

Pérez-Reyna, David; Rodríguez Barraquer, Tomás; Tovar Mora, Jorge Andrés

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Competition in the Colombian banking sector

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WORKING PAPER N° IDB-WP-1659

Competition in the Colombian Banking Sector

David Pérez-Reyna
Tomás Rodríguez
Jorge Tovar

Inter-American Development Bank
Department of Research and Chief Economist

March 2025



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David Pérez-Reyna
Tomás Rodríguez
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Universidad de los Andes

Inter-American Development Bank
Department of Research and Chief Economist

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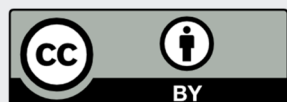
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Abstract

In this paper, we analyze the competition in the Colombian banking sector using bank-level monthly balance sheet information. We estimate the changes in measures of market power due to the exogenous introduction of a liquidity regulation. Our results suggest that introducing a net stable funding ratio increased the Lerner index in the short term, thus signaling a higher exercise of market power. We rationalize these changes in a simple theoretical model that allows us to analyze the tightening of liquidity requirements for banks. Our empirical results are consistent with banks with higher market power in the loan market than in the deposit market.

JEL classifications: E44, G21, L13

Keywords: Competition, Banking sector, Liquidity regulation

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1 Introduction

The spread between loan and deposit rates negatively correlates with GDP per capita (Greenwood, Sanchez and Wang, 2010). It is plausible that the observed correlation can be attributed to the significant market power held by financial institutions. Indeed, as noted by Corvoisier and Gropp (2002), two opposing hypotheses can explain banks' pricing behavior. The first is collusion, which implies using market power to extract rents. With lower competition, banks can charge higher interest rates for loans and earn the spread. Significant interest rate spreads cause lower investment, which translates into lower production. In this way, lack of competition in the banking sector can have first-order effects on welfare. On the other hand, concentration can promote overall competition as more efficient banks grow faster than less efficient ones. This implies that it is plausible that banking concentration can balance social welfare and banking stability (Benchimol and Bozou, 2024).

In this paper, we analyze the competition in the Colombian banking sector using bank-level monthly balance sheet information. We estimate the changes in measures of market power due to the exogenous introduction of a liquidity regulation. Our results suggest that introducing a net stable funding ratio increased the Lerner index in the short term, thus signaling a higher exercise of market power, although on average, the effect is negative. We rationalize these changes in a simple theoretical model that allows us to analyze the tightening of liquidity requirements for banks. Our empirical results are consistent with banks with higher market power in the loan market than in the deposit market.

We estimate the net interest margin (NIM) to measure bank profitability and relate it to competition. Overall, the relationship between market power and bank competition is complex. It is an empirical issue to determine whether regulatory norms affected market power and if they boosted competition temporarily or permanently. We contribute to this debate by exploiting a regulatory change in Colombia.

In response to the financial crisis of 2007-2008, the Basel Committee on Banking Supervision (BCBS) introduced Basel III in November 2010. Originally scheduled to be implemented between 2013 and 2015, its implementation was repeatedly extended to 1 January 2022 and then again to March 2022 .

Basel III aims to strengthen banks' regulation, supervision, and risk management and make them more resilient to financial shocks. Among the three key elements that Basel III considers,

our paper will focus on the third issue, liquidity requirements, and its effect on banking competition in Colombia. Specifically, we analyze the effect of introducing the net stable funding ratio (NSFR), which is the ratio between available stable funding and required stable funding, focusing on long-term liquidity requirements. The NSFR is based on the principle that banks should have a stable funding base to support their activities.

In July 2019, the Superintendencia Financiera (SF), Colombia's banking sector regulator, implemented the NSFR with a phased-in approach initially set for large banks at 80% in March 2020, which increased to 90% in March 2021 and finally 100% in March 2022 (Hernández Correa, 2023).

The NSFR has been generally well-received by the Colombian banking industry, and for the most part, banks met the NSFR requirements, but within the industry, competition for fresh resources arose. A direct implication of this latter claim is that the interest rate for certificates of deposits increased, leading to stiffer competition, as measured by a lower Lerner index (Perez-Reyna and Tovar, 2023).

Our paper contributes to this ongoing discussion by analyzing the effect of NSFR on competition within the Colombian banking system. By considering the implications for liquidity creation, fragility, profitability across banks of different sizes, and the specificities of a developing country setting, we aim to offer a comprehensive perspective on the consequences of NSFR implementation in the Colombian context.

We use publicly available monthly balance sheet data for the banking sector in Colombia between January 2015 and December 2023. We estimate the potential impact of the NSFR regulation on market power. Controlling for key variables that consider the quarterly macroeconomic environment and the effects of the pandemic on banks, we find that the exercise of bank market power increases up to the first eight quarters after the introduction of the NSFR regulation. We assess the robustness of our findings by constructing synthetic controls for the average lending rate, average deposit rate, and interest rate spread for various countries.

To rationalize our findings we propose a three-period model with heterogeneous banks with differing productivity to rationalize our empirical results. There are two representative households: one that supplies one-period savings and one that supplies two-period savings. The former are liquid deposits, and the latter are term deposits. Our model assumes that the household supplying term deposits derives utility from consumption, which is determined by

the return of a CES aggregate of term deposit varieties. Crucially, banks in our model have a monopsony over these varieties, enabling them to set interest rates that maximize their profits while considering the supply of funds.

We also assume that a representative firm produces the consumption good by demanding capital, which results from a CES aggregator of varieties of loans. Banks in our economy also have a monopoly over varieties of loans and choose the interest rate, considering the demand for loans.

In our model, banks produce loans using deposits and term deposits as inputs. More productive banks can produce more loans with the same level of inputs. However, banks are also subject to a liquidity constraint in the spirit of a net stable funding ratio. When this constraint is binding, interest rates for term deposits and loans deviate from a constant markup or mark-down from marginal costs. Our numerical exercise focuses on analyzing the optimal rates under low and high levels of this requirement.

When the NSFR increases, the liquidity constraint is more binding. This implies that interest rates for term deposits and loans increase since banks need a higher supply of term deposits and a lower demand for loans. As such, both optimal interest rates are increasing in the Lagrange multiplier. Our numerical results suggest that the loan rate increases by more than the deposit rate for parameter values that imply a higher market power in the loan market than in the deposit market, thus causing the model Lerner index to increase.

2 Literature Review

The Colombian banking sector has been the subject of extensive research, with varying findings on concentration, efficiency, and market power. This paper contributes to two main strands in the literature. Firstly, it builds on the analysis of the performance of the Colombian banking system, addressing discrepancies in existing studies regarding concentration, efficiency, and competition between national and foreign banks. Secondly, it explores the impact of the Net Stable Funding Ratio (NSFR) on banks, contributing to the ongoing debate on its effects on profitability, risk, and liquidity creation.

The literature on the Colombian banking system presents conflicting findings regarding concentration and performance. Fernández Moreno and Estrada (2013) suggest that efficiency

has increased, whereas Daude and Pascal (2015) and Rodriguez-Lozano (2019) find the opposite. Galán, Veiga and Wiper (2015), Sarmiento et al. (2013), Rodriguez-Lozano (2019), and Daude and Pascal (2015) argue that national banks are larger but less efficient than foreign banks, with higher market power translating into higher interest rates. Nonetheless, Galán, Veiga and Wiper (2015) and Sarmiento et al. (2013) find relative improvements in the efficiency of the Colombian banking sector. However, Perez-Reyna and Tovar (2023) contend that concentration and competition levels are similar to other industries and banking systems. Furthermore, Fernández, Perez-Reyna and Zuleta (2022) highlight the overall high productivity of Colombia's banking system compared to other sectors.

In this context, our paper contributes by leveraging a regulatory change and analyzing potential changes in banks' market power. By doing so, we aim to reconcile conflicting findings and offer a nuanced understanding of the competitive landscape in the Colombian banking sector.

The second strand of our contribution focuses on the impact of the NSFR on banks. The literature on this topic presents divergent views on how NSFR influences profitability, risk, and liquidity creation. King (2013) suggests a possible reduction in bank profitability due to NSFR, while Dietrich, Hess and Wanzenried (2014) do not find a clear relationship between NSFR and financial metrics such as Return on Assets (ROA) and Return on Equity (ROE) for Western European banks. They also find that most banks in their sample still need to fulfill the minimum requirements for NSFR. Dang (2021) anticipates increased bank profitability with higher NSFR, aligning with the views of Giordana and Schumacher (2017). In this last paper, the authors also find that NSFR causes lower default probabilities in banks from Luxembourg. Similarly, Adesina (2019) concludes that NSFR will likely positively impact bank loan creation in Africa.

Adding to the multifaceted discourse on the impact of the Net Stable Funding Ratio (NSFR), several studies present nuanced perspectives on its influence on various banking operations. The Center for Global Development (2019) and Oduora, Ngokab and Odongo (2017) argue that local banks may face more challenging conditions than global banks. Alaoui Mdaghri and Oubdi (2022) contribute to the debate by positing an adverse effect of NSFR on liquidity creation. This suggests that the regulatory framework may have unintended consequences on the liquidity dynamics within the banking system, thereby warranting further investigation.

Conversely, Chiaramonte and Casu (2017), Papadamou et al. (2021), and Adelopo, Vichou

and Cheung (2022) find that the introduction of NSFR is associated with a decrease in fragility within the financial sector. This implies that the regulatory measure could enhance the stability of banks, potentially reducing the likelihood of systemic crises. However, Papadamou et al. (2021) emphasize that the effects are heterogeneous across banks, with banks with low NSFR experiencing a negative effect on their loan supply when interest rates are high. Gržeta, Žiković and Tomas Žiković (2023) provide additional insights into the differential impact of NSFR on banks of varying sizes. Specifically, the study suggests that NSFR increased profits in large banks but decreased profits in smaller ones. This nuanced finding underscores the importance of considering the heterogeneous nature of financial institutions when assessing the consequences of regulatory changes.

In the context of developing countries, Sharma and Chauhan (2023) find that implementing NSFR resulted in decreased banking loans. Sidhu et al. (2022) also report a decrease in Net Interest Margin (NIM) and an increase in non-performing loans. These findings highlight the potential challenges and trade-offs of implementing global regulatory standards in diverse economic contexts.

Lastly, Gomez-Gonzalez et al. (2023) analyzes loan-level data to counteract possible endogeneity in their measurements of competition. We use a complementary strategy: we will analyze bank-level data and exploit the introduction of the NSFR requirements on competition. Considering the exogenous nature of this policy, the effect of this requirement on banking competition measurements indicates the level of competition in the banking sector in Colombia. Beyond dealing with the endogeneity issues that the paper acknowledges, we work with a time period that captures the current effects as we use data going all the way to December 2023, as opposed to 2019. This time difference is essential if, as we hypothesize, NSFR had a role in the exercise of market power. Lastly, beyond the impact on loans, we also focus on the certificates of deposits market, thus explaining our estimations of the net interest margin.

3 The NSFR in Colombia

The NSFR is described in detail in BIS (2014). Following the 2007-08 global financial crisis, the Basel Committee on Banking Supervision developed two complementary strategies to deal with short-term liquidity risk and reduce longer-term funding risk. The latter is called the NSFR.

The main objective is to guarantee sustainable funding to maintain liquidity following un-

expected shocks to the system. It does so by limiting reliance on short-term wholesale funding, encouraging "better assessment of funding across all on—and off—balance sheet items," and promoting funding stability.¹

Formally, NSFR is described by the formula:

$$\frac{\textit{Amount of stable funding}}{\textit{Required amount of stable funding}} \geq 100\%$$

Importantly for our exercise, the NSFR considers that i) longer-term liabilities are more stable than short-term ones, and ii) short-term (maturing in less than a year) deposits "provided by retail customers and funding provided by small business customers are behaviourally more stable than wholesale funding of the same maturity from other counterparties."² In Colombia, however, the regulator opted to penalize CDs with a maturity lower than six months.

