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Competition in the Colombian banking sector*

David Perez-Reyna†, Tomás Rodríguez‡ and Jorge Tovar§

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 and find that a higher Lerner index implies more 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

Following the 2007-08 global financial crisis, banking regulators implemented new measures to strengthen the resilience of financial institutions. A significant change was the introduction of the Net Stable Funding Ratio (NSFR), which in Colombia was implemented with a phased approach in July 2019, requiring banks to maintain specific ratios of stable funding. This paper analyzes how this regulatory change affected competition and market power in the Colombian banking sector.

Using monthly bank-level balance sheet data from January 2015 to December 2023, we examine the impact of NSFR implementation on market concentration and competition. Our analysis employs measures of concentration and market power, the Herfindahl-Hirschman Index (HHI) and the Lerner Index. To address the challenging identification issues arising from the COVID-19 pandemic coinciding with NSFR implementation, we incorporate various controls, including Oxford's Stringency Index, non-performing loans, and central bank policy measures.

Our empirical results reveal a nuanced impact of the NSFR regulation. In the short term (the first eight quarters), the exercise of bank market power increased, as evidenced by higher Lerner indices for both commercial and consumer loans. However, this effect was reversed in the longer term, with market power falling significantly below preregulation levels. For consumer loans, the Lerner index initially rose by 18 percentage points before declining by 21 percentage points, eventually stabilizing at 18 percentage points below pre-NSFR levels. Commercial loans showed a similar pattern, with an initial increase of 13 percentage points followed by a 16-point decrease, settling 10 percentage points below preregulation levels.

We rationalize these results with a simple theoretical model. In our model, banks are subject to an NSFR, which requires the ratio of long-term (stable) deposits to loans to be large enough. They demand deposits from a representative household and supply loans to a representative firm. We assume that banks have market power in long-term deposit and loan markets. Banks operate under monopsonistic and monopolistic competition, and the level of their market power depends on the elasticity of substitution that households have for long-term deposits and firms have for loans. An increase in the NSFR causes banks to either decrease their loans or increase long-term deposits, both of which are achieved by adjusting their respective interest rates. A higher Lerner index implies that banks must optimally adjust the loan rate more, which is consistent with banks having higher market power in this market.

This paper contributes to our understanding of how liquidity regulations affect banking sector competition and market power, with important implications for the design and implementation of regulatory policy.

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 domestic 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 in the banking system and other industries. 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. In contrast, 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 NSFW. 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 oper-

ations. 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 bank stability, 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. Considering the exogenous nature of this policy, the effect of this requirement on banking competition measures indicates the level of competition in the Colombian banking sector. Beyond dealing with the endogeneity issues that the paper acknowledges, we work with a 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.

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 long-term funding risk. The latter is called the NSFR.

The main objective is to ensure sustainable funding to maintain liquidity in the event of

unexpected 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. Formally, NSFR is described by the formula:

$$\frac{\text{Amount of stable funding}}{\text{Required amount of stable funding}} \geq 100\% \tag{1}$$

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 behaviorally more stable than wholesale funding of the same maturity from other counterparties." In Colombia, however, the regulator penalized CDs with a maturity lower than six months.

The NSFR was introduced in Colombia with a transition period and divided financial institutions into two groups. 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. The NSFR must be equal to or greater than 80% for this group. 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." In practice, however, we focus only on Group 1 because it includes the largest national representative financial institutions. Figure 1 shows 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 2, 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, but it is important in the local discussion because banks claimed that the unusual spread since September 2021 was due to the NSFR requirements.[1]

Figure 2 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 mainly parallel. A closer look reveals that CDs interest rates grew faster during the last quarter of the adjustment period (shaded area). Still, as the Central Bank's interest rate increments stopped and the inflation rate increments slowed, the CDs interest rate fell and eventually stabilized.

[1] See Corficolombiana Report.

