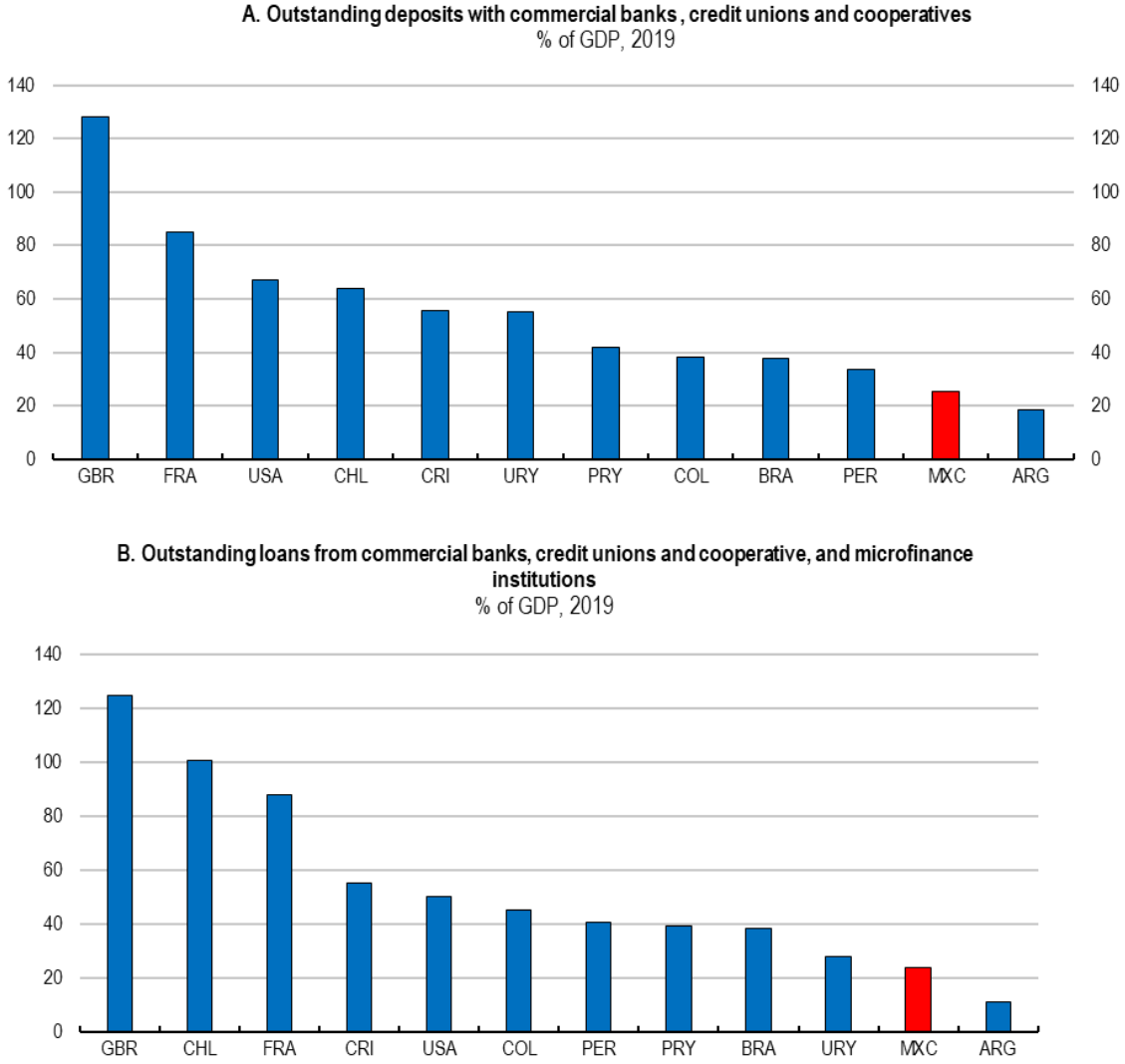
A weak regulation and institutional environment can reduce the effectiveness of the bank-lending channel of monetary policy transmission. High fiscal deficits, a high level of public debt or a weak central bank may all increase the risk of fiscal dominance, raising the country risk premium and thus interest rates. A poorly regulated financial sector that increases the cost of financial intermediation through high asymmetric information and contract enforcement costs, would also make the credit supply less sensitive to changes in the policy rate.

More generally, the literature focusing on emerging market economies finds that the pass-through is stronger in countries with higher banking sectors' competition, a credible inflation targeting regime, better institutional frameworks, higher exchange rate flexibility, low levels of financial dollarization and a more developed financial sector (Barquero-Romero and Cendra-Villalobos, 2020[17]; Mishra et al., 2014[12]; Medina Cas, Carrion-Menendez and Frantischek, 2011[4]; Ozdemir and Altinoz, 2012[11]; Bulíř and Vlček, 2015[18]).

## The bank credit market in Mexico

Mexico ranks low in key indicators of financial depth and financial inclusion compared to both advanced economies and regional peers (Maravalle and González Pandiella, 2022). For example, the size of domestic bank credit to the private sector (households and firms), including commercial banks and credit unions and cooperatives, is around 23.9% of GDP in Mexico (Figure 2, Panel B), less than in Brazil (38.3%), Colombia (45.4%), Costa Rica (55.5%) and Chile (100.8%), and below what it would be expected on the basis of Mexican's economic fundamentals (Herman and Klemm, 2019[19]). A similar picture holds for bank deposits as a share of GDP (Figure 2, Panel A). The share of the population aged between 18 and 79 years holding a bank account, a key indicator of financial inclusion, is only 47% in Mexico, less than in other OECD members in the region such as Costa Rica (68%) and Chile (74%). And the level of financial development is overall low in Mexico, which ranks 31st out of 38 among OECD countries in 2020, according to the IMF financial development index.

### Figure 2. Banks' deposits and credit to the private sector in Mexico are low in international comparison



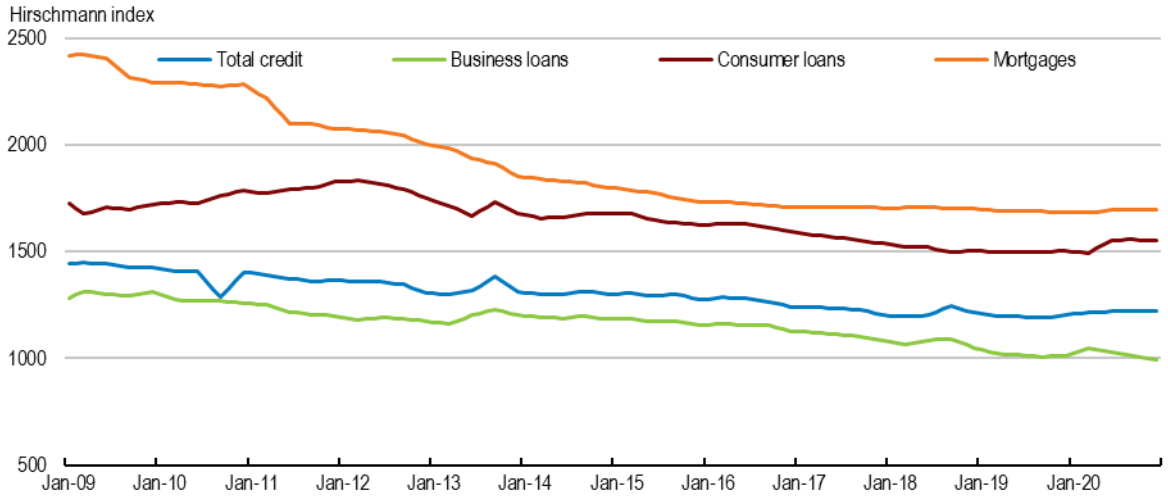

Source: IMF Financial Access Survey.

The three largest banks hold more than 50% of total bank assets (OECD, 2019[20]) and foreign subsidiaries hold around two thirds of the share of total banks' assets in the system. The strong presence of foreign subsidiaries is related to a slower credit growth rate in Mexico following the implementation of Basel III regulatory changes on bank lending, as foreign subsidiaries have decreased their credit growth rate more than domestic banks (Cantú et al., 2019[21]).

The banking sector market concentration, which tends to be inversely related to the degree of market competition, has been flat since 2016 (Figure 3). A financial reform in 2014 decreased the overall degree of concentration in the Mexican banking sector for a few years, but some large banks have increased their market power since (Bátiz-Zuk and Lara Sánchez, 2021[22]). In addition, low competition in the Mexican banking industry has a negative relationship with loan growth (Cantú et al., 2019[21]). Market concentration however varies across segments of bank credit market. It is relatively high for consumer loan and mortgages, and low for the business loan market (Figure 3). Market concentration is also high in the credit card market (Téllez-León and Venegas-Martínez, 2019[23]).

## Figure 3. Concentration in the banking sector varies across segments of bank credit and has remained flat since 2016

Concentration in the banking sector by type of credit

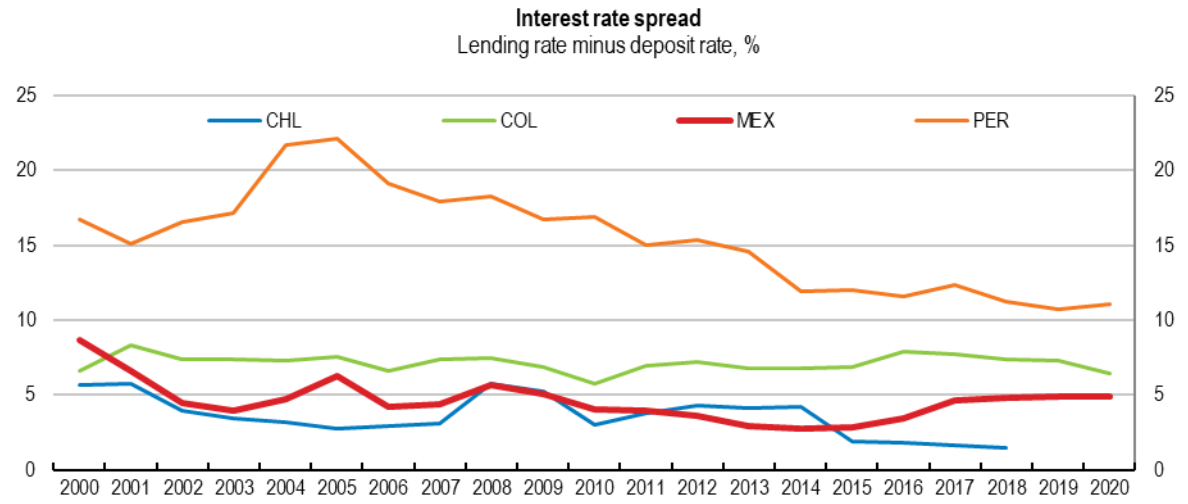



Note: The Hefindhal-Hirschmann index (HHI) is an indicator of market concentration that ranges from 0 to 10000, with higher values signalling that the market is more concentrated. Mexican competition authorities deem a market as highly concentrated when the HHI is above 2000.
Source: CBNV/SHCP; Authors' calculations.