As noted earlier, the NSFR in Colombia was introduced with a transition period and divided financial institutions into two groups.³ The regulator divided the sample in two during the transition period.⁴ Group 1 refers to "banking institutions whose assets represent 2% or more of the banking sector's total assets as of December 31 of the year immediately preceding the calculation cut-off date. The NSFR must always be equal to or greater than 100% for this group of banks." Group 2 refers to "banking institutions whose assets represent less than 2% of the total assets of the banking sector as of December 31 of the year immediately preceding the calculation cut-off date" as well as other institutions that have a significant asset group of credit portfolio and leasing operations. For this group, the NSFR must be equal to or greater than 80%. Without prejudice to the foregoing, the Superintendencia Financiera de Colombia (SuperFinanciera), the Colombian banking supervisory entity, may increase this limit to 100% for any entity in this group, when it is considered necessary based on the supervision processes." Figures 1 and 2 show the evolution of the funding ratio throughout the transition period.

Banks received the new regulation well, and as the central bank increased the reference interest rates during the NSFR adjustment period, as shown in Figure 3, the long-term CD interest rates increased faster than the short-term ones. Naturally, the simple evolution of short—and long-term CD interest rates says little about the real changes.

¹BIS (2014) page 1

²BIS (2014) page 3

³This regulatory requirement is known locally as CFEN.

⁴Circular external 19 de 2019

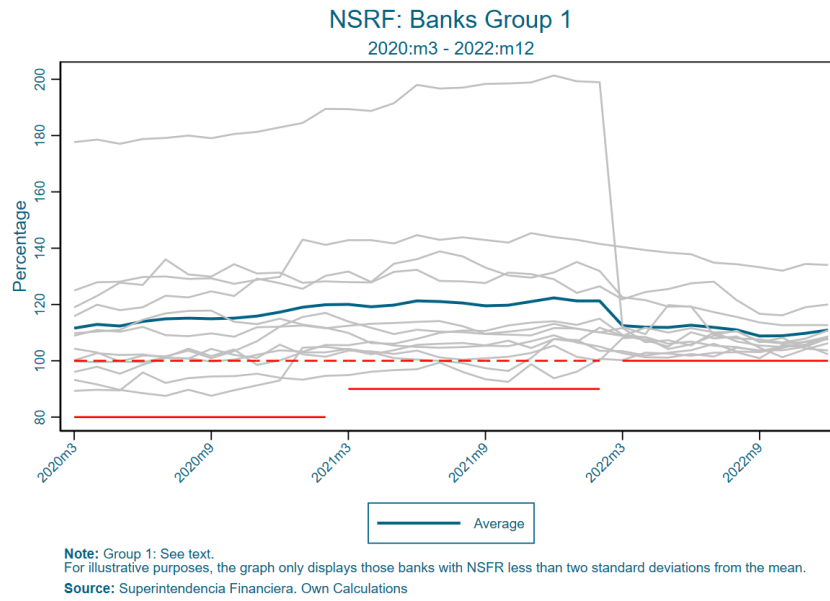


Figure 1: NSFR Transition Period for Group 1 Banks

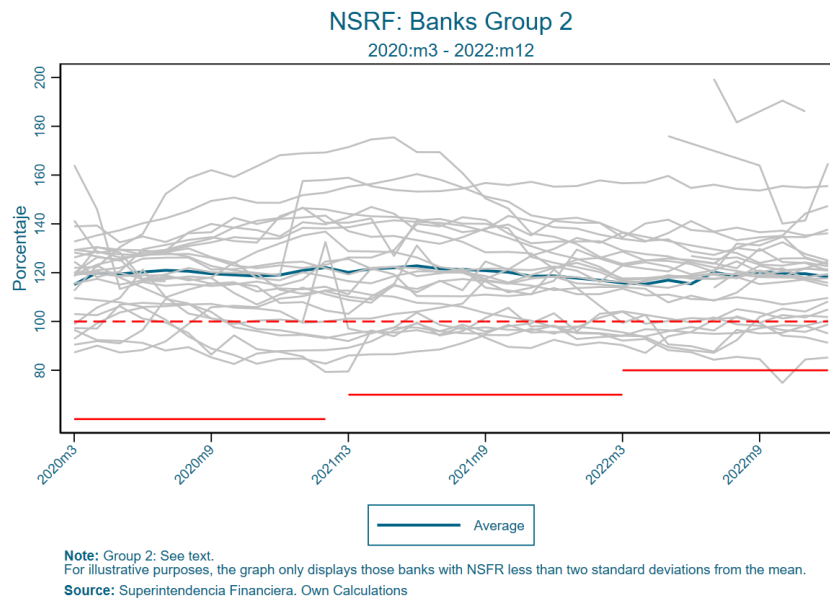


Figure 2: NSFR Transition Period for Group 2 Institutions

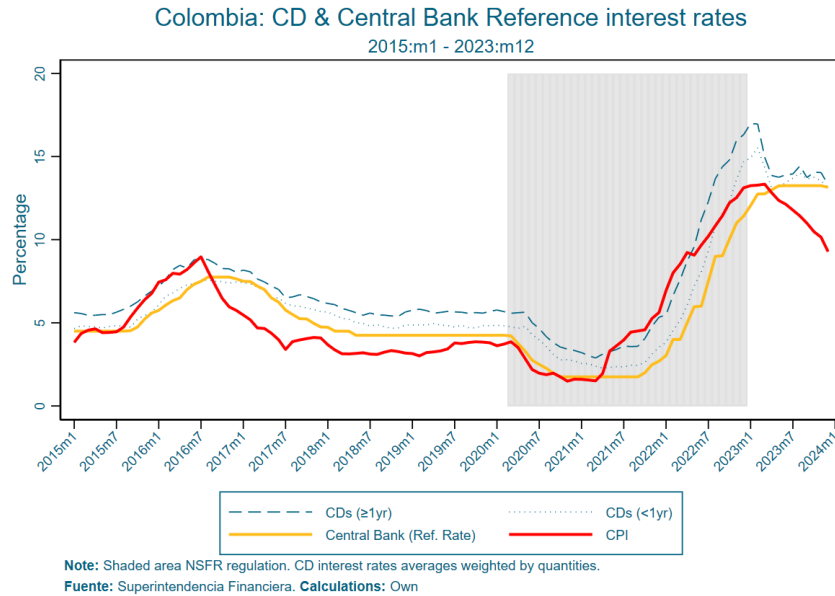


Figure 3: Long vs Short-term Certificates of Deposit

Figure 3 shows that during the second half of the adjustment period, the CPI increased slower than the interest rates, while the Central Bank’s reference rate increment is mostly parallel. A closer look reveals that CDs interest rates grew faster during the last quarter of the adjustment period (shaded area), but as the Central Bank’s interest rate increments stopped and the inflation rate increments slowed down, the CDs interest rate fell and eventually stabilized.

Figure 4 depicts the short and long-term CDs interest rates relative to the Central Bank Interest rate and the CPI. Long-term CDs increased significantly immediately after the NSFR transition period began. Long-term rates stayed relatively high during the first half, but they fell over the second half. Relative to the CPI, the long-term interest rates fell sharply between the last quarter of 2020 and the first semester of 2021, recovering almost steadily after that.

The spread (as measured by the difference between loan interest rates and CD interest rates) can further convey an idea of the banking system’s behavior during the implementation of the NSFR. Figure 5 depicts commercial and consumption interest rate loans minus the CDs interest rates. During the adjustment period, the margin increased for commercial and consumption loans.

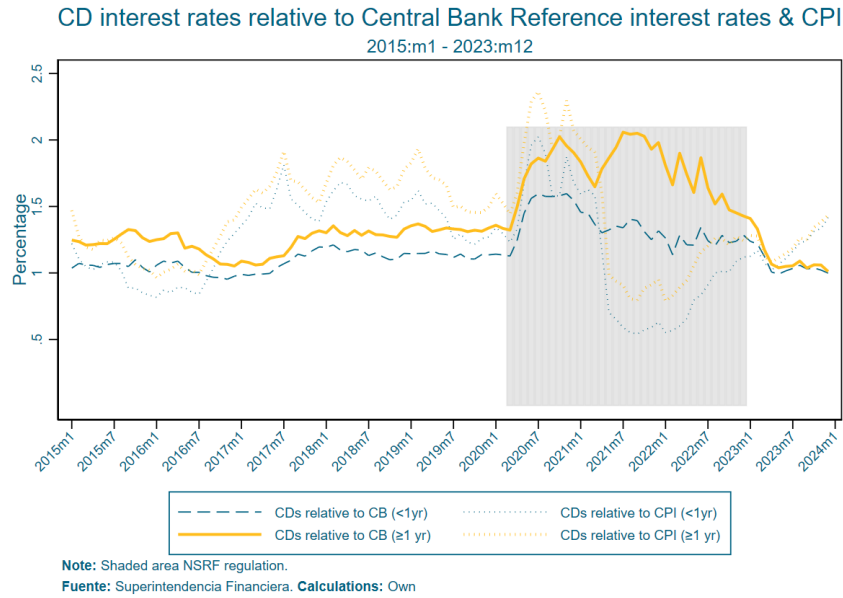


Figure 4: Relative Interest Rates

The above says little about competition in the banking industry, but it suggests some relevant activity during the NSFR implementation period. This leads to the question we seek to explore: did the new regulation foster, maybe inadvertently, stronger competition among banks while seeking fresh resources to comply with the NSFR requirements?

4 Data

We rely on publicly available monthly balance sheet data for the banking sector in Colombia, which is available between January 2015 and December 2023. The data include detailed data on assets, liabilities, equity, and profit and loss statements for each bank supervised by the SFC. Although the NSFR divides bank into two groups, the available dataset covers solely the first group. Thus, we focus on this set of banks.

We also use loan and deposit interest rate data at the bank level. The former, available for the same period, include commercial and consumption loans. The latter, certificate of deposit data, are available per bank and include prices and quantities. Auxiliary information includes information on the number of offices per bank, plus bank-level data on NSFR performance

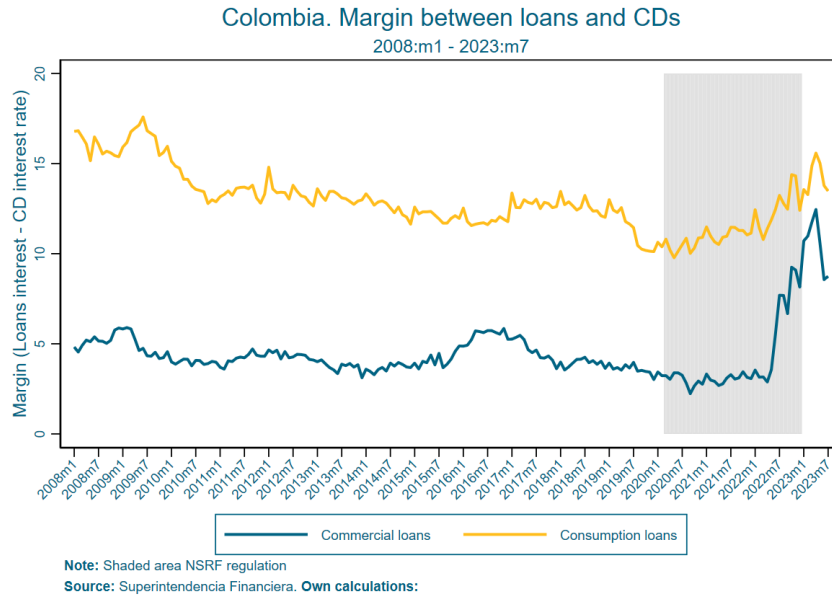


Figure 5: Interest Rate Loans

between March 2020 and December 2022.

5 Measures of Concentration and Market Power

The number of firms in the market is a basic measure of market structure, given that there will be no growth or significant changes in the industry if entry barriers exist. To this end, we use banks defined as such in the SFC dataset. The number of banks oscillates between 22 and 29, implying that entry is (empirically) feasible in the banking industry, as the net number has increased from 25 to 29 in recent years.

Concentration, a measure of market structure, is the first step in determining the potential existence of market power. Focusing on two broad markets, loans and deposits, we estimate the C3 and HHI indicators. The latter is traditionally preferred because it takes into account the firms' average size and the dispersion of their size.

The HHI, of course, can be measured in several ways. We estimate it using total assets and consumer and commercial loans. In our case study, assets serve mostly as descriptive statistics because we are interested in the amounts of loans. Figure 7 depicts both the HHI and the C3 concentration measures.