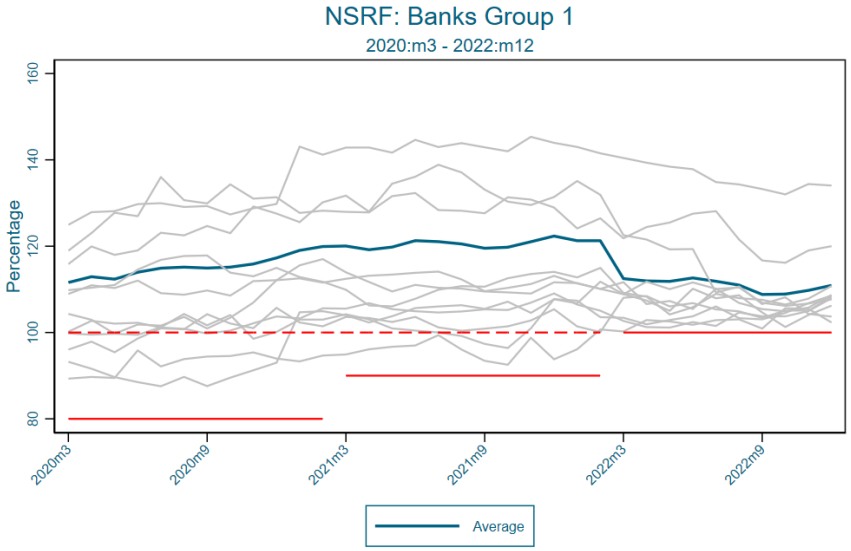

Figure 1: NSFR Transition Period for Group 1 Banks

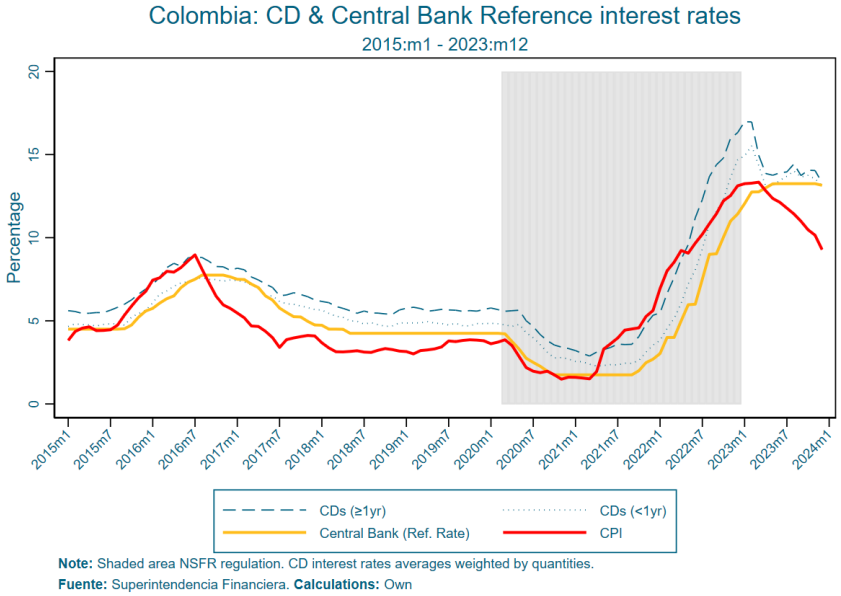

Figure 2: Long vs Short-term Certificates of Deposit

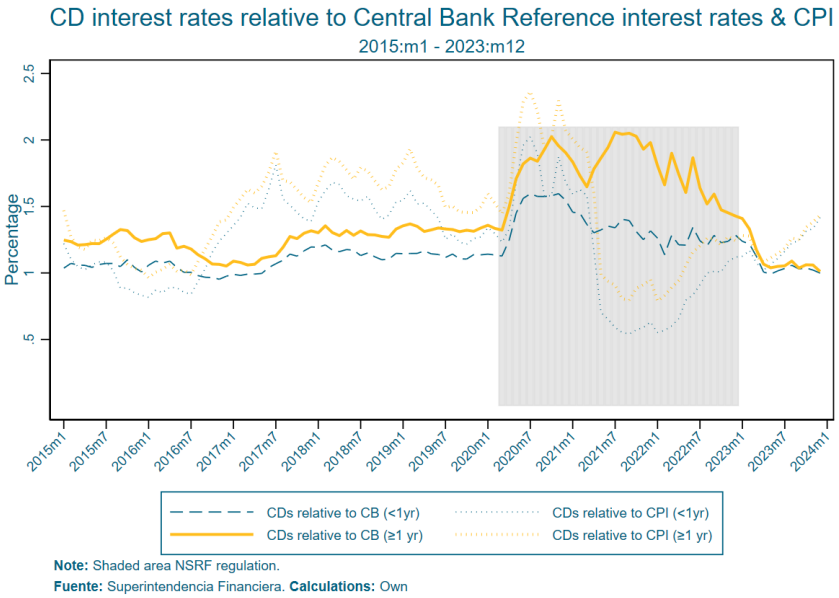

Figure 3: Relative Interest Rates

Figure 3 depicts the short- and long-term CDs interest rates relative to the Central Bank and CPI rates. Long-term CDs increased significantly immediately after the NSFR transition period began. Long-term rates stayed relatively high during the first half but 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 4 depicts commercial and consumption interest rate loans minus the CDs interest rates. During the adjustment period, the margin increased for commercial and consumption loans.