The bank interest rate spread (Figure 4) in Mexico is above what is observed in Chile and has increased over the past five years. Empirical evidence finds that Mexican banks with higher market power tend to lend at higher interest rates, especially if the loan is provided to micro and small firms, and to firms located in central and Southern regions (Cañon, Cortes and Guerrero, 2020[24]).

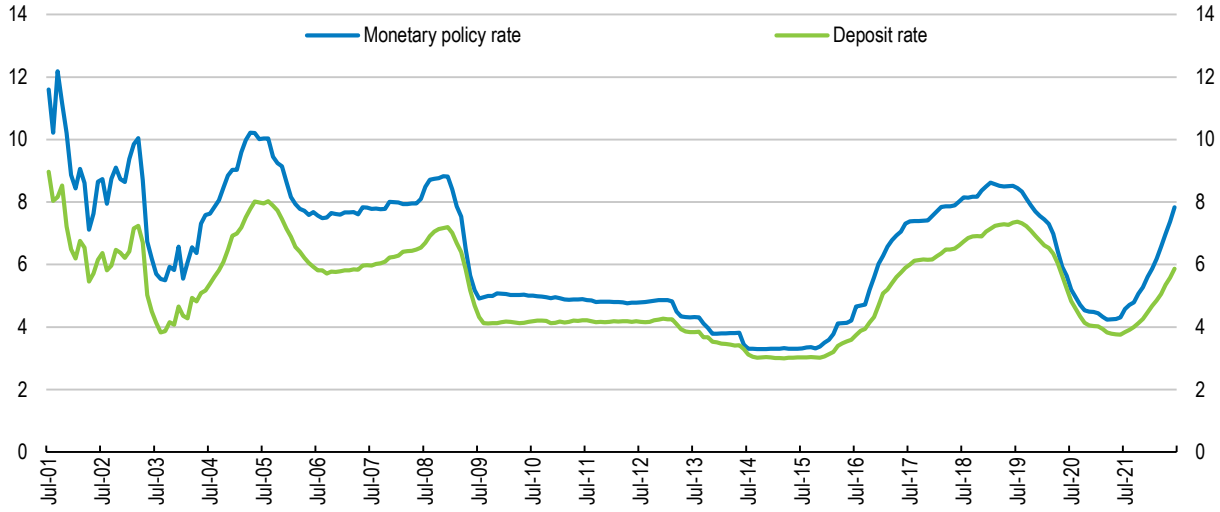
Deposits (checking and saving accounts) are the main source of bank funding and have increased their importance over time: they represented around 80% of all bank liabilities in 2021 against 58% in 2009. Collateralised loans in the form of repurchase agreements are the second main source of funding and represented around 16% of all bank liabilities in 2022, against a share of 36% in 2009. The strong correlation between the deposit rate and the monetary policy rate, suggests that the pass-through of changes in the monetary policy rate on funding costs is fast and complete (Figure 5)

## Figure 4. Banks' interest rate spread has increased in the past 5 years




Note: The interest rate spread is defined as the difference between the average interest rate a bank pays to depositors and the interest rate it receives from loans.
Source: World bank, World Development Indicators.

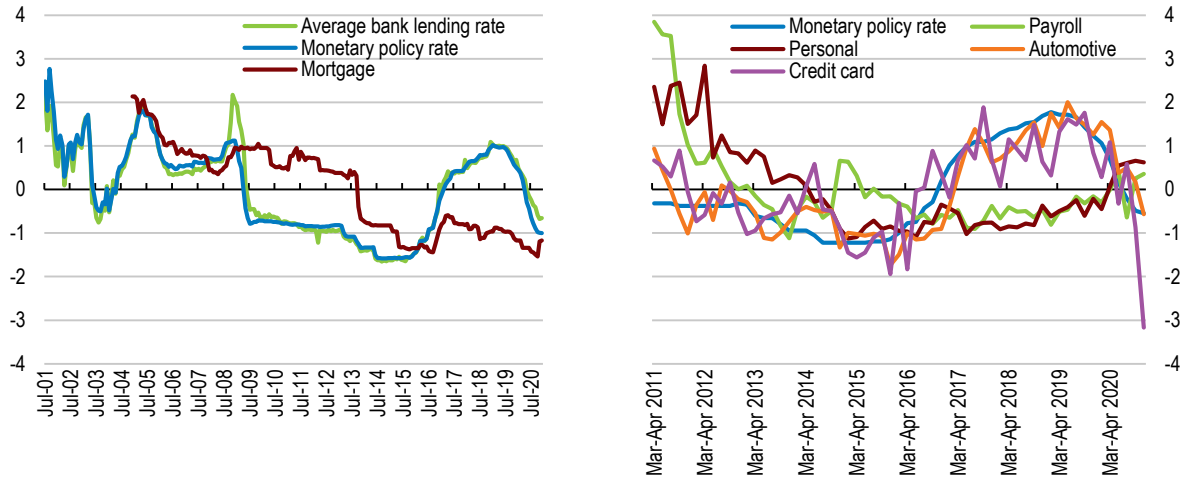
## Figure 5. Bank deposit rates are highly correlated with the monetary policy rate




Source: Banco de México and CNVB.

Different segments of bank credit market appear to be differently affected by monetary policy, as suggested by the evolution of available bank lending rates (Figure 6) and their correlation with the monetary policy rate (Table 1). A coefficient of correlation close to unity suggests that monetary policy might have a fast and strong impact on the average bank lending rate, which captures short and medium term credit to both firms and households, and bank deposit rate. However, the transmission of monetary policy appears to be less powerfully into specific segment of the bank credit market where the correlation is either high but far below unity (automotive loan and credit cards) or very low (mortgages, personal and payroll loans). These segments of bank credit market represent around one third of total bank credit (Figure 7).

## Figure 6. Movements in the monetary policy rate appears to have a different impact across segments of the bank credit market




Note: All variables are standardised to have a comparable scale.
Source: Banco Central de México and IFS.

## Table 1. The correlation with monetary policy rates varies across bank lending rates

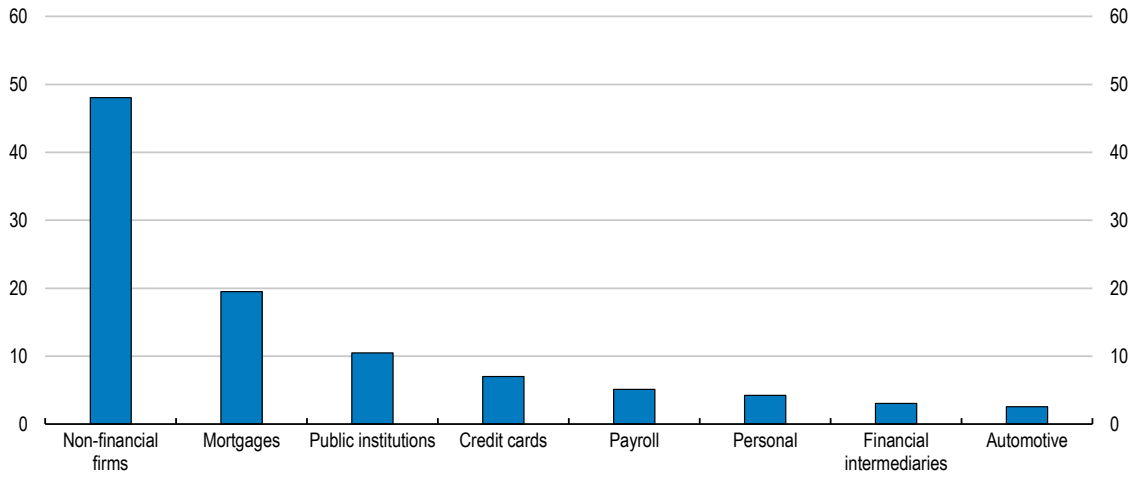
Correlation of bank lending rates with the monetary policy rate

| | Average bank lending | Mortgage | Payroll | Personal | Automotive | Credit card | Deposit rate |
|---|---|---|---|---|---|---|---|
| Correlation | 0.97 | 0.38 | -0.23 | -0.22 | 0.89 | 0.73 | 0.97 |

Source: Banco Central de México; IFS; and authors' calculation.

## Figure 7. Mortgages and credit for consumption amounts to around one third of the bank credit portfolio

Share of bank credit portfolio by type of credit, %, 2021




Note: Consumer credit includes the following categories: credit cards, payroll, personal and automotive.
Source: Banco Central de México.

## Estimating the pass-through of monetary policy to bank lending rates

### *Data*

The dataset includes the monetary policy rate (MP), five bank lending rates and several financial indicators capturing characteristics of the financial structure that might influence the lending channel of transmission of monetary policy (Table 2). The lending rates include the average short-term lending rate computed by the IMF (I_TOT) and four credit-specific bank lending rates related to mortgages (I_HOUSE) and consumption credit markets (credit cards (I_CC), payroll loans (I_CONS_A) and automotive loans (I_CONS_B)).

The borrower credit risk is captured via the non-performing loan rate, which is computed with respect to the outstanding bank credit portfolio (NPL_TOT), the consumption credit portfolio (NPL_CONS) and the mortgage credit portfolio (NPL_HOUSE). Return on asset (ROA) or return on equity (ROE) take into account banks' profitability, and the ratio of banks capital to total banks assets (C_ASSET) the influence of bank leverage on commercial lending. The country risk premium, as measured by the Emerging Market Bond Index (EMBI) spread, takes into account the country risk associated to the institutional environment. The sovereign term spread (TERM_SPREAD) controls for alternatives to lending to the private sector such as investing in government bonds. To control for the degree of bank competition an indicator of market concentration, the Herfindahl-Hirschman index, is computed for the outstanding total bank credit portfolio (HHI_TOT), and for two specific credit markets, the mortgage (HHI_HOUSE) and the consumption credit market (HHI_CONS).