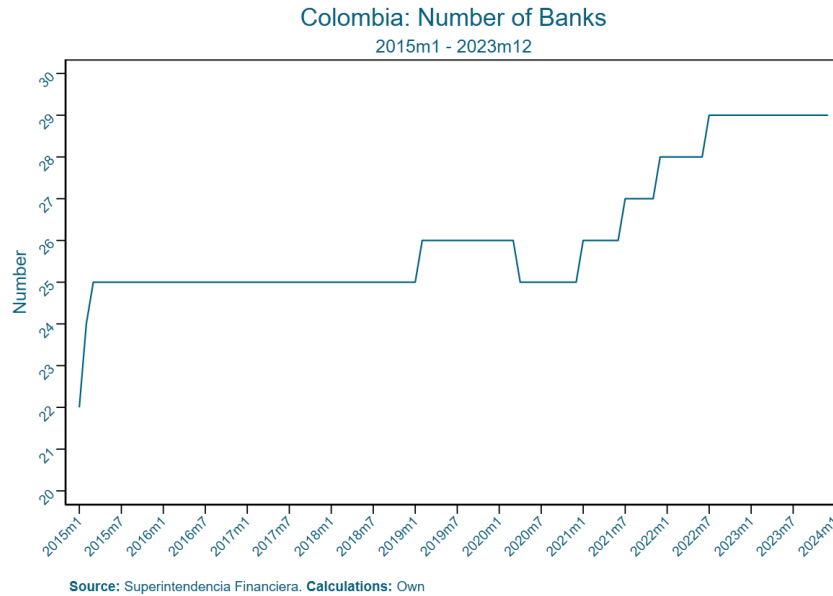


Figure 6: Number of Banks

Competition authorities traditionally focus on markets where the HHI is above 1800, which is not the case in the Colombian banking industry. Similarly, authorities might review a market (normally upon a merger) if the share of the largest firms accounts for over 30% of the market. The C3, whose largest firms account for an average of 25% of the market, reveals that the three largest banks hold just above 50% of the assets.

Figure 8 presents the HHI concentration measure using commercial and consumption loans. HHI for commercial loans is higher than for consumption, but in neither case does it reach levels near the 1800 threshold. The C3 measure suggests that the top three banks hold a bit over 60% of the market, the average market share participation of the largest firm is 15% for consumer loans, and 20% for commercial.

Some might argue that because three banks control around 50% of the market, they could be on a collusion course. There is abundant literature, however, suggesting that in Colombia that is not the case. Daude and Pascal (2015), for instance, using the Panzar and Rosse H-statistic, notes that there is no evidence of a cartel in Colombia. A similar result is reported in Perez-Reyna and Tovar (2023) and Tovar, Jaramillo and Hernández (2011). Others, Gomez-Gonzalez et al. (2023) find a nuanced relationship between the cost of credit and market power.

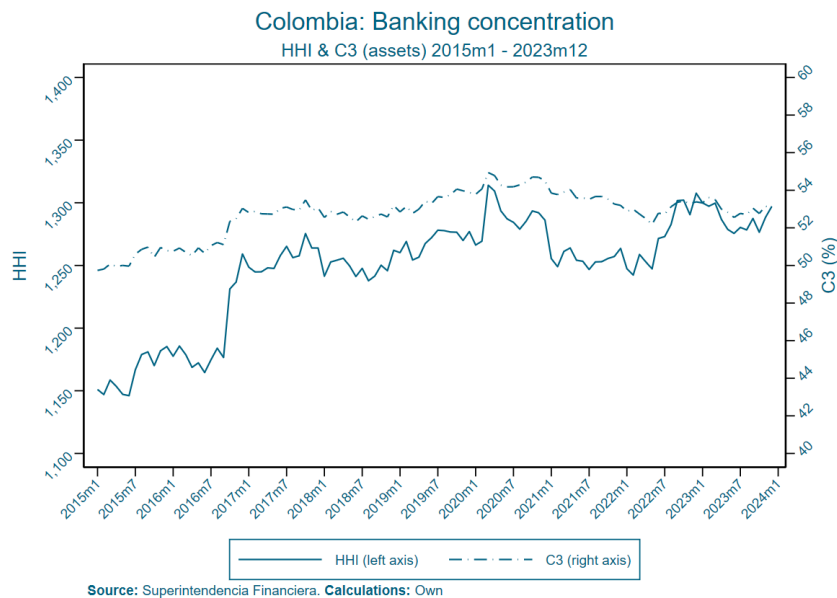


Figure 7: HHI

They say nothing about collusion in the industry, but state that for long credit relationships between bank and client, market power fades, hinting at a competitive market. Lastly, Tabak, Fazio and Cajueiro (2012), using a sample of 10 Latin American countries (albeit, from some years ago), explicitly note that "Peru and Colombia" are the "two most competitive banking markets."

The concentration analysis suggests that, overall, the banking sector is not particularly concentrated, thus explaining why it is not the focus of the competition authority.

The industry's market power can be estimated using alternative approaches. The Lerner Index, as a proxy for market power, is commonly estimated using interest rates (loans and deposits) (Tovar, Jaramillo and Hernández (2011) or the marginal cost (see, for instance, Tan et al., 2021). We favor the former, given its simplicity.

Indeed, the Lerner index, which originates from maximizing the firm's profits, is defined as the difference between the price and the marginal cost divided by the price. Therefore, the indicator varies between zero and one. A lower figure reveals less capacity to exercise market power. Theoretically, if the marginal cost is not observed, it can be inferred econometrically. However, as already noted, in the case of the financial system, this is not necessary because

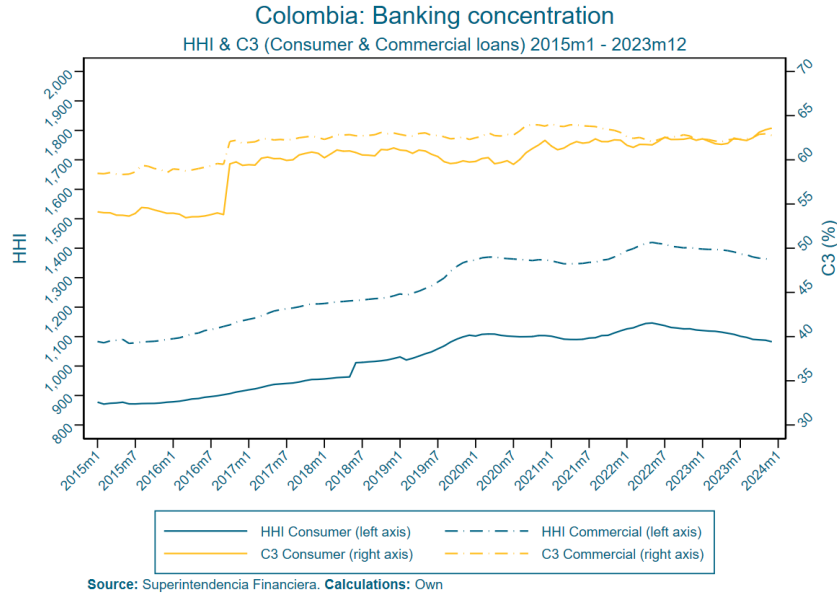


Figure 8: Concentration Measures

there is sufficient information on interest rates. Using data on deposit rates and lending rates for commercial and consumer loans, we have the necessary information to calculate a market power indicator. This indicator is calculated according to the following formula:

$$L_j = \frac{i_j - i^c}{i_j},$$

where i_j is the lending rate in the market for credit type j , and i^c is the deposit rate.

The Lerner index is an indicator of the exercise of market power because it assumes an optimal choice of prices and inputs. That is, there is an efficiency in profits and costs (Degryse, Morales-Acevedo and Ongena, 2019).

Figure 9 presents the evolution of the Lerner index, which, prior to the implementation of the NSFR, was steadily at a level of circa 60%, higher when using commercial loan interest rates than when using consumer interest rates. Between the second semester of 2020, and mid-2021, the Lerner index increased to levels unseen during our sample period. It then began to fall, reaching a level which is currently around around 45%.

Besides the Lerner index, we estimate the Net Interest Margin (NIM), which is defined as net interest income expressed as a percentage of interest-earning assets, a proxy for banking

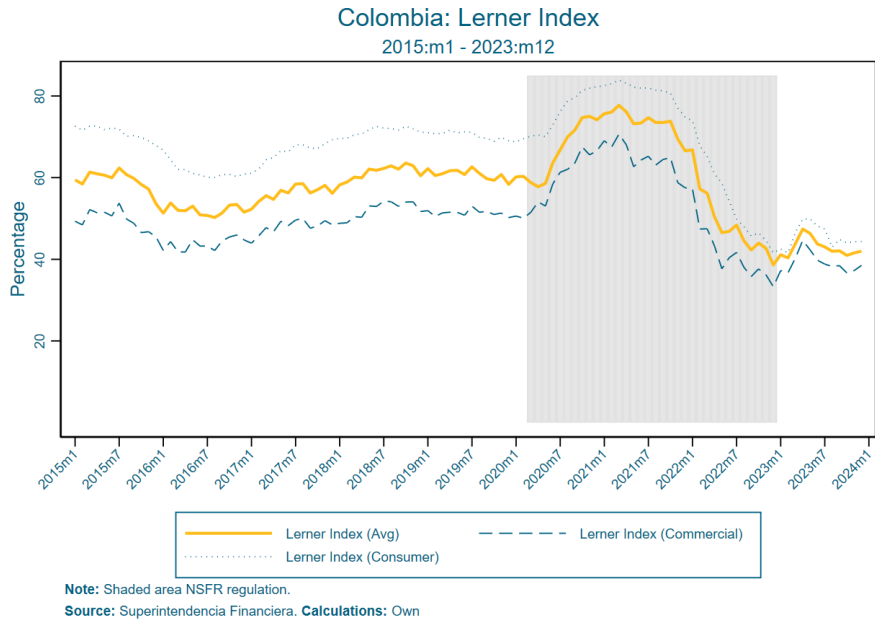


Figure 9: Lerner Index

activities. We use it as an alternative to measures of market power. Indeed, Figure 10 depicts a steady level, except for a couple of spikes during 2022. The econometric exercise will help us understand its behavior.

Either measure reveals a distinctive pattern during the first stages of the implementation period. It is an empirical matter to determine whether the NSFR did or not impact market power in the Colombian banking industry.

6 The Dominant Firm

The descriptive analysis, thus far, has revealed an industry with relatively low levels of concentration and no evidence of a cartelized industry. There is, however, a level of market power (as measured by the Lerner Index) with a concerning increase during the initial stages of the implementation of the NSFR.

To further explore the industry, we estimate in this section the Stenbacka index (Melnik, Shy and Stenbacka, 2008). This indicator aims to determine whether an individual firm has a dominant position. The significance of the exercise is twofold. First, if we can rule out a

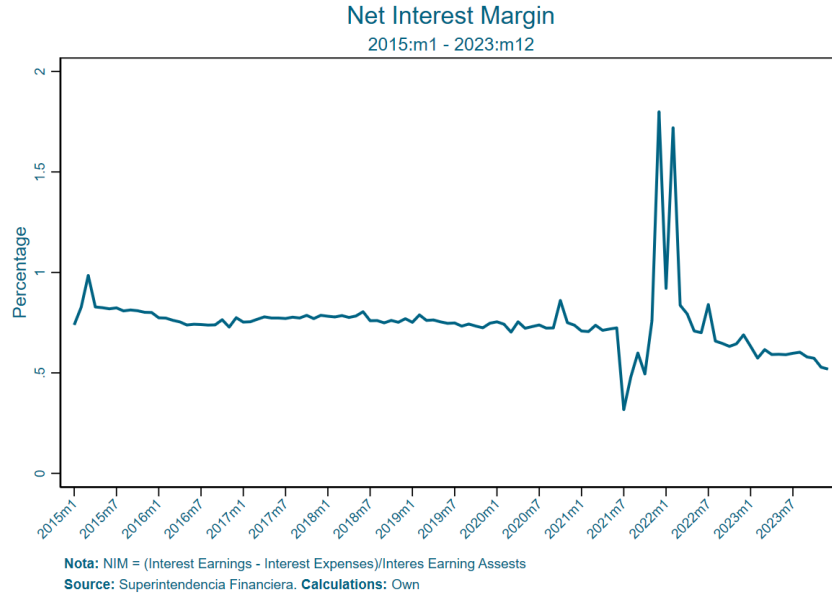


Figure 10: NIM

dominant firm in the industry, it is possible to safely include the HHI index as an exogenous (to the firm) variable in our empirical strategy. Second, if a dominant firm is present in the industry, there is always the risk of using such power in a non-competitive manner, which could force us to further explore the behavior of market power.