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 inadvertently foster stronger competition among banks while seeking fresh resources to comply with the NSFR requirements?

4 Theoretical model

To think through the implications for the banking sector of introducing NSFR, we build a partial equilibrium model based on Diamond and Dybvig (1983). Our model treats long-term deposits and loans from different banks as imperfect substitutes, allowing for different elas-

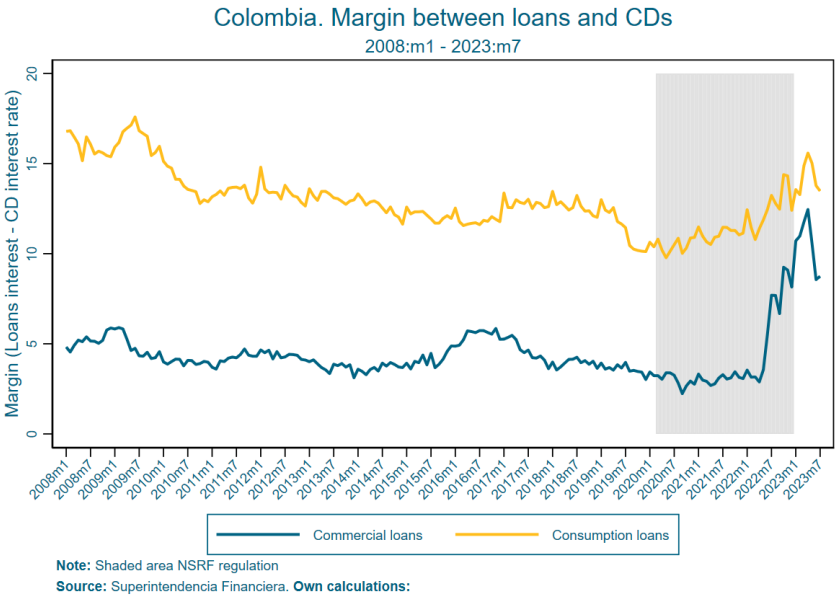

Figure 4: Interest Rate Loans

ticities of substitution in each market, α and σ. Furthermore, banks are heterogeneous in their ability, z, to convert their net liabilities (their short-term and long-term deposits net of their holdings of government bonds) into loans. Each bank's particular ability to transform liabilities into loans and the imperfect substitutability of loans and deposits from different banks are the fundamental sources of market power in our model economy. We use our model to understand what different specifications of the elasticities of substitution in these two markets imply for changes in equilibrium prices and markups in response to a shock like the introduction of NSFR and, therefore, for changes in the Lerner Index.

Our model focuses on the elasticities of substitution in the loan and deposit markets, as these are the key determinants of banks' optimal responses to a restriction on the ratio of long-term deposits to loans. Suppose a bank does not meet the regulation and must increase this ratio. In that case, it can do so by raising the interest rate, $r^T(z)$, to attract more long-term deposits, increasing the interest rate, $R(z)$, it charges on loans to reduce loan issuance, or using a combination of both. At the optimum, the marginal cost of each adjustment must be equal. The elasticity of substitution, α, between loans offered by different banks determines how much a bank must raise $R(z)$ to achieve a given reduction in loan issuance. Similarly, the elasticity of substitution, σ, between long-term deposit accounts determines how much a bank must increase $r^T(z)$ to reduce the deposits it takes from consumers. Intuitively, the lower the elasticity of a market, the more costly it is to adjust quantities in that market.