### Table 2. Variables in the dataset

| Variable | Description | Unit | Time coverage | Source |
|---|---|---|---|---|
| MP | 91 day Interbank Equilibrium Interest Rate | percent, % | Monthly, July 2001 – Dec. 2020 | Banco de Mexico |
| C_ASSET | Ratio of banks capital to total banks assets | percent, % | Monthly, Jan. 2001 – Dec. 2020 | CNBV |
| ROA | Return on Bank Asset | percent, % | Monthly, Dec. 2001 – Dec. 2020 | CNBV |
| ROE | Return on Bank Equity | percent, % | Monthly, Dec. 2001 – Dec. 2020 | CNBV |
| NPL_TOT | Non-performing loan, outstanding credit portfolio | percent, % | Monthly, Jan. 2001 – Dec. 2020 | CNBV |
| NPL_CONS | Non-performing loan, outstanding consumption credit portfolio | percent, % | Monthly, Jan. 2001 – Dec. 2020 | CNBV |
| NPL_HOUSE | Non-performing loan, outstanding mortgage credit portfolio | percent, % | Monthly, Jan. 2001 – Dec. 2020 | CNBV |
| EMBI | Emerging Markets Bonds Index (EMBI) spread, difference between US dollar denominated bonds issued in Mexico and US Treasury Bonds (free of risk). | percent, % | Monthly, Jan. 2001 – Dec. 2020 | WORLDBANK |
| TERM_SPREAD | Spread between the 10 year Fixed rate Bond and the 3-months Bond (Cetes) sovereign yields | percent, % | Monthly, Jun. 2001 – Dec. 2020 | Banco de Mexico |
| HH_TOT | Herfindahl-Hirschman index, outstanding bank credit portfolio | Between 0 and 1 | Monthly, Jun. 2001 – Dec. 2020 | CNBV |
| HH_CONS | Herfindahl-Hirschman index, outstanding bank consumption credit portfolio | Between 0 and 1 | Monthly, Jun. 2001 – Dec. 2020 | CNBV |
| HH_HOUSE | Herfindahl-Hirschman index, outstanding bank mortgage credit portfolio | Between 0 and 1 | Monthly, Jun. 2001 – Dec. 2020 | CNBV |
| I_HOUSE | Mortgage interest rate, for households credits in pesos at fixed rates | percent, % | Monthly, Jun. 2004 – Dec. 2020 | Banco de Mexico |
| I_CONS_A | Interest rate for payroll loans, Bimonthly portfolio | percent, % | Bimonthly, Mar-Apr 2011 - Nov-Dec 2020 | Banco de Mexico |
| I_CONS_B | Interest rate for automotive loans, Bimonthly portfolio | percent, % | Bimonthly, Mar-Apr 2011 - Nov-Dec 2020 | Banco de Mexico |
| I_TOT | Average bank lending Rate | percent, % | Monthly, Jan 1999 - Dec 2020 | IFS |
| I_CC | Credit Card rate | percent, % | Bimonthly, Mar-Apr 2011 - Nov-Dec 2020 | Banco de Mexico |

Source: Banco de Mexico, IFS, CNVB, World Bank.

## *Empirical strategy*

### *Baseline*

The empirical strategy to compute the pass-through follows the standard monetary approach and is based on estimating autoregressive distributed lag (ARDL) models á la Pesaran and Shin (Pesaran and Shin, 1999[25]) as in (Gregor and Melecký, 2018[15]). This flexible modelling approach provides consistent estimations in the presence of variables integrated of order 0 and 1 or cointegrated. A typical ARDL model can be represented as follows:

$$R_{BL,t} = a + t + \sum_{i=0}^{q_1} \delta_{1,i} X_{1,t-i} + \cdots + \sum_{i=0}^{q_{k-1}} \delta_{k-1,i} X_{k-1,t-i} + \sum_{i=0}^{q_k} \delta_{k,i} MP_{t-i} + \sum_{i=1}^{p} \theta_i R_{BL,t-i} + u_t, \quad (1)$$

where $R_{BL}$, the dependent variable, is one of the five bank lending rates and the vector of K regressors includes the monetary policy rate, $MP$, and K-1 variables capturing characteristics of the financial structure, $X_{1,}\ldots,X_{K-1}$. Lags of the dependent variable (p lags) and the regressors ($q_1$,…, $q_k$ lags) are included in the model and selected according to the BIC selection criteria. $u_t$ is the error term and a constant and a time trend are added if statistically significant. $\{\delta_{j,i}\}_{\mathrm{j}=1,\ldots,\mathrm{K}-1}^{\mathrm{i}=0,\ldots,q_i}$ is the vector of coefficients associated to the vector of regressors $\{X_i\}_{\mathrm{i}=1,\ldots,\mathrm{K}-1}$ ,$\{\delta_{j,k}\}^{\mathrm{j}=0,\ldots,q_{ik}}$ is the vector of coefficients associated to $\{MP_{t-i}\}_{\mathrm{i}=1,\ldots,q_k}$, and $\{\theta_i\}^{\mathrm{i}=1,\ldots,\mathrm{p}}$ , is the vector of coefficients associated to $\{R_{BL,t-i}\}_{\mathrm{i}=1,\ldots,p}$. Estimates were computed using the software R x64 4.0.3 and the package ARDL (Natsiopoulos and Tzeremes, 2021[26]; Natsiopoulos and Tzeremes, 2022[27]).

The pass-through of monetary policy into the bank lending rate is obtained from the long-run relationship between the monetary policy rate (MP), the lending rate ($R_{BL}$) and the financial characteristics ($X_i$) that is contained in the error correction term. This long-run relationship can be explicitly derived from the ARDL model by reformulating it in its error correction form as follows:

$$\Delta R_{BL,t} = c + \rho * \left(a_{lr} + t_{lr} + R_{BL,t-1} - \beta_0 MP_{t-1} - \sum_{i=1}^{K-1} \gamma_i X_{i,t-i}\right) + \sum_{i=0}^{q_1} \sigma_{1,i} \Delta X_{1,t-i} + \cdots + \sum_{i=0}^{q_{k-1}} \sigma_{k-1,i} \Delta X_{1,t-i} + \sum_{i=0}^{q_k} \sigma_{k,i} \Delta MP_{t-i} + \sum_{i=1}^{p-1} \varphi_i \Delta R_{BL,t-i} + v_t, \quad (2)$$

$$ECT_t = a_{lr} + t_{lr} + R_{BL,t-1} - \beta_0 MP_{t-1} - \sum_{i=1}^{K-1} \gamma_i X_{i,t-i}, \quad (3)$$

Where Δ is the first difference operator, $ECT$ is the error correction term, $\{\sigma_{j,i}\}_{\mathrm{j}=1,\ldots,\mathrm{K}}^{\mathrm{i}=0,\ldots,i}$, $\{\varphi_i\}^{\mathrm{i}=0,\ldots,p-1}$ , $\{\gamma_j\}_{\mathrm{j}=1,\ldots,\mathrm{K}-1}$are vectors of coefficients, the long run coefficient $\beta_0$ captures the pass-through of monetary policy into the lending rate and the coefficient $\rho$ measures the speed of adjustment. In the long run relationship a constant, $a_{lr}$, and a trend, $t_{lr}$ are included if statistically significant.

The long run multiplier associated to the regressor $X_i$ , LRMi, is obtained from (1) as

$$LRM_i = \frac{\sum_{i=0}^{q_{k-1}} \delta_{k-1,i}}{(1-\sum_{i=1}^{p} \theta_i)}.$$

The Philip Perron unit root test, robust to serial correlation, and the Zivot Andrews unit root test, robust to the presence of a structural break at an unknown point, are performed for any variable (Table 3 and Table 4), most of which are integrated of order 1. The presence of a cointegration relationship is then tested via the Bound F cointegration test (Pesaran, Shin and Smith, 2001[28]) on the selected model for each lending rate (Table 5).

The presence of structural breaks is tested on each selected model via the Bai Perron multiple break point estimation test (Bai and Perron, 1998[29]; Perron, 2006[30]) and a battery of coefficient stability tests (OLS-based and recursive CUSUM test; OLS-based and recursive MUSUM test; Recursive estimate test; and moving estimate test). A further test of the stability of the best-fitting model is performed through a rolling regression as to gain insights into the sample dynamics of the estimated pass-through and speed of adjustment.

*Extensions – Interaction terms*

The possibility of nonlinearity is dealt with at different stages of the analysis. First a Teraesvirta test is preliminarily performed for each bank lending rate to check for potential nonlinear relationship with the monetary policy rate. Failing to reject the null hypothesis of a linear relationship is interpreted in favour of the absence of a non-linear relationship between the specific bank lending rate and the monetary policy rate. Second, a Ramsey Regression Equation Specification Error Test (RESET) is performed for each baseline ARDL estimation to check for general model misspecification. Failing to reject the null hypothesis of no model mispecifications is interpreted as in favour of the absence of nonlinearity. Finally, to capture potential nonlinearities, also based on results of the previous tests, interaction terms between the monetary policy rate (MP) and each financial variable (X) are added to the baseline model as in (Gregor and Melecký, 2018[15]):

$$\Delta R_{BL,t} = \varphi * \Delta MP_t + \theta * \Delta X_t + \rho_{SR} * \Delta MP_t * X_t + \tau * \left(R_{BL,t} - \alpha_1 - \mathrm{t} - \beta * MP_t - \gamma * X_t - \rho_{LR} * MP_t * X_t\right) + \varepsilon_t. \quad (4)$$

In the presence of interaction terms, the pass-through is approximated by:

$$\beta + \rho_{LR}\, AVERAGE(X_t),$$

where $\rho_{LR}$ is the vector of coefficients in the error correction term associated to the vector of financial characteristics $(X_t)$ and $AVERAGE(X_t)$ is the vector of averages of financial characteristic variables over the sample period.

## Table 3. Zivot Andrews unit root test

| Variable | Description | Intercept | Trend | Intercept and trend |
|---|---|---|---|---|
| MP | 91 day Interbank Equilibrium Interest Rate | -4.06 | -2.97 | -3.59 |
| C_ASSET | Ratio of banks capital to total banks assets | -3.44 | -4.84** | -5.19** |
| ROA | Return on Bank Asset | -3.27 | -3.13 | -4.62 |
| ROE | Return on Bank Equity | -3.19 | -2.83 | -4.58 |
| NPL_TOT | Non-performing loan, outstanding credit portfolio | -6.28*** | -5.74*** | -6.29*** |
| NPL_CONS | Non-performing loan, outstanding consumption credit portfolio | -3.89 | -3.40 | -4.04 |
| NPL_HOUSE | Non-performing loan, outstanding mortgage credit portfolio | -6.76*** | -4.49** | -6.69*** |
| EMBI | Emerging Markets Bonds Index (EMBI) spread, difference between US dollar denominated bonds issued in Mexico and US Treasury Bonds (free of risk) | -3.75 | -3.53 | -3.56 |
| TERM_SPREAD | Spread between the 10 year Fixed rate Bond and the 3-months Bond (Cetes) sovereign yields | -4.03 | -2.77 | -4.05 |
| HH_TOT | Herfindahl-Hirschman index, outstanding bank credit portfolio | -4.22 | -4.22 | -4.41 |
| HH_CONS | Herfindahl-Hirschman index, outstanding bank consumption credit portfolio | -8.39*** | -7.99*** | -8.20*** |
| HH_HOUSE | Herfindahl-Hirschman index, outstanding bank mortgage credit portfolio | -5.62*** | -3.85 | -5.39** |
| I_HOUSE | Mortgage interest rate, for households credits in pesos at fixed rates | -5.44*** | -2.64 | -5.71*** |
| I_CONS_A | Interest rate for payroll loans, Bimonthly portfolio | -2.39 | -2.80 | -2.67 |
| I_CONS_B | Interest rate for automotive loans, Bimonthly portfolio | -3.54 | -2.11 | -2.11 |
| I_TOT | Average bank lending rate | -4.29 | -3.34 | -4.21 |
| I_CC | Credit Card rate | -2.34 | -1.9 | -1.88 |

Note: The null hypothesis of the test is the presence of a unit root. *, ** and *** indicate rejection of the null hypothesis at the 10%, 5% and 1%, level of significance, respectively.
Source: Authors' calculation.