We follow closely Melnik, Shy and Stenbacka (2008) estimating:

$$S^D = \frac{1}{2} (1 - \gamma(S_1^2 - S_2^2))$$

a threshold market share beyond which the largest firm is dominant. S_1 is the market share of the largest firm, and S_2 is the market share of the second largest firm, while $\gamma > 0$ is a competition parameter that captures the potential competition on firm 1's dominance. Competition authorities tend to estimate S^D using $\gamma = 1$, but there is no theoretical reason why this should be the case. To guarantee the robustness of our results, we estimate S^D , using three common values in the literature: $\frac{1}{2}$, 1, and 2.

Following Melnik, Shy and Stenbacka (2008), definition 1, in a market with more than two firms, firm 1 is dominant if $S_1 > S^D$ —that is, if its market share exceeds the S^D threshold.

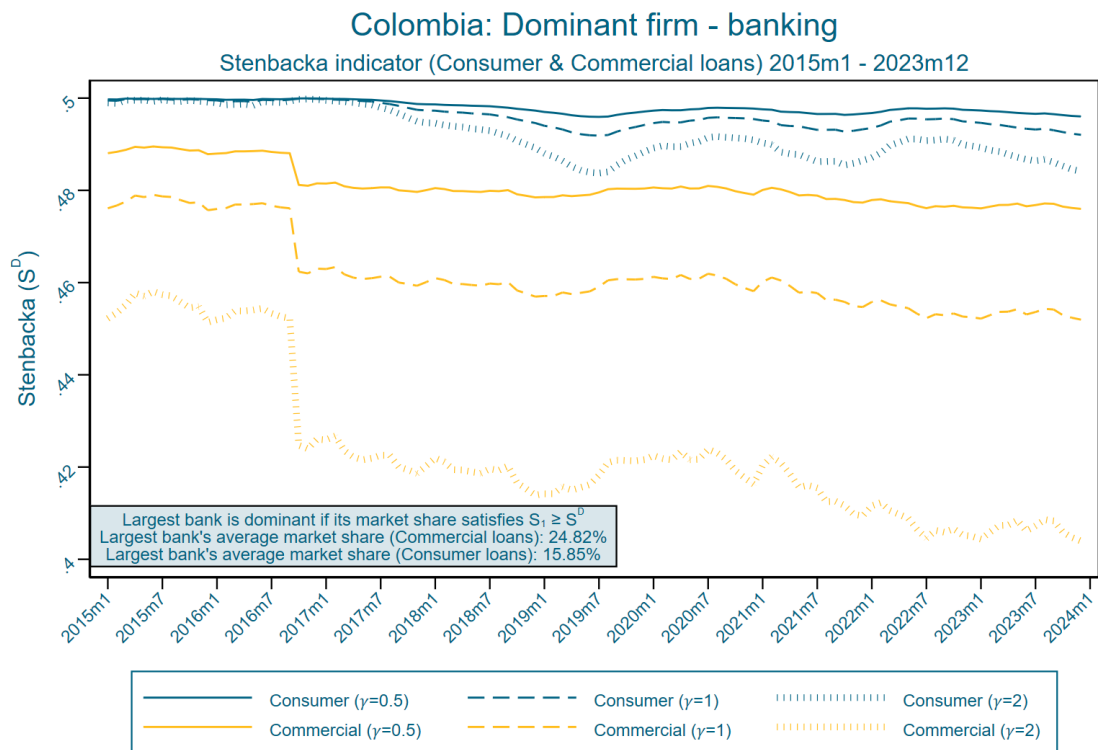


Figure 11: Stenbacka

Figure 11 calculates the Stenbacka indicator for commercial and consumer loans. In neither case can the largest bank, with an average market share of 24% (for commercial loans), and 15% (for consumer loans) be classified as a dominant firm.

Overall, our results suggest that the banking industry has a Lerner index between 40% and 60%, but the concentration is not high, and there is no evidence of having a dominant firm.

7 Methodology

7.1 Impact Evaluation of the Imposition of NSFR

The objective of this exercise is to estimate the potential impact of the NSFR regulation on market power. Indeed, the Lerner Index, the main dependent variable, proxies for market power. We also present estimations using the Net Interest Margin (*NIM*), a spread measure. Specifically, we will estimate models with the following form:

$z_{i,t} = \alpha_i + \lambda_t + \beta_0 NSFR_t + \gamma Concentration_t + \theta \mathbf{X}_t + \epsilon_{i,t}$, where $z_{i,t}$ denotes a measure of market power for bank i in month t ; $NSFR_t$, in its base specification, is a dummy variable for the imposition of NSFR which takes the value 1 in all months after April 2020.⁵ This approach considers that there is an effect starting the implementation period, and it is continuous over time. To further understand the evolution of the regulatory measure and capture its persistent effect over time, we defined NSFR1 as one over the quarter starting in April 2020 and 0 otherwise. NSFR2 is equal to 1 between July 2020 and September 2020, 0 otherwise. We define consecutively additional quarterly dummies until NSFR15, which is one between October 2023 and December 2023.

Note that the NSFR is an exogenous decision. It was introduced by the Basel Committee on Banking Supervision, to which Colombia does not belong. Moreover, even if anticipated, the impact we are analyzing is an increase in costs via higher interest rates. There is no reason to react *ex ante* to the possibility of this new regulation.

The NSFR coincides with the WHO pandemic declaration. Econometrically speaking, this is possibly the worst scenario for properly identifying its effect. On the one hand, there was a negative impact on economic activity; on the other hand, there might have been a boost in

⁵In Colombia, NSFR was phased between June 2019 and March 2020. In this analysis, we define the post-treatment period as starting in April 2020, when regulators set the required compliance at 90% of the final NSFR requirement.

online banking activities and a change in household behavior. Importantly, when dealing with this issue, we emphasize that there is no interest in explicitly measuring the impact of the pandemic but simply in adequately taking it into account.

To guarantee identification, we must control for the pandemic, which, if done properly, would allow our NSFR measures to capture the regulatory effect accurately. Given its widespread impact on the economy and society, however, capturing the pandemic is challenging.

The first step consists of directly measuring the effect of the pandemic. To do so we use Oxford's Stringency Index, a composite indicator that measures nine response metrics.⁶ The index includes school closures, workplace closures, cancellation of public events, restrictions on public gatherings, public transport closures, stay-at-home requirements, public information campaigns, restrictions on internal movements, and international travel controls.⁷

Although helpful, the Stringency Index is not enough to capture the impact of the pandemic. Keep in mind that we are not interested in measuring the pandemic but just in capturing its effects. The Stringency Index arguably captures every social aspect of the pandemic, but it may fall short on the impact on the banking sector.

The Stringency Index, for instance, does not capture the sectoral impact on the banking sector, at least in part. Direct impacts on the banking sector can be potential changes in consumers' ability to deliver on their debts or the response of the Central Bank. Thus, we use non-performing loans and measures implemented by the Central Bank.

Regarding the former, non-performing loans are potentially endogenous with our dependent variable. Given that the objective is not to estimate but simply to capture the effect of the non-performing loans, we use a measure based on instruments that use the exogenous characteristics of competing products (see the discussion on instruments in Berry and Haile 2021).

A bank will be affected by how the market impacts other banks in a given period. Thus, for each month and bank i , we calculate the non-performing loans in all $j \neq i$. For bank i , the observation is the non-performing loans of its competitors. This variable is not endogenous, but under the plausible assumption that the non-performing loans of bank i correlate to those of the sector, we are capturing the effects of these over the dependent variables.

⁶<https://ourworldindata.org/covid-stringency-index>

⁷https://github.com/OxCGRT/covid-policy-tracker/blob/master/documentation/interpretation_guide.md

Moreover, we consider two measures implemented by the Central Bank that impact the banking industry: the reference interest and the reserve requirements. Regarding the former, the Central Bank reacted to the pandemic by lowering the reference interest rate each month consecutively between March and October.

On the latter, the "Central Bank lowered the reserve requirement applicable to savings and checking accounts from 11 to 8 percent and the one applicable to fixed-term savings accounts (less than 18 months) from 4.5 to 3.5 percent."⁸

Thus, we capture the pandemic effects using non-performing loans, monthly changes in the Central Bank's interest rate, and the level of the reserve requirements.

To further guarantee identification, we control for λ_t , a time trend, while α_i denotes the bank fixed effects. The \mathbf{X}_t includes non-performing loans, changes in the Central Bank's interest rate, and the level of the reserve requirements, plus quarterly dummies to control for seasonality, and the economic index published monthly by DANE, Colombia's statistical agency, as a control for economic activity. Lastly, it includes the number of offices that each bank has as a proxy for the network size (and thus geographic coverage).

Market power is naturally a function of Concentration. We measure $Concentration_t$ using HHI and assume that it is exogenous to each bank, given that it is measured at the sector level. Moreover, our decisions are supported by the fact that no bank has a dominant position in the market.

7.2 Results

Table 1 and Figures 12 and 13 show our estimates of the model discussed in Section 7. Our main finding is that controlling for key variables that take into account the quarterly macroeconomic environment and the effects of the pandemic on banks, the market power of the institutions in our sample rises up to the first 8 quarters after the introduction of the NSFR regulation and falls sharply over subsequent quarters, beyond which it stabilizes until the end of our sample period, in December of 2023. This is the case for the Lerner index on commercial loans as well as for the index on consumption loans. As seen in Figures 12 and 13,

⁸<https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19C> visited on August 23, 2024

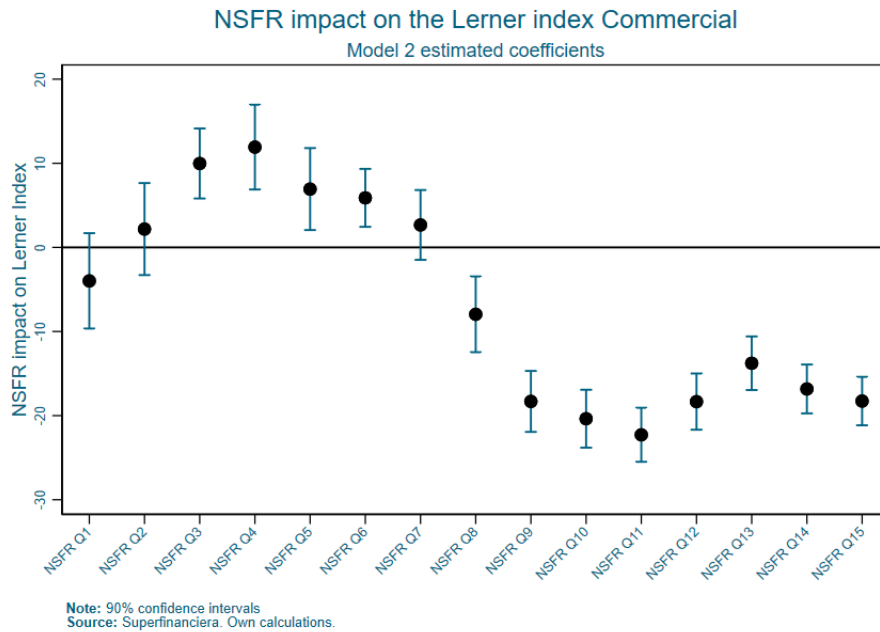


Figure 12: NSFR Transition Period for Group 1 Banks

both the short-term increase of the Lerner indices and the long term fall are significant. In the short term the indices rise up to 18 p.p. (consumption) and 13 p.p. (commercial), and in the longer term they fall up to 21 p.p. (consumption) and 16 p.p. (commercial), stabilizing at 18p.p (consumption) and 10 p.p. (commercial) below their levels before the introduction of the NSFR regulation. The behavior of NIM is less systematic, but we also observe an increase between quarters six and eleven.