Banks

There is a continuum of banks (of measure 1), each indexed by its ability $z \in Z$ to convert its net liabilities into loans, distributed according to G_z. Bank z supplies long-term deposits $T(z)$ at interest rate $r^T(z)$ and loans $L(z)$ at interest rate $R(z)$.[2] 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 $D(z)$, which we treat as perfect substitutes at interest rate r^D, and demand bonds $B(z)$ from the government at an exogenous interest rate r. In what follows, we drop the dependence of D, B, on z for notational convenience. We only explicitly denote the dependence of R, r^T, T, k, and L, on z. Banks obtain benefits from their operation in periods 2 and 3, and the problem they solve is:

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

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

[2]For notational convenience $r^T(z)$ and $R(z)$ denote the gross interest rates (i.e., $r^T(z) = 1 + r'^T(z)$ and $R(z) = 1 + R'(z)$, where $r'^T(z)$ and $R'(z)$ are the interest rates in the standard notation.

consume in the third period.

Short-sighted Household

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

Far-sighted Household

$$\max_{\{T(z)\}} C \equiv \left[\int_z c(z)^{\frac{\sigma-1}{\sigma}} dG_z(z) \right]^{\frac{\sigma}{\sigma-1}}$$
$$\text{s. t. } \int_z T(z) dG_z(z) = W^T$$
$$c(z) = r^T(z) T(z)$$

Representative Firm

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

$$\max_{\{k(z))\}} AK - \int_z R(z) k(z) dG_z(z)$$
$$\text{s. t. } K \equiv \left[\int_z k(z)^{\frac{\alpha-1}{\alpha}} dG_z(z) \right]^{\frac{\alpha}{\alpha-1}}$$

Analysis

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

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

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

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 z will be given by:

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

where $R^T \equiv \left[\int_z \left(r^T(z)\right)^{\sigma-1} dG_z(z)\right]^{\frac{1}{\sigma-1}}$.
The firm will demand loan $k(z)$ supplied by bank z according to:

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

where $K \equiv \left[\int_z k(z)^{\frac{\sigma-1}{\sigma}} dG_z(z)\right]^{\frac{\sigma}{\sigma-1}}$.

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 z must then choose its long-term deposits rate $r^T(z)$ and its loan rate $R(z)$ to solve:

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

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 specific bank z. The above yields the following optimality conditions:

$$r^T(z) = \frac{\sigma-1}{\sigma}\frac{\lambda(z)+r}{\beta} \tag{2}$$

$$R(z) = \frac{\alpha}{\alpha-1}\frac{1}{\beta}\left(\frac{r}{z} + \lambda(z)N\right) \tag{3}$$

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

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

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

$$(\lambda(z) + r)^{\sigma-1} \left(\frac{r}{z} + \lambda(z) N \right)^{\alpha} = N \left(\frac{\alpha - 1}{\alpha} \right)^{\alpha} \beta^{\alpha+(\sigma-1)} \left(\frac{\sigma}{\sigma - 1} \right)^{\sigma-1} \frac{D^L}{S^T} \tag{4}$$

We take S^T and D^L as fixed, as our objective is to understand the optimizing behavior of banks in the short term. Since no individual bank influences these aggregate quantities, each bank takes them as given. General equilibrium effects become crucial in the long run, and banks would adjust their behavior in response. However, our essentially static model is not suited for capturing these dynamics.

A partial equilibrium analysis is suitable for examining the primary 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 case where the NSFR restriction is not binding.

Without 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 analyzing the behavior of banks when the NSFR constraint is active, we discuss the behavior of the Lerner Index. When the NSFR constraint is not binding, the Lerner index of bank z with loan productivity z is given by,

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

This follows immediately from expressions (2) and (3) and from the fact that in our model the Lerner index is given by $\mathcal{L}(z) = \frac{R(z) - r^T(z)}{R(z)} = 1 - \frac{r^T(z)}{R(z)}$. There are two main takeaways. The first one is that in the model, the Lerner index increases with the parameters σ and, α which express the fundamental market power of banks. The second is that the Lerner Index is decreasing in z. Banks that can convert net liabilities into loans more efficiently compete aggressively and offer loans at lower interest rates. At the same time, they are more profitable as their more significant loan volumes more than compensate for their lower rates.

We now look at the main differences between the description above and the behavior of banks when the NSFR constraint is binding. When NSFR is binding $r^T(z)$, the interest rate that the bank charges in the long-term deposits market is increasing in z; it can be non-monotonic in N, and it is higher than what would be the case if the constraint were not binding.

It is increasing in z because the marginal cost of the NSFR constraint is higher for more efficient banks, and therefore, these banks are willing to pay a higher interest rate for long-term deposits.