## Table 4. Philippe Perron unit root test, Z-tau statistic

| Variable | Description | Short version | Long version with constant | Long version with constant and trend |
|---|---|---|---|---|
| MP | 91 day Interbank Equilibrium Interest Rate | -2.51 | -2.64 | -2.61 |
| C_ASSET | Ratio of banks capital to total banks assets | -2.08 | -2.04 | -2.53 |
| ROA | Return on Bank Asset | -2.37 | -2.50 | -1.93 |
| ROE | Return on Bank Equity | -2.04 | -2.18 | -2.15 |
| NPL_TOT | Non-performing loan, outstanding credit portfolio | -5.61*** | -5.82*** | -4.70*** |
| NPL_CONS | Non-performing loan, outstanding consumption credit portfolio | -3.72*** | -3.66*** | -3.27 |
| NPL_HOUSE | Non-performing loan, outstanding mortgage credit portfolio | -5.87 | -5.70 | -3.97 |
| EMBI | Emerging Markets Bonds Index (EMBI) spread, difference between US dollar denominated bonds issued in Mexico and US Treasury Bonds (free of risk) | -2.83 | -2.55 | -2.78 |
| TERM_SPREAD | Spread between the 10 year Fixed rate Bond and the 3-months Bond (Cetes) sovereign yields | -2.86 | -3.07** | -3.25 |
| HH_TOT | Herfindahl-Hirschman index, outstanding bank credit portfolio | -0.94 | -0.68 | -2.35 |
| HH_CONS | Herfindahl-Hirschman index, outstanding bank consumption credit portfolio | -3.03** | -2.94** | -3.11 |
| HH_HOUSE | Herfindahl-Hirschman index, outstanding bank mortgage credit portfolio | -1.07 | -1.30 | -1.95 |
| I_HOUSE | Mortgage interest rate, for households credits in pesos at fixed rates | -1.80 | -1.80 | -2.30 |
| I_CONS_A | Interest rate for payroll loans, Bimonthly portfolio | -5.04*** | -5.37*** | -3.91** |
| I_CONS_B | Interest rate for automotive loans, Bimonthly portfolio | -1.80 | -1.95 | -2.45 |
| I_TOT | Average bank lending rate | -4.86*** | -4.79*** | -4.55*** |
| I_CC | Credit card rate | -9.91*** | -9.85*** | -9.8*** |

Note: The null hypothesis of the test is the presence of a unit root. *, ** and *** indicate rejection of the null hypothesis at the 10%, 5% and 1%, level of significance, respectively.
Source: Authors' calculation.

## Table 5. Bound F Cointegration test

| Cointegration model specification | Average bank lending rate | Mortgage rate | Payroll loan rate | Automotive loan rate | Credit card rate |
|---|---|---|---|---|---|
| No constant | 5.96 *** (0.01) | 3.08* (0.06) | 7.14*** (0.00) | 5.87*** (0.00) | 2.68 (0.13) |
| Constant in the long run relationship | *3.50** *(0.1)* | *3.70*** *(0.02)* | 7.75*** (0.00) | 5.13*** (0.00) | 9.42*** (0.00) |
| Constant in the short run relationship | *5.10** *(0.08)* | *3.48*** *(0.05)* | 7.77*** (0.00) | 5.75*** (0.00) | 10.51*** (0.0) |
| Trend in the long run relationship, constant in the short run | 3.98 (0.16) | 3.16* (0.1) | 13.85*** (0.00) | 5.66*** (0.00) | 8.1*** (0.0) |
| Constant and trend in the short run relationship | 5.96 (0.12) | 3.39 (0.11) | 13.95*** (0.00) | 6.26*** (0.00) | 9.1*** (0.0) |

Note: The null hypothesis of the test is no cointegration. *, ** and *** indicate rejection of the null hypothesis at the 10%, 5% and 1%, level of significance, respectively.
Source: Authors' calculation.

## Empirical results

### *Main results and policy implications*

The interest rate pass-through into bank lending rate in Mexico is high on average, though there is room for improvement in specific segments of the bank credit market (Table 6). The pass-through of monetary policy changes into the average bank lending rate, which covers short and medium term bank loans to both firms and households, is full and relatively fast (3 months). Changes in monetary policy also appear to transmit quickly and fully into bank deposit rates (Figure 5). However, in specific segments of the credit market accounting for around one third of all bank credit portfolio the pass-through is incomplete, and only a proportion between one-fifth and half of the change in the monetary policy rate is passed onto the corresponding bank lending rates (Table 6, baseline model). The pass-through is however fast, as the transmission of monetary policy into these lending rates takes usually two-three months, with the exception of the mortgage rate in which the adjustment takes around one year. The finding of a fast but incomplete pass-through in specific segments of the bank credit market is robust to the introduction of non-linearity (interaction terms) into the model specification (Table 6, model with interaction terms). Results from the preliminary Teraesvirta tests (for the two consumption bank lending rates) and the RESET test on the baseline ARDL models (for the mortgage and the credit card rate) point to potential non-linearities. The introduction of the interaction terms help capture these nonlinearities and solves model mispecifications issues.

**Table 6. Summary of the results on estimating pass-through and speed of adjustment**

| | Average bank lending | Mortgage | Payroll loan | Automotive loan | Credit card |
|---|---|---|---|---|---|
| **Baseline model** | | | | | |
| Pass-through | 0.97 | 0.43 | 0.2 | 0.36 | 0.42 |
| Speed of adjustment | 3 months | 12 months | 2 months | 3 months | 2 months |
| **Model with interaction terms** | | | | | |
| Pass-through | 1.3 | 0.68 | 0.11 | 0.42 | 0.5 |
| Speed of adjustment | 4 months | 9 months | 2 months | 2 months | 2 months |
| **Share of total bank credit (%)** | n.a. | 19.5 | 5.1 | 2.5 | 7 |

Note: The pass-through indicates the proportion of the change in the monetary policy rate that is transmitted to the bank lending rate. A value of 1 indicates full transmission of monetary policy into the lending rate; a value of 0 indicates no transmission of monetary policy. The share of total bank credit of a specific segment of the bank credit market is computed as the share of bank liabilities in that specific segment over total bank liabilities.
Source: Authors' calculations.

These results point to potential improvements in the transmission of monetary policy. By strengthening the interest rate channel, monetary policy could gain in efficiency as a given impact on the economic activity could be achieved through a smaller change in the monetary policy rate. In particular, given the nature of the lending rates featuring an incomplete pass-through, efficiency gains would materialise in the transmission of monetary policy onto household consumption and investment (mortgage). A higher pass-through could also help monetary policy pursue more easily its goal(s) as a more efficient monetary policy, by requiring smaller changes in the monetary policy rate, could have a lower impact on debt servicing costs and international capital flows.

Results provide indications of the financial features that might be associated with incomplete pass-through. The index of market concentration, which is an imperfect proxy for market power, and the return on equity or bank capital asset leverage, which are two indicators of the health of the banking system, are all statistically significantly correlated with the bank lending rates for which the pass-through of monetary policy is incomplete. More specifically, a higher degree of market concentration is correlated to a higher

level of bank lending rates. This suggests that the presence of high banks' market power might reduce the pass-through in these segments of the bank credit, and that increasing competition in these segments could strengthen the interest rate channel. This interpretation is in line with the fact that the index of banks' market concentration is the highest in the segments of mortgages and consumer loans, where pass-through is incomplete, and the lowest in the segment of business credit (Figure 3), whose credit rate, captured by the average bank lending rate, features a fast and complete pass-through.

In the segments of the bank credit market with incomplete pass-through a lower bank lending rate is also generally associated with a higher banks' return on equity or ratio of capital to assets. The Mexican banking system did not feature an especially low level of profitability with respect to the OECD average over the period considered. For example, taking the average bank return on equity over the period 2010-21, Mexico (11.3%) ranks above both the OECD average (6.8%) and median (7.8%) (World Bank Global Financial Development Database). This suggests that banks may find it profitable not to increase lending rates following a monetary policy tightening, but rather engage in credit rationing to preserve profitability because of high credit risk due to relevant asymmetric information issues. Policies aimed at reducing such asymmetries would then help ease access to finance by households and firms, and increase both the level of financial development and financial inclusion, which are relatively low in Mexico (Figure 2). For example, strengthening the credit registry system to ensure that all lenders are able to access all credit history information, as well as developing credit scores for informal firms and workers by using alternative source of information (e.g. digital data generated from transactions between households and firms and households and the government, such as payment of utilities or loan payment) could help increase financial inclusion (OECD, 2022[31]).

The following sub-sections provide a detailed description of the results from the estimation of the pass-through for the five bank lending rates analysed: the average bank lending rate, the mortgage rate, the payroll loan rate, the automotive loan rate and the credit card rate. For each rate, three tables present results from the estimation of the baseline (equation 2) and the interaction term model (equation 4), and the associated long run multipliers (equation 3). For each model, a table reports the results from model specification tests, notably a diagnostic test of the correctness of the chosen functional form (RESET test) and two test for the presence of serial correlation in the error term (Durbin Watson and Breusch-Godfrey tests). No coefficient stability test (not reported) highlighted stability issues in any model, and only a table reporting estimates of the pass-through and speed of adjustment from a rollover estimation is added.

### *Average bank lending rate*

Estimates from both the baseline and interaction term model show that the pass-through of monetary policy into the average bank lending rate is complete (around unity) and fast (3-4 months). Both model specification give similar results in terms of pass-through and speed of adjustment. The interaction term specification is however preferred, as diagnostic tests point to serial correlation in the baseline model.

Coefficient estimates from the best baseline ARDL model are provided in Table 7, and the corresponding long run multipliers are reported in Table 8. The measure of the country risk (EMBI), the index of bank concentration (HH_TOT) and the ratio of capital to bank assets (C_ASSET) are all statistically significantly correlated with the average bank lending rate in the long run. More specifically, a higher degree of market concentration in the banking sector, measured by the Herfindahl-Hirschman index, or a higher country risk, are both associated with a higher level of the average bank lending rate. Bank deleveraging, measured by the capital-to–asset ratio, is similarly associated to an increase in the level of the average bank lending rate.

The specification tests of the baseline model are reported in Table 9, and the Breusch-Godfrey test points to potential issues of serial correlation. Results from the rollover estimation suggest that the pass-through has remained stable while the speed of adjustment might have increased since 2010 (Table 10). However, no coefficient stability test rejects the null hypothesis of coefficient stability over the estimation period.