Overall, our empirical findings suggest that in the short term the NSFR impacted positively the Lerner Index while in the long run the effect reverses.

7.3 Extensions: Size and Welfare

So far, the results suggest that the NSFR impacts positively the Lerner Index in the short run, but negatively in the long run. The changes in banks behavior is associated with the regulation, but it may differ by the size of the banks. It may be, as in Tabak, Fazio and Cajueiro (2012), that larger banks benefit more from competition. It can also be that size increases risk-taking, but competition restraints such tendencies (Kasman and Carvalho, 2014).

To test the effect of bank's size on the Lerner index, we replicate the above regression, but

	Commercial LI		Consumption LI		NIM	
NSFR1		-3.980 [3.446]		2.356 [2.343]		-0.043 [0.061]
NSFR3		9.976*** [2.529]		15.438*** [1.846]		0.005 [0.037]
NSFR5		6.933** [2.961]		17.221*** [2.072]		-0.050 [0.044]
NSFR7		2.669 [2.523]		14.576*** [1.967]		0.048 [0.032]
NSFR9		-18.312*** [2.203]		-7.152*** [1.782]		0.098*** [0.032]
NSFR11		-22.281*** [1.952]		-17.049*** [2.002]		0.041 [0.032]
NSFR13		-13.774*** [1.937]		-10.285*** [2.035]		-0.027 [0.039]
NSFR15		-18.271*** [1.749]		-10.983*** [2.228]		-0.080** [0.035]
HHIComercial	0.022*** [0.005]	0.017*** [0.005]				
ISE	0.209*** [0.052]	-0.021 [0.051]	0.259*** [0.046]	-0.053 [0.045]	0.002** [0.001]	0.000 [0.001]
Stringency	0.340*** [0.016]	0.068 [0.043]	0.420*** [0.019]	-0.009 [0.031]	0.002*** [0.000]	0.002** [0.001]
Trend	-0.129*** [0.024]	0.078*** [0.026]	-0.429*** [0.037]	-0.367*** [0.040]	-0.003*** [0.000]	-0.002*** [0.001]
Offices	-0.010 [0.006]	-0.007 [0.006]	-0.010* [0.006]	-0.011** [0.005]	-0.000** [0.000]	-0.000** [0.000]
NPLTotal_i	0.462** [0.193]	-0.776*** [0.197]	2.390*** [0.170]	0.568*** [0.146]	0.020*** [0.003]	0.024*** [0.003]
Reserve Requirements	-0.001 [0.000]	-0.001* [0.000]	-0.002*** [0.000]	-0.001* [0.000]	0.000*** [0.000]	0.000* [0.000]
C. B. Int. Rate (growth)	-0.097** [0.042]	-0.009 [0.057]	0.132*** [0.035]	0.044 [0.043]	0.002*** [0.001]	-0.001 [0.001]
NSFR	-7.886*** [1.422]		-6.414*** [1.618]		0.015 [0.027]	
HHIConsumption			0.052*** [0.009]	0.100*** [0.010]		
HHIAssets					-0.000 [0.000]	-0.001*** [0.000]
Constant	-13.807 [9.513]	24.676** [9.955]	-16.577* [9.262]	-10.024 [9.706]	0.250 [0.206]	1.099*** [0.288]
Observations	2,347	2,347	2,334	2,334	2,541	2,541
R-squared	0.727	0.780	0.661	0.752	0.929	0.931
Bank FE	YES	YES	YES	YES	YES	YES
Quarterly FE	YES	YES	YES	YES	YES	YES

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 1: Results of OLS regressions relating the commercial Lerner index, the consumption Lerner index and the Net Interest Margin (NIM) using quarterly data. The regressions shown in columns (1), (3) and (5) include a single dummy variable (NSFR) which is equal to 1 beginning on April 2020 and is 0 otherwise. The regressions shown in columns (2), (4) and (6) include a dummy variable for each quarter beginning on April 2020. The table only shows the estimated coefficients for the odd quarters.

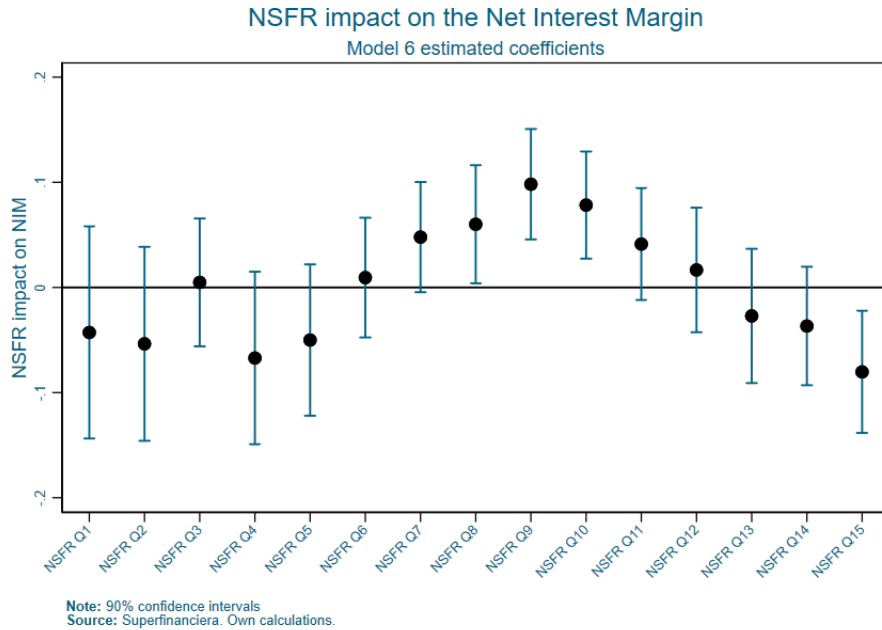


Figure 13: NSFR Transition Period for Group 1 Banks

including the log of bank’s total assets, and in a second specification the interaction of NSFR with the size of the bank. The results of these regressions are shown in Table 2.

The first thing to note is that the impact of NSFR on the Lerner index is robust, as we find results similar to our previous estimates. The main finding is that, indeed, larger banks are able to set up large Lerner Indices, but more interestingly, the regulatory NSFR measure correlates with larger banks having a higher Lerner Index.

One could argue that the regulatory measure is costly enough for business, that it negatively impacts consumers via a higher Lerner Index, but particularly because they are paid lower interest rates. The last two columns of Table 2 imply the latter. Larger banks offer lower certificate of deposit rates, particularly during the NSFR implementation period.

7.4 Robustness Checks

As a complementary exercise, to assess the robustness of our findings, we analyze the impact of the introduction of the NSFR regulation in Colombia constructing a synthetic control for the average lending rate, average deposit rate, and interest rate spread. This task presents sig-

	Commercial LI		Consumption LI		CDs	
NSFR	-7.103*** [1.430]	-34.662*** [5.195]	-4.781*** [1.558]	-32.603*** [4.674]	-4.299*** [0.250]	-0.634 [0.713]
ln(Assets)	-3.366*** [1.190]	3.154*** [1.205]	-3.335** [1.354]	3.135** [1.361]	0.417*** [0.133]	0.380*** [0.135]
NSFR * ln(Assets)		1.697*** [0.317]		1.725** [0.276]		-0.223*** [0.041]
Constant	44.293** [23.430]	22.469 [24.143]	-78.316** [25.506]	92.442 [25.501]	27.351*** [2.837]	28.807*** [2.881]
Observations	2,322	2,322	2,309	2,309	2,516	2,516
R-squared	0.730	0.732	0.663	0.670	0.757	0.759
Bank FE	YES	YES	YES	YES	YES	YES
Quarterly FE	YES	YES	YES	YES	YES	YES

Robust standard errors in brackets. *** p<0.01, ** p<0.05, * p<0.1

Table 2: Results of OLS regressions relating the commercial Lerner index, the consumption Lerner index and the total certificates of deposit using quarterly data. All regressions include a single dummy variable (NSFR) which is equal to 1 beginning on April 2020 and is 0 otherwise. Regressions shown in columns (1), (3) and (5) include Ln(Assets) as a measure of banks' sizes, and regressions shown in columns (2), (4) and (6) include the interaction between ln(Assets) and the NSFR dummy.

nificant challenges. First, every country experienced the pandemic, but regulatory and social measures varied across countries. Second, many countries experienced various idiosyncratic regulatory innovations and economic shocks before and after the implementation periods of the NSFR in Colombia. We interpret the results of this exercise cautiously. Essentially, when they support our earlier findings, they boost the confidence in the results. In the cases in which the results of the synthetic control exercise move in another direction, we have to treat carefully the findings obtained using our main methodology.

To strengthen our results as much as possible, we carry out our analysis relying on three different samples of countries. In the main text, we present the results based on all Latin American countries for which we have complete annual data between 2004 and 2023. In the Appendix, we provide additional results using a the largest possible sample of countries with complete data and a smaller subset of countries that did not implement significant financial regulatory changes between 2018 and 2023, as identified by Bank for International Settlements (n.d.). All our data were extracted from World Bank (n.d.).

The results are qualitatively consistent using these three very different samples, and the magnitudes of the estimated treatment effects are similar. Figure 17 shows our results, using the sample of Latin American countries for which we have complete annual lending rates and

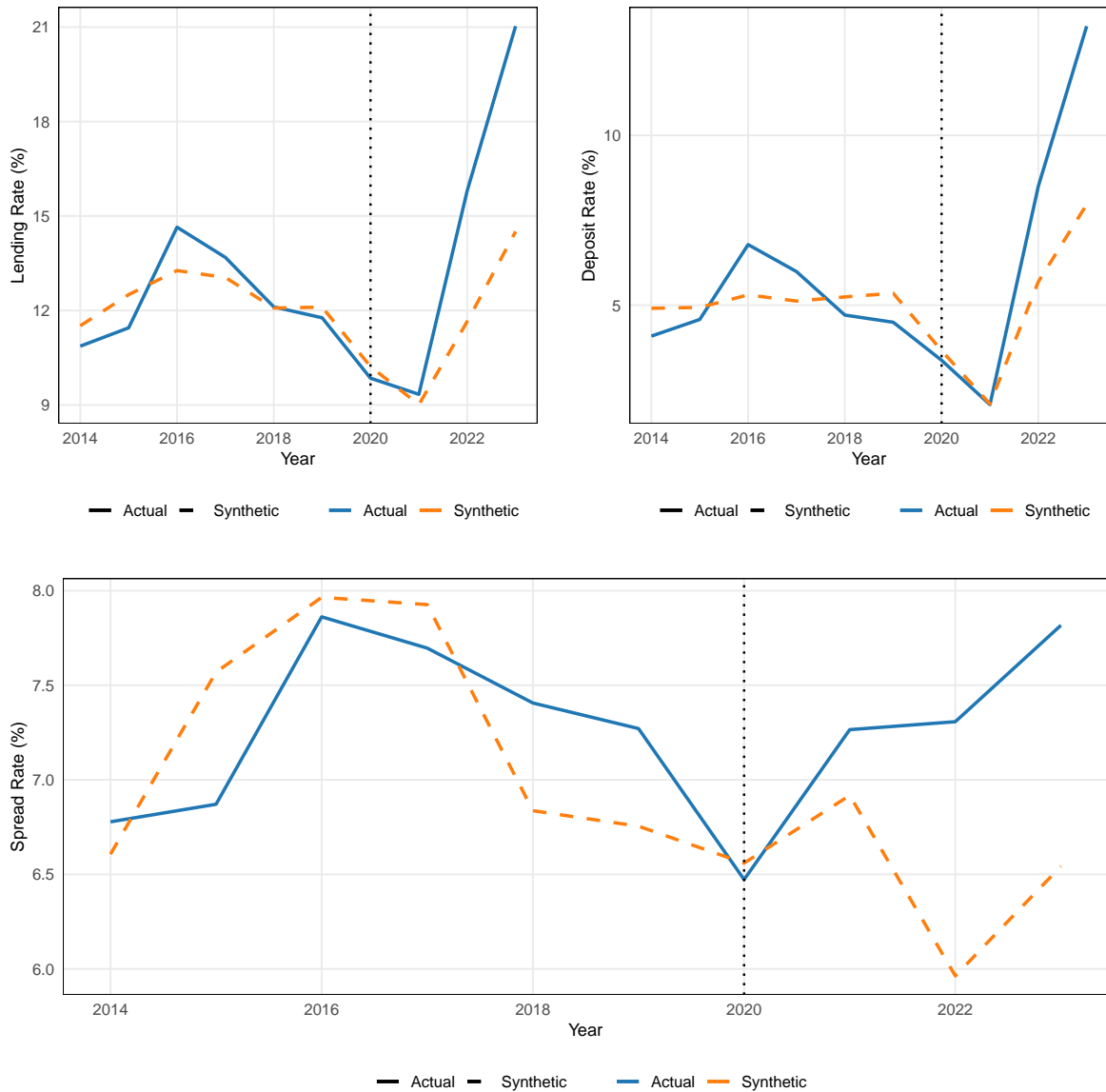


Figure 14: Actual lending rate, deposit rate and spread rate time series, versus their synthetic controls constructed using the Latin American sample of countries. The treatment date is shown in all plots with a dotted line.

deposit rates between 2014 and 2023.⁹

The difference between the observed time series and the synthetic counterfactuals imply an average treatment effect of the introduction of NSFR on the nominal deposit rates of 1.9

⁹Besides Colombia this list of countries includes Argentina, Bolivia, Brazil, Costa Rica, Dominican Republic, Guatemala, Honduras, Mexico, Nicaragua and Uruguay.

p.p and 2.7 p.p on the nominal lending rates over the post-treatment period. The impact on the spread between these rates is thus 0.72 p.p.