$r^T(z)$ can be non-monotonic in N, the level of the NSFR constraint, because the marginal cost of the NSFR constraint is non-monotonic in N, and this is the only channel through which $r^T(z)$ depends on N. As N increases, banks always increase $R(z)$, as discussed below, to reduce $L(z)$ and satisfy the constraint. However, whether they increase or decrease $r^T(z)$ depends on the elasticities of substitution of $k(z)$ and $c(z)$. For instance, for specific values of r, if long-term deposits are highly inelastic (small σ) and capital is highly elastic, then a slight increase of $R(z)$ leads to a substantial decrease of $L(z)$ and a significant increase of the ratio $T(z)/L(z)$, which allows the bank to reduce the rate that it offers for long-term deposits without a significant sacrifice in the level of $T(z)$.

When NSFR is binding, $R(z)$ is higher and decreasing in z, but the magnitude of the derivative is smaller than when NSFR is not binding. When the NSFR constraint is not binding, $R(z)$ is decreasing in z. The fact that this continues to be the case in the model when the NSFR constraint is binding is not apparent, given that two mechanisms are 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 fewer loans. This reasoning explains why $R(z)$ is higher when the constraint is binding than when it is not, and it also explains why the derivative of $R(z)$ 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. Notice that the sign of the derivative of $R(z)$ with respect to N is given by the sign of the derivative of $\lambda(z)N$ which is given $\frac{\partial \lambda(z)}{\partial N}N + \lambda(z)$. The first term can be positive or negative since the marginal cost of the NSFR constraint can be non-monotonic in N.

When regulators introduce or tighten the NSFR constraint, banks raise $r^T(z)$ to attract more long-term deposits $T(z)$. Since they have market power in the loans market ($\alpha < \infty$), they raise $R(z)$ to offset their higher funding costs. The extent to which they raise $R(z)$ will depend on α; however, they always pass on a more significant increase in loan prices $R(z)$ relative to the rise in marginal costs $r^T(z)$. The reason is that complying with NSFR forces banks to increase deposits and decrease loans. Decreasing the volume of loans means that the only way in which they can curb the reduction in their total profits is by increasing the profit margin on their loans. That is, they widen the gap between $R(z)$ and $r^T(z)$, and thus, the margin $R(z) - r^T(z)$ increases. This intuition does not immediately apply to the Lerner

Index, as the sign of its derivative depends of the relative sizes of $R\frac{\partial r}{\partial N}$ and $r\frac{\partial R}{\partial N}$ and not just $\frac{\partial r}{\partial N}$ and $\frac{\partial R}{\partial N}$. When the NSFR constraint is binding, the Lerner Index of a bank z with loan productivity z is given by,

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

It follows that $\mathcal{L}(z)$ is increasing β, and decreasing in z, α and σ. The derivative of the Lerner Index with respect to N depends crucially on the sign and magnitude of the derivative of $\lambda(z)$ with respect to N. As in the cases of $\frac{\partial R(z)}{\partial z}$ and $\frac{\partial \lambda(z)N}{\partial N}$ analyzed in the Appendix we can find an explicit expression for $\frac{\partial \mathcal{L}(z)}{\partial N}$. We examine this derivative numerically and find that while the margin $R(z) - r^T(z)$ always increases in N, the Lerner index can decrease in N for some parameter vectors. However, this is only the case for less than one in one thousand vectors examined. Overall, the main predictions of our model are that the margin $R(z) - r^t(z)$ is always increasing in the NSFR constraint and that the Lerner Index is increasing for the vast majority of parameter vectors.

5 Data

We rely on publicly available monthly balance sheet data for the Colombian banking sector, which is available from January 2015 to December 2023. The data includes detailed information on assets, liabilities, equity, and profit and loss statements for each bank supervised by the SFC. Although the NSFR divides banks 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, includes commercial and consumption loans. The latter, certificate of deposit data, is available per bank and includes prices and quantities. Auxiliary data provides information on the number of offices per bank, plus bank-level data on NSFR performance between March 2020 and December 2023.

5.1 Measures of concentration and market power

The number of firms in the market is an essential 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 (Figure 5).