## Table 7. Baseline ARDL model: Average bank lending rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | -2.79*** | 0.56 | -4.98 | 0.00 |
| Lending rate: lagged (I_TOT) | 0.69*** | 0.04 | 17.38 | 0.00 |
| Monetary Policy rate (MP) | 1.12*** | 0.04 | 28.08 | 0.00 |
| Monetary Policy rate: lagged | -0.83*** | 0.06 | -13.41 | 0.00 |
| Non-performing loan - total credit (NPL_TOT) | 0.29*** | 0.10 | 2.99 | 0.00 |
| Non-performing loan - total credit: lagged | -0.29*** | 0.10 | -2.93 | 0.00 |
| ROE | -0.01 | 0.01 | -0.89 | 0.38 |
| Emerging market bond spread (EMBI) | 0.16*** | 0.02 | 7.16 | 0.00 |
| Term spread | -0.03 | 0.02 | -1.15 | 0.25 |
| HH index outstanding credit (HH_TOT) | 11.90*** | 2.34 | 5.08 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | 0.10*** | 0.03 | 3.81 | 0.00 |
| No. observations | 228 | | | |
| Adjusted R-squared | 0.99 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The best model is selected according to the BIC criterion and is a ARDL (1,1,1,0,0,0,0,0).
Source: Authors' calculation.

## Table 8. Long run multipliers in the baseline ARDL model: Average bank lending rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary Policy rate (MP) : Pass-through | 0.97*** | 0.05 | 20.13 | 0.00 |
| Non-performing loan - total credit (NPL_TOT) | 0.00 | 0.09 | -0.02 | 0.98 |
| ROE | -0.02 | 0.02 | -0.90 | 0.37 |
| Emerging market bond spread | 0.53*** | 0.07 | 7.85 | 0.00 |
| Term spread | -0.09 | 0.08 | -1.14 | 0.26 |
| HH index outstanding credit (HH_TOT) | 38.97*** | 7.06 | 5.52 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | 0.33*** | 0.08 | 4.30 | 0.00 |
| Speed of adjustment: (Lending rate: lagged) | -0.31*** | 0.04 | -7.65 | 0.00 |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculation.

## Table 9. Specification tests of the baseline ARDL model: Average bank lending rate

Baseline

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 1.18 | 0.28 |
| Durbin-Watson test | 2.24 | 0.91 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 4.96 | 0.03 |

Source: Authors' calculation.

## Table 10. Rollover regression estimation: Average bank lending rate

| Period | Pass-through | Speed of adjustment |
|---|---|---|
| Jan. 2002 – Dec. 2009 | 0.75 | -0.46 |
| Jan. 2003 – Dec. 2010 | 0.82 | -0.45 |
| Jan. 2004 – Dec. 2011 | 1.04 | -0.44 |
| Jan. 2005 – Dec. 2012 | 1.18 | -0.50 |
| Jan. 2006 – Dec. 2013 | 1.22 | -0.51 |
| Jan. 2007 – Dec. 2014 | 1.21 | -0.50 |
| Jan. 2008 – Dec. 2015 | 1.28 | -0.54 |
| Jan. 2009 – Dec. 2016 | 1.41 | -0.63 |
| Jan. 2010 – Dec. 2017 | 1.13 | -0.74 |
| Jan. 2011 – Dec. 2018 | 1.02 | -0.75 |
| Jan. 2012 – Dec. 2019 | 0.98 | -0.76 |
| Dec. 2012 – Nov. 2020 | 0.99 | -0.51 |

Note: Rolling estimations have a fixed window of 8 years (96 observations) and a step size of one year.
Source: Authors' calculation.

The interaction term between monetary policy and financial market characteristics is statistically significant for the index of bank market concentration, the non-performing loan rate, the capital asset ratio and the country risk index (Table 11). The non-linear model with interaction terms shows no model specification issues (Table 12).

## Table 11. Long run multipliers of the non-linear ARDL model with interaction terms: Average bank lending rate

Dependent variable: Average bank lending rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary policy rate (MP) | -0.32 | 0.25 | -1.28 | 0.20 |
| Non-performing loan - total credit (NPL) | 0.44 | 0.41 | 1.08 | 0.28 |
| ROE | 0.13 | 0.13 | 1.02 | 0.31 |
| Emerging market bond spread (EMBI) | 0.08 | 0.28 | 0.28 | 0.78 |
| Term spread (TS) | 0.04 | 0.24 | 0.15 | 0.88 |
| HH index outstanding credit (HH) | 17.68 | 18.58 | 0.95 | 0.34 |
| Ratio of capital to total bank assets (C_ASSET) | -0.47** | 0.22 | -2.13 | 0.03 |
| **Interaction terms:** | | | | |
| MP_NPL | -0.10* | 0.05 | -1.90 | 0.06 |
| MP_EMBI | 0.09* | 0.05 | 1.86 | 0.06 |
| MP_HH | 5.47** | 2.37 | 2.31 | 0.02 |
| MP_CA | 0.09*** | 0.03 | 3.01 | 0.00 |
| Speed of adjustment | -0.26 | 0.04 | -6.22 | 0.00 |
| Pass-through | 1.28 | | | |
| No. observations | 228 | | | |
| Adjusted R-squared | 0.99 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The pass-through is computed by taking into account the average value of each variable interacting with the monetary policy rate when the interaction term is statistically significant. The selected best model according to the BIC criterion is a ARDL(2,4,0,0,2,0,0,0,1,1,2,0,0,0).
Source: Authors' calculation.

### Table 12. Specification tests of the non-linear ARDL model: Average bank lending rate

Non-linear model with interaction terms

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 0.25 | 0.62 |
| Durbin-Watson test | 2.10 | 0.44 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 1.80 | 0.18 |

Source: Authors' calculation.

### *Mortgage rate*

Estimates from both the baseline and interaction term model show that the pass-through of monetary policy into the mortgage rate is not complete, with a proportion between 0.43 (baseline model) and 0.68 (interaction term model) of the change in the monetary policy rate being transmitted into the mortgage rate. The pass-through is also slow, as the adjustment takes between 9 months (interaction term model) and one year (baseline). The model with interaction terms is preferred, as diagnostic tests point to serial correlation in the baseline model.

### Table 13. Baseline ARDL model: Mortgage rate

Dependent variable: Mortgage rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| (Intercept) | 0.94*** | 0.37 | 2.53 | 0.01 |
| Mortgage rate (I_HOUSE): lagged | 0.92*** | 0.03 | 36.68 | 0.00 |
| Monetary Policy rate (MP) | 0.03*** | 0.01 | 2.92 | 0.00 |
| Non-performing loan - mortgage credit (NPL_HOUSE) | -0.01 | 0.03 | -0.29 | 0.77 |
| ROE | -0.03*** | 0.01 | -3.89 | 0.00 |
| Emerging market bond spread (EMBI) | -0.04** | 0.02 | -2.24 | 0.03 |
| Term spread | 0.01 | 0.02 | 0.53 | 0.59 |
| HH index mortgage credit (HH_HOUSE) | 2.24*** | 0.66 | 3.41 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -0.02 | 0.02 | -1.19 | 0.23 |
| No. observations | 228 | | | |
| Adjusted R-squared | 0.98 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The selected best model according to the BIC criterion is a ARDL (1,0,0,0,0,0,0,0).
Source: Authors' calculation.

Coefficient estimates from the best baseline ARDL model are provided in Table 13 and the corresponding long run multipliers are reported in Table 14. The measure of country risk (EMBI), the index of banks' market concentration in the mortgage segment of the bank credit market (HH_HOUSE) and the measure of bank profitability (ROE) are statistically significantly correlated with the mortgage rate in the long-run. More specifically, a higher degree of bank's market concentration, measured by the Herfindahl-Hirschman index, is associated to a higher level of the mortgage rate. Higher profitability in the banking sector, measured by the return on equity indicator (ROE), is instead associated with a lower level of the mortgage rate. This may point to asymmetric information causing problems in the banking sector (moral hazard and adverse selection) with banks preferring to rationing credit rather than raise interest rates that would increase the probability of loan default and decreases profitability. A higher country risk, measured by the EMBI spread, is associated with a lower mortgage rate. This counterintuitive result may point to model specification issues.

Results from the model specification tests are reported in Table 15 and the RESET test rejects the null hypothesis of correctness of the functional form. This suggest that introducing non-linearities via interaction terms might be a better modelling approach. Results from the rollover estimation point to some instability in both that speed of adjustment and the pass-through (Table 16). However, no coefficient stability test reject the null hypothesis of coefficient stability over the estimation period.

### Table 14. Long run multipliers in the baseline ARDL model: Mortgage rate

Dependent variable: Mortgage rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary Policy rate (MP): Pass-through | 0.43*** | 0.17 | 2.58 | 0.01 |
| Non-performing loan - mortgage credit (NPL_HOUSE) | -0.11 | 0.39 | -0.27 | 0.79 |
| ROE | -0.35*** | 0.11 | -3.04 | 0.00 |
| Emerging market bond spread (EMBI) | -0.47*** | 0.18 | -2.62 | 0.01 |
| Term spread | 0.13 | 0.25 | 0.50 | 0.62 |
| HH index mortgage credit (HH_HOUSE) | 29.47*** | 5.89 | 5.00 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -0.30 | 0.24 | -1.21 | 0.23 |
| Speed of adjustment : (Mortgage rate: lagged) | -0.08*** | 0.03 | -3.01 | 0.00 |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.
Source: Authors' calculation.

### Table 15. Specification test of the baseline ARDL model: Mortgage rate

Baseline model

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 5.55 | 0.02 |
| Durbin-Watson test | 1.93 | 0.14 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 0.27 | 0.60 |

Source: Authors' calculation.

### Table 16. Rollover estimation: Mortgage rate

| Period | Pass-through | Speed of adjustment |
|---|---|---|
| Jan. 2002 – Dec. 2009 | 0.029 | -0.342 |
| Jan. 2003 – Dec. 2010 | 0.036 | -0.326 |
| Jan. 2004 – Dec. 2011 | 0.100 | -0.308 |
| Jan. 2005 – Dec. 2012 | 0.084 | -0.321 |
| Jan. 2006 – Dec. 2013 | 0.328 | -0.099 |
| Jan. 2007 – Dec. 2014 | 0.154 | -0.122 |
| Jan. 2008 – Dec. 2015 | 0.176 | -0.143 |
| Jan. 2009 – Dec. 2016 | 0.613 | -0.107 |
| Jan. 2010 – Dec. 2017 | 0.440 | -0.210 |
| Jan. 2011 – Dec. 2018 | 0.409 | -0.256 |
| Jan. 2012 – Dec. 2019 | 0.235 | -0.208 |
| Dec. 2012 – Nov. 2020 | 0.454 | -0.272 |

Note: Rolling estimations have a fixed window of 8 years (96 observations) and a step size of one year.
Source: Authors' calculation.