The results on the effects on deposit rates are qualitatively consistent with our earlier results, as the deposit interest rate is lower than the control group. Our main methodology suggests that both depositors and credit recipients were negatively impacted by NSFR. A simple accounting exercise based on our synthetic control discussed in detail in the next section indicates that the overall effect over all consumers of bank services was negative due to its significant effect on lending rates.

Having extensively discussed issues in controlling for the pandemic, we believe that our main results are more reliable than our synthetic controls given the numerous regulatory innovations introduced at different moments in our period of interest in almost all of the countries that can serve to construct good counterfactuals.

7.5 Additional Welfare Effects

One of the main advantages of the synthetic counterfactuals presented in Section 7.4 is that they allow us to carry out some basic consumer welfare accounting under some strong auxiliary assumptions by relying on the stylized fact, shown in Figure 15, that over the sample period, the total size of bank deposits in Colombia was approximately equal to the size of their loan portfolios. Based on our estimates of the average treatment effects of NSFR on the deposit and lending rates faced by consumers we can argue that the overall effect on the costs faced by credit recipients due to higher lending rates was 1.5 times as large as the benefits accrued by depositors due to higher deposit rates. These results are quantitatively similar to those found earlier.

The exercise assumes the ratios of deposits to loan portfolios as given and does not consider the potential welfare implications arising from the fact that, over time, both borrowers and depositors adjust the size of their portfolios in response to interest rate changes. Additionally, it overlooks the influence of banks' market power, where rate adjustments reflect their assessment of the trade-off between portfolio size and average profitability. Keeping these important caveats in mind, our exercise suggests that in the short term, the introduction of the NSFR was reflected in a higher overall cost for credit recipients relative to the greater benefits to depositors.

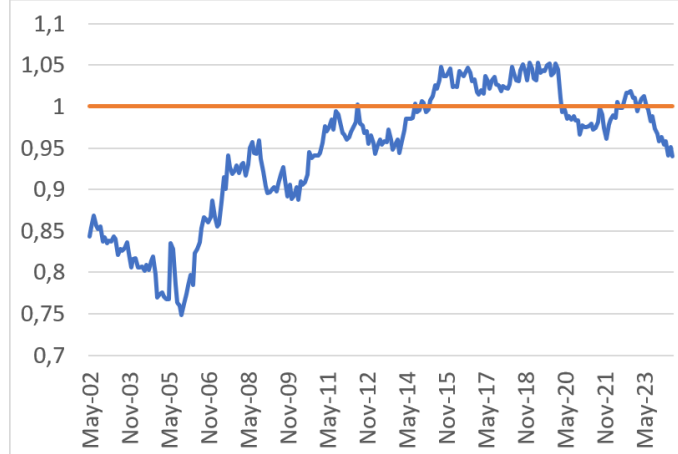


Figure 15: Loans to Deposits Ratio in the Colombian Banking system.

7.6 Theoretical Model

In this section, we present the three-period model that explains the main features of the short-term changes that we observe in response to the introduction of the NSFR regulation.

We build upon Diamond and Dybvig (1983). Our model treats long deposits and loans from different banks as imperfect substitutes, allowing for possibly different elasticities of substitutions in both markets. Banks are heterogeneous in their ability to convert their net liabilities (their short-term and long-term deposits net of their holdings of government bonds) into loans.

Banks

There is a continuum of banks (of measure 1), each indexed by $\omega \in \Omega$, distributed according to G_ω . Bank ω supplies long term deposits $T(\omega)$ at interest rate $r^T(\omega)$ and loans $L(\omega)$ at interest rate $R(\omega)$.¹⁰ As discussed in detail in the sections introducing firms and households, loans and long-term deposits offered by different banks are imperfect substitutes and thus may trade at different prices. Banks also offer short-term deposits $D(\omega)$ which we treat as perfect substitutes at interest rate r^D , and demand bonds $B(\omega)$ from the government at an exogenous interest rate r . In what follows, we drop the dependence of D , B , and z on ω for notational convenience. That is, we only explicitly denote the dependence of R , r^T , T , k and L , on ω .

¹⁰For notational convenience $r^T(\omega)$ and $R(\omega)$ denote the net interest rates (i.e., $r^T(\omega) = 1 + r'^T(\omega)$ and $R(\omega) = 1 + R'(\omega)$, where $r'^T(\omega)$ and $R'(\omega)$ are the interest rates in the standard notation.

Banks obtain benefits from their operation in periods 2 and 3 and the problem they solve is:

$$\begin{aligned} & \max_{L(\omega), R(\omega), r^t(\omega)D, T(\omega), B} \pi_2 + \beta\pi_3 \\ \text{s. t. } & L(\omega) = k(\omega) \\ & L(\omega) = z(D + T(\omega) - B) \\ & \pi_2 = rB - r^D(\omega)D \\ & \pi_3 = R(\omega)L - r^T(\omega)T(\omega) \\ & \frac{T(\omega)}{L(\omega)} \geq N \end{aligned}$$

where $k(\omega)$ is the capital of variety ω demanded by the representative firm and z , ($z(\omega)$), denotes the bank's ability to transform net liabilities ($D + T(\omega) - B$) into loans. N denotes the exogenous requirement on the funding ratio $\left(\frac{T(\omega)}{L(\omega)}\right)$, analogous to the NSFR. Note that since banks fund the loans that they offer by way of their net liabilities, ($D + T(\omega) - B$), a higher N implies that banks must rely to a greater extent on their long-term deposits $T(\omega)$, than on their short-term deposits D to fund their loans.

Representative Households

In our model, we have two representative households: i) a short-sighted household which earns and exogenous income in the first period and invests part of it in short-term deposits in order to be able to consume in the second period, and ii) a far-sighted household which only values consumption in $t = 3$ and invests its first-period income in long-term deposits to be able to consume in the third period.

Short-sighted Household

$$\begin{aligned} & \max_{C_1, C_2, D} \frac{C_1^{1-\gamma}}{1-\gamma} + \beta \frac{C_2^{1-\gamma}}{1-\gamma} \\ \text{s. t. } & C_1 + D = W \\ & C_2 = r^D D \end{aligned}$$

Far-sighted Household

$$\begin{aligned} & \max_{\{T(\omega)\}} C \equiv \left[\int_{\omega} c(\omega)^{\frac{\sigma-1}{\sigma}} dG_{\omega}(\omega) \right]^{\frac{\sigma}{\sigma-1}} \\ \text{s. t. } & \int_{\omega} T(\omega) dG_{\omega}(\omega) = W^T \\ & c(\omega) = r^T(\omega)T(\omega) \end{aligned}$$

Representative Firm

A representative firm demands loans of all varieties $\omega \in \Omega$ to maximize profits. It borrows $k(\omega)$ of capital of variety ω at interest rate $R(\omega)$.¹¹ We assume that the firm borrows at $t = 1$ and produces at $t = 3$

$$\max_{\{k(\omega)\}} AK - \int_{\omega} R(\omega)k(\omega)dG_{\omega}(\omega)$$

s. t. $K \equiv \left[\int_{\omega} k(\omega)^{\frac{\alpha-1}{\alpha}} dG_{\omega}(\omega) \right]^{\frac{\alpha}{\alpha-1}}$

Analysis

The short-sighted household's supply of deposits will be given by:

$$D = \frac{W\beta^{\frac{1}{\gamma}}r^D\frac{1-\gamma}{\gamma}}{1 + \beta^{\frac{1}{\gamma}}r^D\frac{1-\gamma}{\gamma}}$$

Note that $\gamma < 1$ so C_1 is decreasing in r^D and D is increasing in r^D , the market's interest rate on short-term deposits. The far-sighted household's supply of long-term deposits of the variety offered by bank ω will be given by:

$$T(\omega) = \left(\frac{r^T(\omega)}{R^T} \right)^{\sigma-1} W^T$$

where $R^T \equiv \left[\int_{\omega} (r^T(\omega))^{\sigma-1} dG_{\omega}(\omega) \right]^{\frac{1}{\sigma-1}}$.

The firm will demand loan $k(\omega)$ supplied by bank ω according to:

$$k(\omega) = \left(\frac{1}{R(\omega)} \right)^{\alpha} A^{\alpha} K$$

where $K \equiv \left[\int_{\omega} k(\omega)^{\frac{\sigma-1}{\sigma}} dG_{\omega}(\omega) \right]^{\frac{\sigma}{\sigma-1}}$.

It follows that for there to exist an equilibrium, it must be the case that the rate on short-term deposits r^D must equal the exogenously given rate on government bonds r . The market clearing condition for all varieties of long term deposits implies that bank ω must then choose its long-term deposits rate $r^T(\omega)$ and its loan rate $R(\omega)$ in order to solve:

¹¹The firm must pay $R(\omega)$ units of numeraire in period 2 for each unit of capital borrowed in period 1. That is, $R(\omega)$ stands for $(1 + R(\omega))^2$ in the usual notation.

$$\max_{\{r^T(\omega), R(\omega)\}} r r^T(\omega)^{\sigma-1} S^T - \beta (r^T(\omega)^\sigma) S^T + \beta \left(\frac{1}{R(\omega)}\right)^{\alpha-1} D^L - \frac{r}{z} \left(\frac{1}{R(\omega)}\right)^\alpha D^L + \lambda(\omega) \left((r^T(\omega))^{\sigma-1} S^T - N \left(\frac{1}{R(\omega)}\right)^\alpha D^L \right)$$

where $S^T = \frac{W^T}{(R^T)^{\sigma-1}}$ and $D^L = A^\alpha K$ measure the effective aggregate supply of long term deposits and the effective aggregate demand for capital. Importantly, these terms are unaffected by the decisions of any given specific bank ω . The above yields:

$$r^T(\omega) = \frac{\sigma-1}{\sigma} \frac{\lambda(\omega)+r}{\beta}$$

$$R(\omega) = \frac{\alpha}{\alpha-1} \frac{1}{\beta} \left(\frac{r}{z} + \lambda(\omega)N \right)$$

Finally, in any equilibrium in which the constraint $\frac{T(\omega)}{L(\omega)} \geq N$ is binding we must have

$$T(\omega) = r^T(\omega)^{\sigma-1} S^T(\omega) = N \left(\frac{1}{R(\omega)} \right)^\alpha D^L$$

which together with (2) and (3) above, yields:

$$(\lambda(\omega) + r)^{\sigma-1} \left(\frac{r}{z} + \lambda(\omega)N \right)^\alpha = N \left(\frac{\alpha-1}{\alpha} \right)^\alpha \beta^{\alpha+(\sigma-1)} \left(\frac{\sigma}{\sigma-1} \right)^{\sigma-1} \frac{D^L}{S^T}$$

We take S^T and D^L as fixed, as the objective of our analysis is to better understand the optimizing behavior of banks in the short term. Given that any one bank has no influence over these aggregates, each of them takes them as given. In the long term, general equilibrium effects are crucial and banks would certainly alter their behavior in response to them. However, our essentially static model is not appropriate to adequately analyze these mechanisms. A partial equilibrium analysis of our model is appropriate to understand the main effects in the short run. Equations (2), (3) and (4) fully characterize the solution of our model in terms of the exogenous parameters. We begin by analyzing the model when the NSFR restriction is not binding.