Concentration, a measure of market structure, is the first step in determining the potential

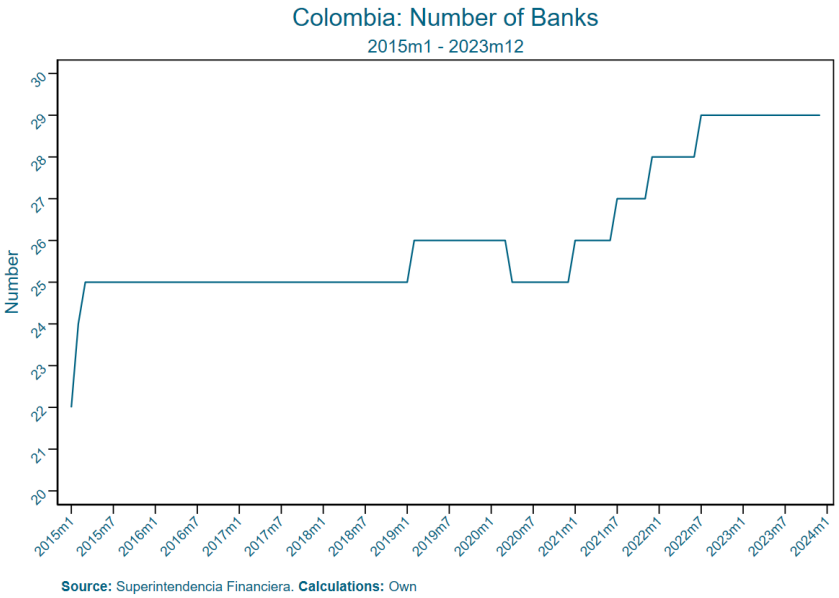

Figure 5: Number of Banks

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 considers 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 mainly as descriptive statistics because we are interested in the amounts of loans. Figure 6 depicts both the HHI and the C3 concentration measures.

Competition authorities traditionally focus on markets where the HHI exceeds 1800, which is not true in the Colombian banking industry. Similarly, authorities might review a market (usually upon a merger) if the share of the largest firms accounts for over 30

Figure 7 presents the HHI concentration measure using commercial and consumption loans. HHI for commercial loans is higher than for consumption, but it does not reach levels near the 1800 threshold. The C3 measure suggests that the top three banks hold a bit over 60% of the market, and 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. However, abundant literature suggests that this is not the case in Colombia. 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). Gomez-Gonzalez et al.