## Table 17. Long run multipliers of the non-linear ARDL model with interaction terms: mortgage rate

Dependent variable: Mortgage rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Intercept | | | | |
| Monetary policy rate (MP) | -2.73*** | 1.01 | -2.71 | 0.01 |
| Non-performing loan - mortgage credit (NPL_HOUSE) | -1.10 | 0.85 | -1.28 | 0.20 |
| ROE | -0.94*** | 0.33 | -2.85 | 0.00 |
| Emerging market bond spread (EMBI) | -1.91*** | 0.61 | -3.12 | 0.00 |
| Term spread (TS) | -1.21*** | 0.44 | -2.73 | 0.01 |
| HH index outstanding mortgage credit (HH_HOUSE) | 17.69*** | 4.80 | 3.69 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -0.10 | 0.21 | -0.49 | 0.63 |
| **Interaction terms:** | | | | |
| MP_NPL | 0.19* | 0.10 | 1.88 | 0.06 |
| MP_ROE | 0.11** | 0.05 | 2.44 | 0.02 |
| MP_EMBI | 0.23** | 0.09 | 2.49 | 0.01 |
| MP_TS | 0.24*** | 0.08 | 3.09 | 0.00 |
| Speed of adjustment : (Mortgage rate: lagged) | -0.11*** | 0.03 | -4.12 | 0.00 |
| Pass-through | 0.68 | | | |
| No. observations | 228 | | | |
| Adjusted R-squared | 0.99 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The pass-through is computed by taking into account the average value of each variable interacting with the monetary policy rate when the interaction term is statistically significant. The selected best model according to the BIC criterion is a ARDL (1,0,0,0,0,1,0,0,0,0,0,1).
Source: Authors' calculation.

Interaction terms are statistically significant for non-performing loan ratio (MP_NPL), bank's profitability (MP_ROE), the country risk index (MP_EMBI) and the term spread (MP_TS) (Table 17). The introduction of non-linearities improves the interpretation of the results. For example, a higher country risk, ceteris paribus, is associated with a higher, or unchanged, mortgage rate for high values of the monetary policy rates that occur more frequently un periods of high inflation and financial turbulence. The non-linear model with interaction terms also does not present model specification issues (Table 18).

## Table 18. Specification test of the non-linear ARDL model: Mortgage rate

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 0.27 | 0.60 |
| Durbin-Watson test | 1.92 | 0.08 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 0.35 | 0.55 |

Source: Authors' calculation.

### *Payroll loan rate*

Estimates from both the baseline and interaction term model show that the pass-through of monetary policy into the payroll loan rate is incomplete, between 0.11 (interaction term model) and 0.2 (baseline), but fast (2 months). The interaction term model points to some significant non-linearities, even though the baseline model does not present any specification issues and is more parsimonious on the number of parameters.

Results from the estimation of the best baseline ARDL model are provided in Table 19, with the corresponding long run multipliers in Table 20. The measure of the country risk (EMBI) and the index of bank concentration (HH_TOT) have a long-run impact on the average bank lending rate that is significantly different from zero. More specifically, a higher degree of market concentration in the banking sector, measured by the Herfindahl-Hirschman index is associated to a higher level of the payroll loan rate. A higher country risk is instead associated with a lower level of the payroll loan rate, though the opposite would be expected. This counterintuitive result may point to model specification issues, even if standard diagnostic tests do not highlight any specification issue Table 21. Results from the rollover estimation point to some instability in the pass-through estimation, which could also be due to the limited sample size (Table 22). However, no coefficient stability test reject the null hypothesis of coefficient stability over the estimation period.

**Table 19. Baseline ARDL model: Payroll loan rate**

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Intercept | -0.92 | 5.52 | -0.17 | 0.87 |
| Trend | 0.06** | 0.03 | 2.43 | 0.02 |
| Payroll loan rate (I_CONS_A): lagged | 0.42*** | 0.07 | 6.00 | 0.00 |
| Monetary Policy rate (MP) | 0.12 | 0.09 | 1.25 | 0.22 |
| Non-performing loan – outstanding consumption credit (NPL_CONS) | -0.42 | 0.26 | -1.64 | 0.11 |
| Non-performing loan – outstanding consumption credit: lagged | -0.38 | 0.43 | -0.89 | 0.38 |
| Non-performing loan - outstanding consumption credit: lagged 2 | 0.04 | 0.47 | 0.09 | 0.93 |
| Non-performing loan - outstanding consumption credit: lagged 3 | 0.70* | 0.39 | 1.79 | 0.08 |
| ROE | -0.49*** | 0.13 | -3.86 | 0.00 |
| ROE: lagged | 0.08 | 0.14 | 0.60 | 0.55 |
| ROE: lagged 2 | 0.35** | 0.12 | 2.93 | 0.01 |
| Emerging market bond spread (EMBI) | -0.08 | 0.15 | -0.56 | 0.58 |
| Emerging market bond spread: lagged | -0.04 | 0.12 | -0.30 | 0.76 |
| Emerging market bond spread: lagged 2 | -0.56 | 0.13 | -4.31 | 0.00 |
| Term spread | -0.07*** | 0.16 | -0.44 | 0.66 |
| HH index outstanding consumption credit (HH_CONS) | 15.79 | 41.30 | 0.38 | 0.70 |
| HH index outstanding consumption credit: lagged | 84.93** | 41.56 | 2.04 | 0.05 |
| Ratio of capital to total bank assets (C_ASSET) | -0.04 | 0.22 | -0.18 | 0.86 |
| No. observations | 56 | | | |
| Adjusted R-squared | 0.88 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The selected best model according to the BIC criterion is a ARDL (1,0,3,2,2,0,1,0)
Source: Authors' calculation.

## Table 20. Long run multipliers of the baseline ARDL model: Payroll loan rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary Policy rate (MP) : Pass-through | 0.20 | 0.16 | 1.31 | 0.20 |
| Non-performing loan – outstanding consumption credit (NPL_CONS) | -0.10 | 0.64 | -0.16 | 0.88 |
| ROE | -0.10 | 0.15 | -0.66 | 0.51 |
| Emerging market bond spread (EMBI) | -1.17*** | 0.41 | -2.82 | 0.01 |
| Term spread | -0.12 | 0.28 | -0.44 | 0.67 |
| HH index outstanding consumption credit (HH_CONS) | 174.60*** | 46.24 | 3.78 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -0.07 | 0.38 | -0.18 | 0.86 |
| Speed of adjustment: (Payroll loan rate: lagged) | -0.58*** | 0.07 | -9.18 | 0.00 |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. Constant and trend are not displayed.
Source: Authors' calculation.

## Table 21. Specification test of the baseline ARDL model: Payroll loan rate

Baseline model

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 1.41 | 0.25 |
| Durbin-Watson test | 2.25 | 0.34 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 1.54 | 0.21 |

Source: Authors' calculation.

## Table 22. Rollover estimation: Payroll loan rate

| Period | Pass-through | Speed of adjustment |
|---|---|---|
| Mar-Apr. 2011 – Jan-Feb. 2019 | 0.29 | -0.53 |
| Jul.-Aug. 2011 – May-Jun. 2019 | 0.31 | -0.52 |
| Nov.-Dec. 2011 – Sep.-Oct. 2019 | 0.23 | -0.50 |
| Mar-Apr. 2012 – Jan-Feb. 2020 | 0.32 | -0.45 |
| Jul.-Aug. 2012 – May-Jun. 2020 | 0.15 | -0.49 |
| Nov.-Dec. 2012 – Sep.-Oct. 2020 | 0.01 | -0.68 |

Note: Rolling estimations have a fixed window of 8 years (48 observations) and a step size of four months.
Source: Authors' calculation.

Interaction terms are statistically significant for non-performing loan ratio (MP_NPL), bank's profitability (MP_ROE) and the country risk index (MP_EMBI) (Table 23) but, overall, the magnitude of their correlation with the payroll loan rate for most of the values assumed by the monetary policy rate over the period is small. Thus, the financial factor that is mostly associated with the payroll loan rate is the index of bank concentration in the credit consumption market. The non-linear model with interaction terms also does not present model specification issues (Table 24).

## Table 23. Long run multipliers of the non-linear ARDL model with interaction terms: Payroll loan rate

Dependent variable: Payroll loan rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary policy rate (MP) | 0.13 | 1.09 | 0.12 | 0.90 |
| Non-performing loan – outstanding consumption credit (NPL_CONS) | 2.00* | 1.09 | 1.84 | 0.07 |
| ROE | -1.21*** | 0.23 | -5.22 | 0.00 |
| Emerging market bond spread (EMBI) | 0.04 | 0.60 | 0.07 | 0.95 |
| HH index outstanding consumption credit (HH_CONS) | 115.98*** | 31.01 | 3.74 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -0.78** | 0.30 | -2.63 | 0.01 |
| Term spread (TS) | -0.09 | 0.16 | -0.56 | 0.58 |
| Interaction terms: | | | | |
| MP_NPL | -0.49** | 0.22 | -2.19 | 0.03 |
| MP_ROE | 0.19*** | 0.04 | 5.14 | 0.00 |
| MP_EMBI | -0.15* | 0.09 | -1.70 | 0.10 |
| Speed of adjustment: (Payroll loan rate: lagged) | | | | |
| Pass-through | 0.11 | | | |
| No. observations | 56 | | | |
| Adjusted R-Squared | 0.91 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The pass-through is computed by taking into account the average value of each variable interacting with the monetary policy rate when the interaction term is statistically significant. Constant and trend are not displayed. The selected best model according to the BIC criterion is a ARDL (1,0,3,2,1,1,0,0,1,0).
Source: Authors' calculation.

## Table 24. Specification tests of the non-linear ARDL model: Payroll loan rate

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 1.77 | 0.19 |
| Durbin-Watson test | 2.35 | 0.36 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 2.67 | 0.10 |

Source: Authors' calculation.

### *Automotive loan rate*

Estimates from both the baseline and interaction term model show that the pass-through of monetary policy into the payroll loan rate is incomplete, with a proportion between 0.36 (baseline model) and 0.42 (interaction term model) of the change in the monetary policy rate being transmitted to the payroll loan rate, but fast (2-3 months). The baseline and the interaction-terms model provide very similar results. The baseline model is more parsimonious (less parameters to estimate) but presents a potential issue of serial correlation. The interaction term model has no model specification issues but no interaction term is statistically significant and interpretation of results is counterintuitive.

Coefficient estimates of the best baseline ARDL model are provided in Table 25, and the corresponding long run multipliers are shown in Table 26. The index of bank concentration (HH_CONS), the measure of bank profitability (ROE) and the bank capital leverage measure (C_ASSET) are all statistically significantly correlated with the automotive loan rate in the long-run. A higher degree of market concentration in the banking sector, measured by the Herfindahl-Hirschman index, and an increase in bank leverage, measured by the capital–to–asset ratio, are associated with a higher level of the automotive loan rate.

Instead, an increase in bank profitability, measured by the return on equity indicator (ROE), is associated with a lower level of the automotive loan rate. This may point to asymmetric information causing problems in the banking sector (moral hazard and adverse selection) with banks preferring to rationing credit rather than raise interest rates that would increase the probability of loan default and decreases profitability.

Results from the model specification tests are reported in Table 27 and highlight a potential issue of serial correlation. Moreover, the RESET test barely fails to reject the null hypothesis of correctness of the functional form. Results from the rollover estimation show that the point estimate of the pass-through and the speed of adjustment are stable over time (Table 28).