PROPOSITION 1

(A bank's behavior in the long-term deposits market when NSFR is not binding)

Whenever the NSFR restriction is not binding:

1. *The interest rate offered by banks on long-term deposits does not depend on z and is given by $r^T(\omega) = \frac{\sigma-1}{\sigma} \frac{r}{\beta}$.*
2. *$r^T(\omega)$ is increasing in σ , in r , and decreasing in β .*

This proposition follows from considering expression (2) when the net funding constraint is not binding ($\lambda(\omega) = 0$). The intuition for the first part is that each bank determines the amount it lends, $L(\omega) = k(\omega)$, by setting its lending rate and funding it using its net liabilities

$(T(\omega) + D - B)$. For the choice of instruments to be optimal, the marginal cost of using any source of funding must be the same. The amount of long-term deposits, $T(\omega)$, at which this occurs does not depend on the bank's ability, z , to transform net liabilities into loans.

Part two follows from the fact that a higher elasticity of substitution of consumption sources and thereby of long-term deposits $T(\omega)$ means that banks must offer a higher rate of return to attract any quantity of deposits. A higher exogenous rate of return, r , of government bonds, means that the optimal marginal cost of any source of funding must be higher and this can only be achieved through a higher rate of return on long term deposits. Finally, if banks place more weight on the future, discounting the third period income with a higher β , they place a higher volume of loans and fund them with sources which do not entail third period payouts, as is the case for long-term deposits. They do so by setting a lower rate of return on these deposits.

PROPOSITION 2

(A bank's behavior in the loans market when NSFR is not binding)

Whenever the NSFR restriction is not binding:

1. $R(\omega)$ is given by $R(\omega) = \frac{\alpha}{\alpha-1} \frac{1}{\beta} \frac{r}{z}$
2. $R(\omega)$ is increasing in r , decreasing in α , in β and in z .

This proposition follows from considering expression (3) when the net funding constraint is not binding ($\lambda(\omega) = 0$). The intuition for part one of the proposition is that more efficient banks (those with higher z') have a greater incentive to decrease the interest rate they charge on their loans because they can meet the resulting higher demand with a smaller increase in their net liabilities ($T(\omega) + D - B$). In contrast, $r^T(\omega)$ does not depend on z because, whereas the marginal benefit to a bank of extending more loans depends on z , the marginal cost of the funds does not. The reasoning behind the second part of the proposition is analogous to the one behind Proposition 1.

Propositions 1 and 2 show that in the absence of the NSFR constraint, the banks in our model behave as expected. Their fundamental market power stems from the imperfect substitutability of loans from different banks and of long term deposits. Greater market power in the loans market (lower α) leads to higher loan interest rates and greater market power in the long term deposits market (lower σ) leads to a lower interest rate on long term deposits. Before

moving to analyze the behavior of banks when the NSFR constraint is active we discuss the behavior of the Lerner Index.

PROPOSITION 3

(Behavioral market power when the NSFR constraint is not binding)

When the NSFR constraint is not binding, the Lerner index of bank ω with loan productivity z is given by,

$$\mathcal{L}(\omega) = 1 - \frac{r^T(\omega)}{R(\omega)} = 1 - \frac{z(\sigma - 1)(\alpha - 1)}{\sigma\alpha}$$

Proposition 3 follows immediately from expression (2) and (3) and from the fact that in our model the Lerner index is given by $\mathcal{L}(\omega) = \frac{R(\omega) - r^T(\omega)}{R(\omega)} = 1 - \frac{r^T(\omega)}{R(\omega)}$. It has two main take-aways. The first one is that in the model the Lerner index is increasing in the parameters σ and α that express the fundamental market power of banks.

The second is that the Lerner Index is decreasing in z . Banks that are able to convert net liabilities into loans more efficiently compete more aggressively and offer loans at lower interest rates. At the same time, they are more profitable as their greater loan volumes more than compensate their lower rates. We now move on to look at the main differences between the description above and the behavior of banks when the NSFR constraint is binding.

PROPOSITION 4

(The marginal cost of the constraint for different banks)

1. $\lambda(\omega)$ is non-decreasing in z
2. $\lambda(\omega)$ can be non-monotonic on N for various combinations of the parameters. In such cases it is increasing for low values of N and decreasing for sufficiently high values of N .

Part one follows from the fact that by analyzing equation (4), $\lambda(\omega)$ can be shown to be increasing in z . Intuitively, the marginal cost of tightening the constraint, $\frac{T(\omega)}{L(\omega)} \geq N$, is higher for more efficient banks, as they sacrifice greater profits for any reduction in the loans that they make. An implication of this proposition is that the set of banks such that $\frac{T(\omega)}{L(\omega)} > N$ are less efficient than banks for whom $\frac{T(\omega)}{L(\omega)} = N$. Numerical analysis shows that for a variety of parameter combinations $\lambda(\omega)$ is non-monotonic in N , and these exercises establish the second part of the proposition.

PROPOSITION 5

(A bank's behavior in the long term deposits market when NSFR is binding)

1. $r^T(\omega)$ is higher than what would be the case if the constraint were not binding.
2. $r^T(\omega)$ is increasing in z
3. $r^T(\omega)$ can be non-monotonic in N .

Part one follows from the fact that in order to comply with the constraint, banks offer a higher interest rates to increase long term deposits. Part two follows from the fact that as shown in Proposition 4, $\lambda(\omega)$ is increasing in z . This means that banks with higher z 's are willing to pay out a higher interest rate for long term deposits. Part two follows from the fact that when N is binding, an increase in the elasticity of long-term deposits implies that at the former optimal rate, the constraint is violated. Banks must therefore not only increase the rate that they offer as they would under no constraints, but also this increment must be pronounced enough so that they continue to satisfy the constraint. Part three follows from the fact that $\lambda(\omega)$ is non-monotonic in N . Notice that $r^T(\omega)$ only depends on N through $\lambda(\omega)$. Given that it is an increasing linear function of $\lambda(\omega)$, its first order derivative with respect to N always has the same sign as that of $\lambda(\omega)$. The intuition for this result is that as N increases, banks always increase $R(\omega)$ (as discussed below in Proposition 7) in order to reduce $L(\omega)$ and satisfy the constraint. However, whether they increase or decrease $r^T(\omega)$ depends on the elasticities of substitution of $k(\omega)$ and $c(\omega)$ For instance, for certain values of r , if long-term deposits are highly inelastic (small σ) and capital is highly elastic, then a small increase of $R(\omega)$ leads to a substantial decrease of $L(\omega)$ and a large increase of the ratio $T(\omega)/L(\omega)$, which allows the bank to reduce the rate that it offers for long-term deposits without a large sacrifice in the level of $T(\omega)$.

PROPOSITION 6

(A bank's behavior in the loans market when NSFR is binding)

1. $R(\omega)$ is higher than would be the case if the constraint were not binding.
2. $R(\omega)$ is decreasing in z , but the magnitude of the derivative is smaller than when NSFR is not binding.
3. $R(\omega)$ is increasing in N , except for regions of the parameter space in which the NSFR restriction is not binding.

Notice that from Proposition 2 we have that when the NSFR constraint is not binding, $R(\omega)$ is decreasing in z . The fact that this continues to be the case in the model when the NSFR constraint is binding is not obvious given that there are two mechanisms at play. On the one hand, banks that can produce loans more efficiently equate their marginal income from loans to their marginal cost at a higher level of loans, which they achieve by setting a lower interest rate. On the other hand, the marginal opportunity cost of the constraint is higher for these more efficient banks, which means that they have a more powerful incentive than less efficient banks to comply with it by issuing less loans. This reasoning explains why $R(\omega)$ is higher when the constraint is binding than when it is not, and it also explains why the derivative of $R(\omega)$ with respect to z is less negative. However, we do not have a conceptual explanation for the fact that this derivative never gets to be positive. It follows from the specific algebraic expressions involved, and we thus relegate the non-illuminating proof to the Appendix. Part three of the proposition is also intuitively unclear, as it involves two competing mechanisms, and we relegate the proof to the Appendix. Notice that the sign of the derivative of $R(\omega)$ with respect to N is given by the sign of the derivative of $\lambda(\omega)N$ which is given $\frac{\partial \lambda(\omega)}{\partial N}N + \lambda(\omega)$. The first term can be positive or negative, since by Proposition 4, $\lambda(\omega)$ can be non-monotonic in N .

To end, we focus on the behavior of the Lerner Index when the NSFR restriction is binding.

PROPOSITION 7

(Behavioral market power when the NSFR constraint is binding)

When the NSFR constraint is binding,

1. *The Lerner Index of a bank ω with loan productivity z is given by,*

$$\mathcal{L}(\omega) = 1 - \frac{r^T(\omega)}{R(\omega)} = 1 - \left(\frac{\sigma - 1}{\sigma} \right) \left(\frac{\alpha - 1}{\alpha} \right) \frac{\lambda(\omega) + r}{\frac{r}{z} + \lambda(\omega)N}$$

2. *$\mathcal{L}(\omega)$ is increasing in N and β , and decreasing in z , α , σ .*

The derivative of the Lerner Index with respect to N depends crucially on the sign and magnitude of the derivative of $\lambda(\omega)$ with respect to N . As in the cases of $\frac{\partial R(\omega)}{\partial z}$ and $\frac{\partial \lambda(\omega)N}{\partial N}$ analyzed in the Appendix we can find an explicit expression for $\frac{\partial \mathcal{L}(\omega)}{\partial N}$. We examine this derivative numerically and find that for all vectors of parameters, the Lerner Index is increasing in N . That is, a tighter net funding ratio leads the banks in our model to offer a higher interest rate on long-term deposits and to charge a higher interest rate on loans, and the gap between these increases in N relative to the interest rate charged on loans. Likewise we use numerical analysis to establish the comparative static results involving the other parameters.

8 Conclusions

This paper is composed of four identifiable exercises. First, we review the market structure of the Colombian banking sector between January 2015, and December 2023. Second, we estimate the effects that regulatory measures had on the industry's market power. Third we use synthetic controls to check our previous results. Third, we develop a model to understand the short-term effects.

Our results suggest that the Colombian banking sector is not particularly concentrated and lacks the power of a dominant firm. In line with recent literature, this finding opens the door to explore whether the banking sector is robust enough to withstand potential sectoral crises.

Our econometric results, controlling for market structure, economic activity and the pandemic, reveal that the NSFR has a short-term effect whereby market power tends to increase. In the long run, the NSFR correlates to lower market power although, with some caveats, the synthetic exercise seems to support our earlier results.

The model aids the understanding of the short-term effect, shedding light on the mechanisms through which the introduction of the NSFR restriction leads to a higher rate on loans and on long-term deposits. Interestingly our model, although relatively simple, allows for a non-monotonic relation between the level of the restriction on the NSFR and the interest rate on long-term deposits. This feature of the model implies that we could use this kind of model together with the observed change in behavior of the banks in order to infer broad patterns in the nature of the fundamental sources of market power of banks.

increments in the rates on long-term deposits and higher interest rates on loans following the NSFR implementation lead to an increase in the gap.

Overall, we conclude that in a non-concentrated industry, the regulatory NSFR measure had an unanticipated significant effect on the exercise of market power.

Appendix

Alternative Specifications of the Synthetic Control

The following are the results of our estimation of the causal effects of the introduction of NSFR on the average deposit rates, average lending rates and on the spread using the largest

possible sample of countries with complete data¹² (Figure 16) and a smaller subset of countries that did not implement significant financial regulatory changes between 2018 and 2023, as identified by Bank for International Settlements (n.d.)¹³ (Figure 17). Using the large sample of countries the difference between the observed time series and the synthetic counterfactuals imply an average treatment effect of the introduction of NSFR on the nominal deposit rates of 2.1 p.p and 2.6 p.p on the nominal lending rates over the post-treatment period. The impact on the spread between these rates is thus 0.47 p.p. Using the small sample of countries, the difference between the observed time series and the synthetic counterfactuals implies an average treatment effect of the introduction of NSFR on the nominal deposit rates of 1.1 p.p and 2.1 p.p on the nominal lending rates over the post-treatment period. The impact on the spread between these rates is thus 0.91 p.p.