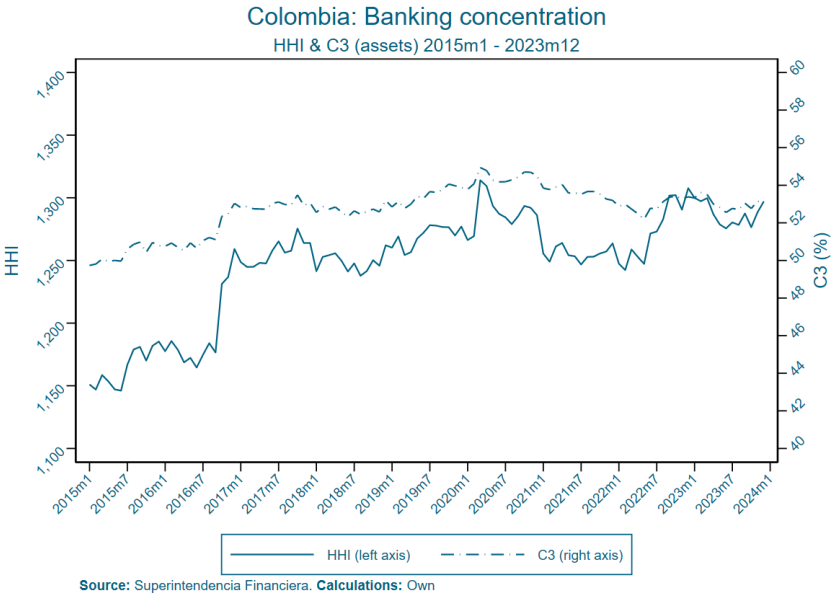

Figure 6: HHI

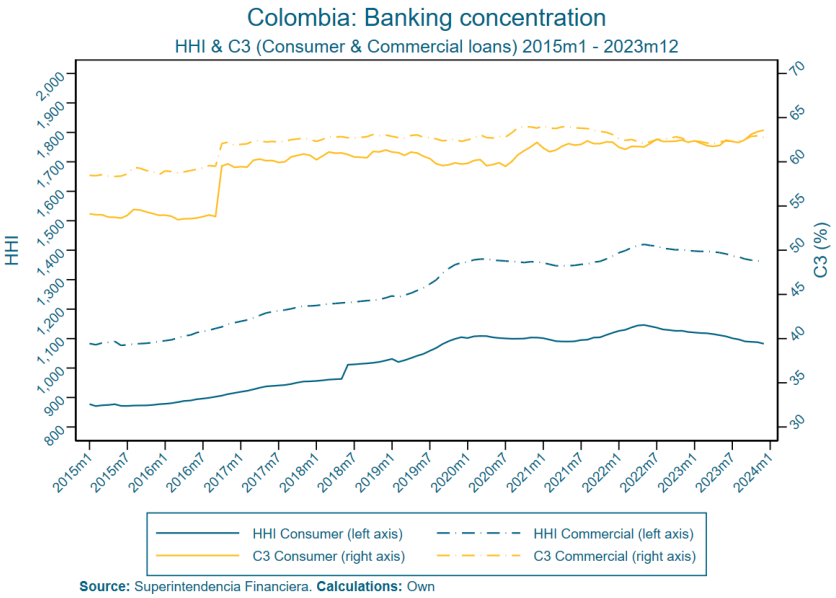

Figure 7: Concentration Measures

(2023) find a nuanced relationship between the cost of credit and market power. Lastly, Tabak, Fazio and Cajueiro (2012), using a sample of ten Latin American countries, explicitly note that Peru and Colombia are the "two most competitive banking markets."

The analysis suggests that, overall, the banking sector is not exceptionally concentrated, which explains why the industry is not the focus of the competition authority.

The Lerner Index, as a proxy for market power, is commonly assessed 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 ranges from zero to 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, this is not necessary in the financial system because there is sufficient information on interest rates. Using data on deposit and lending rates for commercial and consumer loans, we have the information required 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 indicates the exercise of market power because it assumes an optimal choice of prices and inputs. Profits and costs are efficient (Degryse, Morales-Acevedo and Ongena, 2019).

Figure 8 presents the evolution of the Lerner index, which, before the implementation of the NSFR, was steadily at a level of circa 60%, higher when using commercial loan interest rates than 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, currently around 45%. It is an empirical matter to determine whether the NSFR impacted market power in the Colombian banking industry.

5.2 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. However, the level of market power (as measured by the Lerner Index) is concerningly increasing during the initial stages of the implementation of the NSFR. We estimate the Stenbacka index in this section (Melnik, Shy and Stenbacka, 2008) to explore the industry further. This indicator aims to determine whether an individual firm has a dominant position. The significance of the exercise is twofold. First, suppose we can rule out a dominant firm in the industry. In that case, it is possible to safely

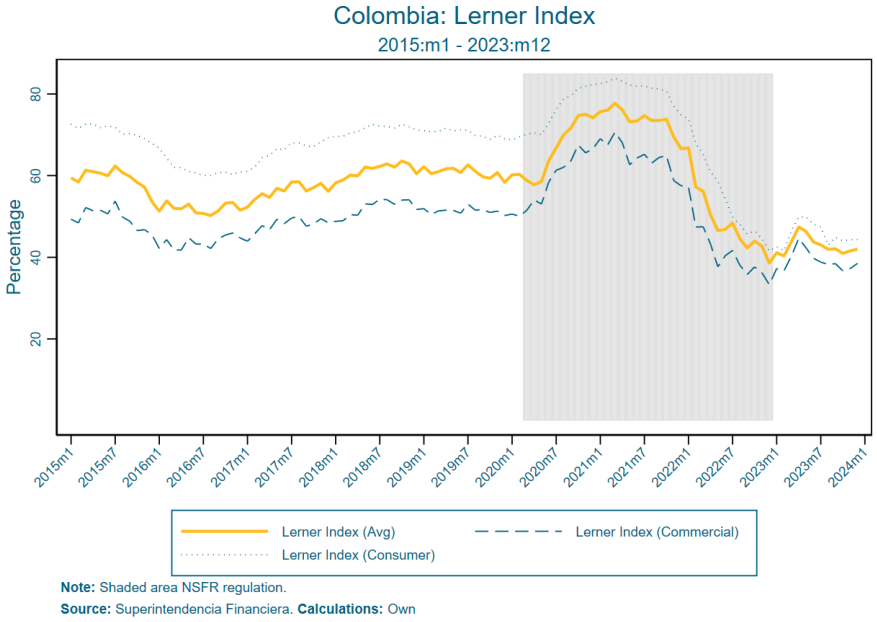

Figure 8: Lerner Index

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

Following Melnik, Shy and Stenbacka (2008) we estimate

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

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. At the same time, $\gamma > 0$ is a competition parameter that captures the potential competition on firm 1's dominance. Competition authorities tend to estimate SD 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 9 shows 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