## Table 25. Baseline ARDL model: Automotive loan rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Intercept | 2.9 | 4.3 | 0.7 | 0.50 |
| Trend | 0.0* | 0.0 | 1.8 | 0.07 |
| Automotive loan rate (I_CONS_B): lagged | 0.3** | 0.1 | 2.5 | 0.02 |
| Monetary Policy rate (MP) | -0.2 | 0.2 | -1.0 | 0.32 |
| Monetary Policy rate: lagged | 0.4* | 0.3 | 1.7 | 0.09 |
| Non-performing loan – outstanding consumption credit (NPL_CONS) | 0.1 | 0.2 | 0.4 | 0.72 |
| ROE | 0.1** | 0.1 | 2.4 | 0.02 |
| Emerging market bond spread (EMBI) | -0.1 | 0.1 | -0.7 | 0.47 |
| Emerging market bond spread: lagged | -0.2*** | 0.1 | -2.6 | 0.01 |
| Emerging market bond spread: lagged 2 | 0.2* | 0.1 | 1.9 | 0.06 |
| Term spread | -0.3** | 0.1 | -2.5 | 0.02 |
| Term spread: lagged | 0.4*** | 0.1 | 3.4 | 0.00 |
| HH index outstanding consumption credit (HH_CONS) | 32.7* | 18.7 | 1.8 | 0.09 |
| Ratio of capital to total bank assets (C_ASSET) | -0.4** | 0.2 | -2.4 | 0.02 |
| No. observations | 57 | | | |
| Adjusted R-Squared | 0.94 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The selected best model according to the BIC criterion is a ARDL (1,1,0,0,2,1,0,0)
Source: Authors' calculation.

## Table 26. Long run multipliers of the baseline ARDL model: Automotive loan rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary Policy rate (MP) : Pass-through | 0.36*** | 0.10 | 3.68 | 0.00 |
| Non-performing loan - outstanding consumption credit (NPL_CONS) | 0.09 | 0.24 | 0.36 | 0.72 |
| ROE | 0.20* | 0.10 | 1.93 | 0.06 |
| Emerging market bond spread (EMBI) | -0.20 | 0.25 | -0.77 | 0.45 |
| Term spread | 0.09 | 0.12 | 0.71 | 0.48 |
| HH index consumption credit (HH_CONS) | 48.14* | 27.76 | 1.73 | 0.09 |
| Ratio of capital to total bank assets (C_ASSET) | -0.55** | 0.24 | -2.32 | 0.03 |
| Speed of adjustment: : (automotive loan rate, lagged) | -0.68*** | 0.12 | -5.31 | 0.00 |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. Constant and trend are not displayed.
Source: Authors' calculation.

## Table 27. Specification test of the baseline ARDL model: Automotive loan rate

Baseline model

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 2.16 | 0.13 |
| Durbin-Watson test | 2.37 | 0.58 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 3.52 | 0.06 |

Source: Authors' calculation.

## Table 28. Rollover estimation: Automotive loan rate

| Period | Pass-through | Speed of adjustment |
|---|---|---|
| Mar-Apr. 2011 – Jan-Feb. 2019 | 0.45 | -0.59 |
| Jul.-Aug. 2011 – May-Jun. 2019 | 0.39 | -0.66 |
| Nov.-Dec. 2011 – Sep.-Oct. 2019 | 0.33 | -0.70 |
| Mar-Apr. 2012 – Jan-Feb. 2020 | 0.36 | -0.67 |
| Jul.-Aug. 2012 – May-Jun. 2020 | 0.45 | -0.64 |
| Nov.-Dec. 2012 – Sep.-Oct. 2020 | 0.42 | -0.65 |

Source: Authors' calculation.

## Table 29. Long run multipliers of the non-linear ARDL model with interaction terms: automotive loan rate

Dependent variable: Automotive loan rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary policy rate (MP) | -0.50 | 2.22 | -0.23 | 0.82 |
| Non-performing loan – outstanding consumption credit (NPL_CONS) | -0.31* | 0.18 | -1.73 | 0.09 |
| ROE | 0.06*** | 0.02 | 2.62 | 0.01 |
| Emerging market bond spread (EMBI) | -1.04*** | 0.40 | -2.62 | 0.01 |
| HH index outstanding consumption credit (HH_CONS) | 21.80 | 66.15 | 0.33 | 0.74 |
| Ratio of capital to total bank assets (C_ASSET) | -0.45* | 0.23 | -1.93 | 0.06 |
| Term spread (TS) | 0.06 | 0.33 | 0.19 | 0.84 |
| **Interaction terms:** | | | | |
| MP_TS | 0.02 | 0.06 | 0.27 | 0.79 |
| MP_HH | 4.06 | 14.27 | 0.28 | 0.78 |
| MP_EMBI | 0.09 | 0.07 | 1.31 | 0.20 |
| Speed of adjustment: : (automotive loan rate, lagged) | -0.82*** | 0.15 | -5.5 | 0.00 |
| Pass-through | 0.42 | | | |
| No. observations | 57 | | | |
| Adjusted R-Squared | 0.92 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The pass-through is computed by taking into account the average value of each variable interacting with the monetary policy rate when the interaction term is statistically significant. Constant and trend are not displayed. The selected best model according to the BIC criterion is a ARDL (1,0,0,0,0,0,0,0,1,2,1).
Source: Authors' calculation.

The estimation of the model with interaction terms finds that no interaction term is statistically significant (Table 29), and the sign of the correlation of ROE, country risk measure (EMBI) and non-performing loan rate are the opposite of what would be expected, making interpretation of results difficult. Standard diagnostic tests, however, do not highlight any model specification issue (Table 30).

### Table 30. Specification test of the non-linear ARDL model: Automotive loan rate

Non-linear model with interaction terms

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 0.73 | 0.40 |
| Durbin-Watson test | 2.27 | 0.13 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 2.56 | 0.11 |

Source: Authors' calculation.

### *Credit card rate*

Estimates from both the baseline and interaction term model show that the pass-through of monetary policy into the credit card rate is incomplete, with a proportion between 0.42 (baseline model) and 0.5 (interaction term model) of the change in the monetary policy rate being transmitted into the credit card rate , but fast (2 months). The two models provide similar results in terms of pass-through and speed of adjustments and present no model specification issues. However, the model with interaction terms is preferred for the presence of statistically significant interaction terms and provides an easier interpretation of results.

Results from the estimation of the best baseline ARDL model are provided in Table 31, with the corresponding long run multipliers in Table 32. The measure of the country risk (EMBI), the index of bank concentration (HH_TOT), the non-performing loan ratio (NPL_CONS) and the ratio of capital to bank assets (C_ASSET) all have a long-run impact on the average bank lending rate that is significantly different from zero. More specifically, a higher degree of market concentration in the banking sector, measured by the Herfindahl-Hirschman index, a higher country risk, bank deleveraging, measured by the capital-to–asset ratio, and a deterioration in the consumption credit portfolio, measured by an increase in the non-performing loan ratio, are all associated with a lower credit rate. These results are however counterintuitive as, for example, the expected impact of a higher market concentration on the credit card rate would have an opposite sign, and may point to model specification issues.

### Table 31. Baseline ARDL model: Credit card rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Intercept | 46.56*** | 8.54 | 5.45 | 0.00 |
| Credit card rate (I_CC): lagged | 0.13 | 0.13 | 0.95 | 0.35 |
| Credit card rate (I_CC): lagged 2 | -0.18 | 0.13 | -1.33 | 0.19 |
| Monetary Policy rate (MP) | -0.96*** | 0.34 | -2.80 | 0.01 |
| Monetary Policy rate: lagged | 1.91*** | 0.59 | 3.21 | 0.00 |
| Monetary Policy rate: lagged 2 | -0.95 | 0.61 | -1.55 | 0.13 |
| Monetary Policy rate: lagged 3 | 0.43 | 0.36 | 1.21 | 0.23 |
| Non-performing loan (NPL_CONS): | -0.52 | 0.33 | -1.56 | 0.13 |
| Non-performing loan: lagged | 1.17** | 0.57 | 2.04 | 0.05 |
| Non-performing loan: lagged 2 | -0.14 | 0.66 | -0.22 | 0.83 |
| Non-performing loan: lagged 3 | -1.86*** | 0.50 | -3.73 | 0.00 |
| ROE | 0.10 | 0.11 | 0.85 | 0.40 |

| | | | | |
|---|---|---|---|---|
| Emerging market bond spread (EMBI) | -0.46** | 0.20 | -2.36 | 0.02 |
| Term spread | 0.09 | 0.24 | 0.38 | 0.71 |
| Term spread: lagged | 0.54** | 0.21 | 2.55 | 0.02 |
| HH index outstanding consumption credit (HH_CONS) | -51.26*** | 14.71 | -3.48 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -1.37*** | 0.30 | -4.58 | 0.00 |
| Ratio of capital to total bank assets: lagged | 1.20*** | 0.27 | 4.50 | 0.00 |
| Ratio of capital to total bank assets: lagged 2 | -0.76*** | 0.28 | -2.73 | 0.01 |
| No. observations | 56 | | | |
| Adjusted R-Squared | 0.87 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The selected best model according to the BIC criterion is a ARDL (2,3,3,0,0,1,0,1)
Source: Authors' calculation.

## Table 32. Long run multipliers of the baseline ARDL model: Credit card rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary Policy rate (MP) : Pass-through | 0.42*** | 0.11 | 3.68 | 0.00 |
| Non-performing loan - outstanding consumption credit (NPL_CONS) | -1.29*** | 0.42 | -3.04 | 0.00 |
| ROE | 0.09 | 0.11 | 0.83 | 0.41 |
| Emerging market bond spread (EMBI) | -0.44** | 0.18 | -2.47 | 0.02 |
| Term spread | 0.60*** | 0.20 | 3.07 | 0.00 |
| HH index consumption credit (HH_CONS) | -48.92*** | 14.64 | -3.34 | 0.00 |
| Ratio of capital to total bank assets (C_ASSET) | -0.88** | 0.35 | -2.51 | 0.02 |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. Constant and trend are not displayed.
Source: Authors' calculation.

The model specification tests are reported in Table 33, and the RESET test barely fails to reject the null hypothesis of correctness of the functional form. This suggests that introducing non-linearities via interaction terms might be a correct modelling approach. Results from the rollover estimation suggest that pass-through and the speed of adjustment have remained stable over time (Table 34). However, no coefficient stability test rejects the null hypothesis of coefficient stability over the estimation period.

## Table 33. Specification test of the baseline ARDL model: Credit card rate

Baseline model

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 2.39 | 0.11 |
| Durbin-Watson test | 2.10 | 0.20 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 0.41 | 0.52 |

Source: Authors' calculation.