Omitted Proofs

LEMMA 1 $R(\omega) = \frac{\alpha-1}{\alpha} \frac{1}{\beta} \left(\frac{r}{z} + \lambda(\omega)N \right)$ is decreasing in z .

Proof:

Applying the implicit function theorem,¹⁴ we have that,

$$\frac{\partial R(\omega)}{\partial z} = \frac{r\beta(r + Nz\lambda) \left(\frac{(r+\lambda)(\sigma-1)}{\beta\sigma} \right)^\sigma \sigma}{z^2 \left(N^2 \frac{DL}{ST} z \alpha (r + \lambda)^2 \left(\frac{z(\alpha-1)\beta}{\alpha(r+Nz\lambda)} \right)^\alpha + r\beta \left(\frac{(r+\lambda)(\sigma-1)}{\beta\sigma} \right)^\sigma \sigma + Nz\beta\lambda \left(\frac{(r+\lambda)(\sigma-1)}{\beta\sigma} \right)^\sigma \sigma \right)}$$

This expression is clearly negative for all positive values of λ .

LEMMA 2 $\lambda(\omega)N$ is an increasing function of N for all $N > 0$.

¹²The list of countries is Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Armenia, Azerbaijan, Bahamas, The, Bangladesh, Belarus, Belize, Bhutan, Bolivia, Bosnia and Herzegovina, Botswana, Brazil, Brunei Darussalam, Bulgaria, Cabo Verde, China, Colombia, Costa Rica, Czechia, Dominica, Dominican Republic, Egypt, Arab Rep., Eswatini, Fiji, Georgia, Grenada, Guatemala, Guyana, Honduras, Hong Kong SAR, China, Hungary, Indonesia, Jamaica, Kenya, Korea, Rep., Kuwait, Kyrgyz Republic, Lesotho, Macao SAR, China, Madagascar, Malaysia, Maldives, Mauritius, Mexico, Moldova, Montenegro, Mozambique, Namibia, Nicaragua, Nigeria, North Macedonia, Norway, Papua New Guinea, Qatar, Romania, Russian Federation, Rwanda, Samoa, San Marino, Seychelles, Sierra Leone, South Africa, South Sudan, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Suriname, Switzerland, Thailand, Timor-Leste, Tonga, Trinidad and Tobago, Ukraine, Uruguay, Uzbekistan, Vanuatu, Viet Nam.

¹³The list of countries is Argentina, Brazil, China, Indonesia and South Africa.

¹⁴In the expression that follows we drop the dependence of z on ω for clarity.

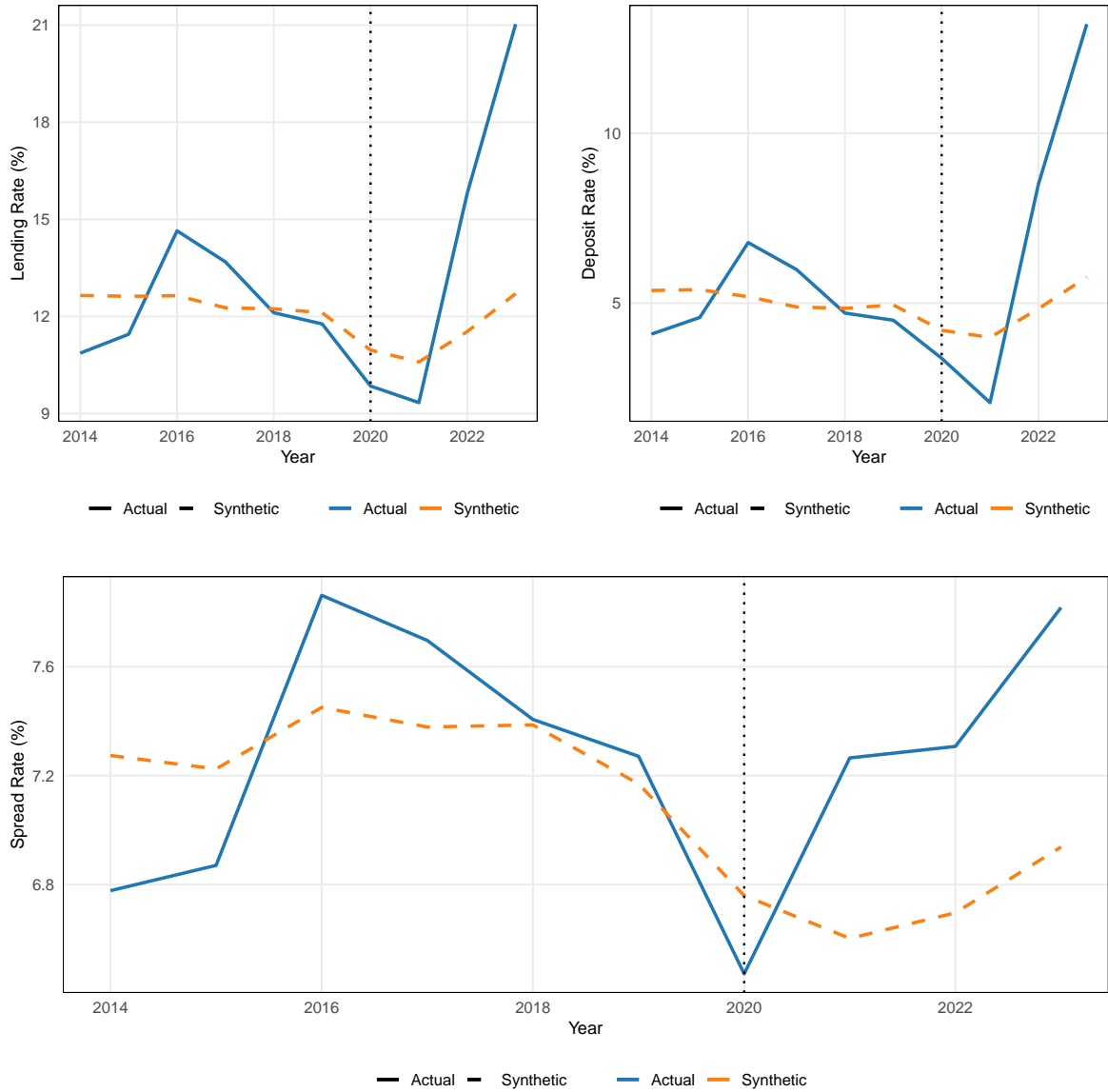


Figure 16: Actual lending rate, deposit rate and spread rate time series, versus their synthetic controls constructed using the sample of countries with complete data between 2014 and 2023 in World Bank (n.d.). The treatment date is shown in all plots with a dotted line

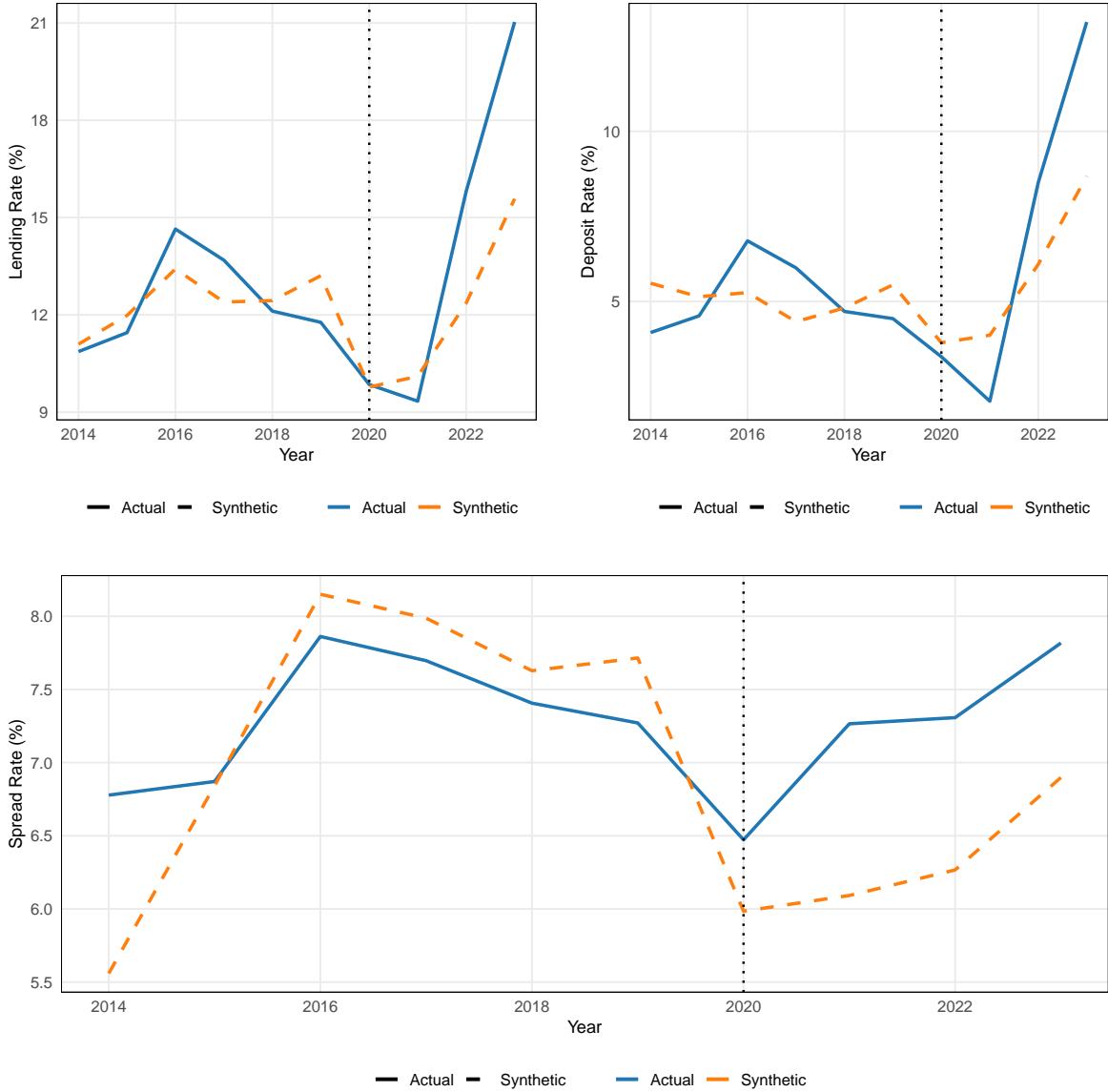


Figure 17: Actual lending rate, deposit rate and spread rate time series, versus their synthetic controls constructed using a small subset of countries that did not implement significant financial regulatory changes between 2018 and 2023, as identified by Bank for International Settlements (n.d.). The treatment date is shown in all plots with a dotted line.

Proof:

Let $f = \lambda(\omega)N$, $h = \left(\frac{z(\alpha-1)\beta}{(r+fz)\alpha}\right)$ and $g = \left(\frac{(\lambda(\omega)N+Nr)(\sigma-1)}{N\beta\sigma}\right)^\sigma \sigma$. Then, applying the implicit function theorem to expression (4), we have that for all $N > 0$ ¹⁵,

$$\frac{\partial f}{\partial N} = \frac{\frac{1}{N}(r+fz)\left(f^2\frac{D^L}{S^T}h^\alpha + 2Nfr\frac{D^L}{S^T}h^\alpha + N^2r^2\frac{D^L}{S^T}h^\alpha + f\beta g\right)}{\left(f^2\frac{D^L}{S^T}z\alpha h^\alpha + fz\left(2Nr\frac{D^L}{S^T}\alpha h^\alpha + \beta g\right) + r\left(N^2r\frac{D^L}{S^T}z\alpha h^\alpha + \beta g\right)\right)}$$

This expression is clearly non-negative for all positive values of N and non-negative values of $\lambda(\omega)$.

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¹⁵These expressions were computed using *Mathematica*.

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