### Table 34. Rollover estimation: Credit card rate

| Period | Pass-through | Speed of adjustment |
|---|---|---|
| Mar-Apr. 2011 – Jan-Feb. 2019 | 0.58 | -1.14 |
| Jul.-Aug. 2011 – May-Jun. 2019 | 0.56 | -1.11 |
| Nov.-Dec. 2011 – Sep.-Oct. 2019 | 0.54 | -1.02 |
| Mar-Apr. 2012 – Jan-Feb. 2020 | 0.62 | -1.08 |
| Jul.-Aug. 2012 – May-Jun. 2020 | 0.56 | -0.99 |
| Nov.-Dec. 2012 – Sep.-Oct. 2020 | 0.56 | -1.02 |

Source: Authors' calculation.

Interaction terms are statistically significant for the index of bank market concentration, the non-performing loan rate (MB_NPL), the index of market concentration (MB_HH), the return on equity (MB_ROE) and the country risk index (MB_EMBI) (Table 35). The introduction of non-linearities improves the interpretation of the results. For example, a higher degree of market concentration, ceteris paribus, is associated with a higher, or unchanged, credit card rate for most (66%) of the monetary policy rates that occurred over the period 2010-20. The non-linear model with interaction terms also does not present model specification issues (Table 36).

### Table 35. Long run multipliers of the non-linear ARDL model with interaction terms: Credit card rate

Dependent variable: Credit card rate

| Regressors | Estimate | Standard error | t-value | Pr(>\|t\|) |
|---|---|---|---|---|
| Monetary policy rate (MP) | 4.3 | 5.6 | 0.8 | 0.4 |
| Non-performing loan – outstanding consumption credit (NPL_CONS) | -7.6*** | 2.1 | -3.6 | 0.0 |
| ROE | 1.5*** | 0.4 | 3.5 | 0.0 |
| Emerging market bond spread (EMBI) | -3.4*** | 1.0 | -3.4 | 0.0 |
| HH index outstanding consumption credit (HH_CONS) | 231.6 | 160.9 | 1.4 | 0.2 |
| Term spread (TS) | 0.5*** | 0.2 | 2.3 | 0.0 |
| **Interaction terms:** | | | | |
| MP_NPL | 1.6*** | 0.5 | 3.5 | 0.0 |
| MP_ROE | -0.3*** | 0.1 | -3.4 | 0.0 |
| MP_EMBI | 0.6*** | 0.2 | 3.6 | 0.0 |
| MP_HH | -51.9* | 32.2 | -1.6 | 0.1 |
| Speed of adjustment: : (credit card rate, lagged) | -0.82 | | | |
| Pass-through | 0.49 | | | |
| No. observations | 56 | | | |
| Adjusted R-Squared | 0.876 | | | |

Note: Statistical significance: *** p<0.01, ** p<0.05, * p<0.1. The pass-through is computed by taking into account the average value of each variable interacting with the monetary policy rate when the interaction term is statistically significant. Constant and trend are not displayed. The selected best model according to the BIC criterion is a ARDL (1,0,0,0,2,0,2,0,0,2,1).
Source: Authors' calculation.

### Table 36. Specification test of the non-linear ARDL model: Credit card rate

Non-linear model with interaction terms

| Specification Test | Statistic | p-value |
|---|---|---|
| RESET test | 0.01 | 0.91 |
| Durbin-Watson test | 2.25 | 0.31 |
| Breusch-Godfrey test for serial correlation of order up to 1 | 2.05 | 0.15 |

Source: Authors' calculation.

## References


Andries, N. and S. Billon (2016), "Retail bank interest rate pass-through in the euro area: An empirical survey", *Economic Systems*, Vol. 40/1, pp. 170-194, https://doi.org/10.1016/j.ecosys.2015.06.001. [16]

Bai and P. Perron (1998), "Estimating and testing linear models with multiple structural changes", *Econometrica*, Vol. 66/1, pp. 47-68, https://doi.org/10.2307/2998540. [29]

Banxico (2022), *Informe trimestral Abril - Junio*. [5]

Banxico (2016), "Cambios Recientes en el Mecanismo de Transmisión de la Política Monetaria en México", *Extracto del Informe Trimestral* Enero – Marzo 2016, Recuadro 2, pp. 47-52, https://www.banxico.org.mx/publicaciones-y-prensa/informes-trimestrales/recuadros/%7B4E9CF0BE-8E0B-B599-6500-6553239FEF8B%7D.pdf. [2]

Barquero-Romero, J. and L. Cendra-Villalobos (2020), "Traspaso de la tasa de política monetaria en Costa Rica de 2000 a 2018", *Banco Central de Costa Rica Documento de Trabajo* No. 1, https://repositorioinvestigaciones.bccr.fi.cr/handle/20.500.12506/334. [17]

Bátiz-Zuk, E. and J. Lara Sánchez (2021), "Measuring the evolution of competition and the impact of the financial reform in the Mexican banking sector, 2008-2019", *Banco de México Working Papers*, Vol. 2021/06, https://www.banxico.org.mx/publicaciones-y-prensa/documentos-de-investigacion-del-banco-de-mexico/%7B84054C36-CC98-4337-0DF8-EDE678F2F4DA%7D.pdf. [22]

Becker, R., D. Osborn and D. Yildrim (2012), "A threshold cointegration analysis of interest rate pass-through to UK mortgage rates", *Economic Modelling*, Vol. 29/6, pp. 2504-2513, https://doi.org/10.1016/j.econmod.2012.08.004. [9]

Bulíř, A. and J. Vlček (2015), "Monetary Transmission: Are Emerging Market and Low Income Countries Different?", *IMF Working Papers No. 15/239*. [18]

Cañon, C., E. Cortes and R. Guerrero (2020), "Bank Competition and The Price of Credit: Evidence Using Mexican Loan Level Data", *Inter-American Development Bank Working Papers* No. 1103, http://dx.doi.org/10.18235/0002521. [24]

Cantú, C. et al. (2019), "A loan-level analysis of bank lending in Mexico", *BIS Working Paper No. 802*, https://www.bis.org/publ/work802.htm. [21]

Cottarelli, C. and A. Kourelis (1994), "Financial structure, bank lending rates and the transmission mechanism of Moentary Policy", *IMF Staff Paper* No. 41, https://doi.org/10.2307/3867521. [14]

Égert, B. and R. MacDonald (2009), "Monetary Transmission Mechanism in Central and Eastern Europe: Surveying the Surveyable", *Jounral of Policy Modelling*, Vol. 23/2, pp. 273-327, https://doi.org/10.1111/j.1467-6419.2008.00563.x. [8]

Gregor, J. and M. Melecký (2018), "The pass-through of monetary policy rate to lending rates: The role of macro-financial factors", *Economic Modelling*, Vol. 73, pp. 71-88, https://doi.org/10.1016/j.econmod.2018.03.003. [15]

Herman, A. and A. Klemm (2019), "Financial Deepening in Mexico", *Journal of Banking and Financial Economics*, Vol. 1/11, http://www.wz.uw.edu.pl/portaleFiles/3842-journal-of-b/issues/JBFE_1(11)2019.pdf. [19]

Hofmann, B. (2004), "Interest rate pass-through and monetary transmission: Evidence from individual financial institutions' retail rates", *Economica*, Vol. 71/281, pp. 99-123, https://doi.org/0.1111/j.0013-0427.2004.00359.x. [10]

Jiří, G. (2021), "Interest Rate Pass-Through: A Meta-Analysis Of The Literature", *Journal of Economic Surveys*, Vol. 35/1, pp. 141-191. [13]

Maravalle, A. and A. Gonzaléz Pandiella (2022), "Expanding access to finance to boost growth and reduce inequalities in Mexico", *OECD Economic Department Working Papers No. 1717*. [6]

Medina Cas, S., A. Carrion-Menendez and F. Frantischek (2011), "The Policy Interest-Rate Pass-Through in Central America", *IMF Working Papers* No. 11/240, https://www.imf.org/en/Publications/WP/Issues/2016/12/31/The-Policy-Interest-Rate-Pass-Through-in-Central-America-25299. [4]

Mishra, P. et al. (2014), "Monetary policy and bank lending rates in low-income countries: Heterogeneous panel estimates", *Journal of Economic Development*, Vol. 111/C, pp. 117-131, https://doi.org/10.1016/j.jdeveco.2014.08.005. [12]

Natsiopoulos, K. and N. Tzeremes (2022), "ARDL bounds test for cointegration: Replicating the Pesaran et al. (2001) results for the UK earnings equation using R", *Journal of Applied Econometrics*, https://doi.org/10.1002/jae.2919. [27]

Natsiopoulos, K. and N. Tzeremes (2021), "ARDL: ARDL, ECM and Bounds-Test for Cointegration", *R package version 0.1.1*, https://CRAN.R-project.org/package=ARDL. [26]

Nguyen, C. (2018), "The Mexican interest rate pass-through in the post-U.S. subprime mortgage crisis era", *The international trade journal*, Vol. 32/1, pp. 100-115. [3]

OECD (2022), *OECD Economic Surveys: Mexico 2022*, OECD publishing, Paris. [31]

OECD (2019), *OECD Economic Surveys: Mexico 2019*, OECD Publishing, Paris, https://doi.org/10.1787/a536d00e-en. [20]

Ozdemir, N. and C. Altinoz (2012), ""Determinants of Interest Rate Pass-through for Emerging Market Economies: The Role of Financial Market Structure", *International Advances in Economic Research*, Vol. 18/4, pp. 397-407, https://doi.org/10.1007/s11294-012-9377-9. [11]

Perron, P. (2006), "Dealing with structural breaks", *in T.C. Mills, K. Patterson (Eds.), Palgrave Handbook of Econometrics, Vol. 1: Econometric Theory*, Vol. , Palgrave Macmillan, New York. [30]

Pesaran, M. and Y. Shin (1999), "An Autoregressive Distributed-Lag Modelling Approach to Cointegration Analysis", *in S. Strøm (Ed.) Econometrics and Economic Theory in the 20th Century: The Ragnar Frisch Centennial Symposium* , Cambridge University Press, pp. 371 - 413, https://doi.org/10.1017/CCOL521633230.011. [25]

Pesaran, M., Y. Shin and R. Smith (2001), "Bounds testing approaches to the analysis of level relationships", *Journal of Applied Econometrics*, Vol. 16, pp. 289-326, https://doi.org/10.1002/jae.616. [28]

Rousseas, S. (1985), “A Markup Theory of Bank Loan Rates”, *Journal of Post Keynesian Economics* 8. [7]

Sidaoui, J. and M. Ramos-Francia (2008), “The Monetary Transmission Mechanism in Mexico: Recent Developments”, *in Transmission Mechanisms for Monetary Policy in Emerging Market Economies, BIS Papers* No. 35, pp. 363-394, https://www.bis.org/publ/bppdf/bispap35.pdf. [1]

Téllez-León, I. and F. Venegas-Martínez (2019), “Determinants of Financial Deepening in Mexico: A Dynamic Panel Data Approach”, *Revista De Métodos Cuantitativos Para La Economía Y La Empresa* No. 27, pp. 285-299, https://www.upo.es/revistas/index.php/RevMetCuant/article/view/2761. [23]