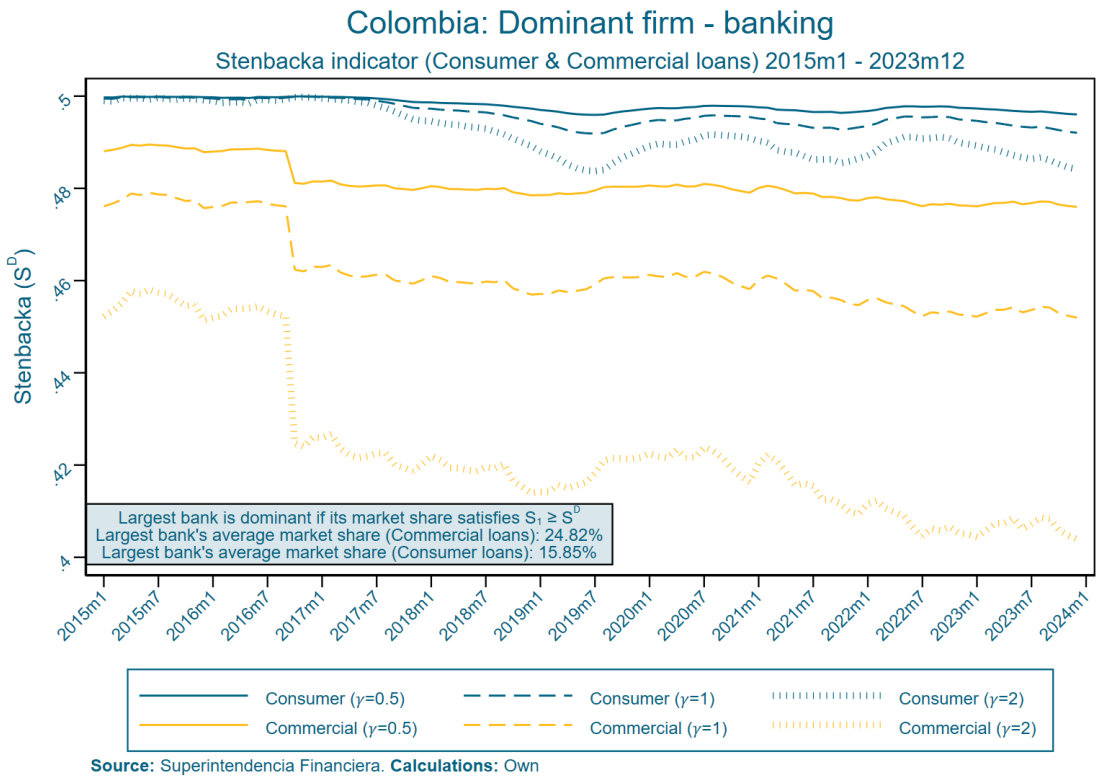

Figure 9: Stenbacka

60%, but the concentration is not high, and there is no evidence of a dominant firm.

6 Empirical methodology

6.1 Impact evaluation of the imposition of NSFR

This exercise aims to estimate the potential impact of the NSFR regulation on market power. Indeed, the Lerner Index, the main dependent variable, proxies for market power. Specifically, we will estimate models with the following form:

$$z_{i,t} = \alpha_i + \lambda_t + \beta_0 \textit{NSFR}_t + \gamma \textit{Concentration}_t + \theta \mathbf{X_t} + \epsilon_{i,t}, \tag{5}$$

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. This approach considers that there is an effect starting the implementation period, which is continuous over time. To further understand the evolution of the regulatory measure and capture its persistent effect over time, we defined $NSFR_1$ as one over the quarter starting in April 2020 and 0 otherwise; $NSFR_2$ is equal to 1 between July 2020 and September 2020 and 0 otherwise. We consecutively define additional quarterly dummies until $NSFR_{15}$, 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 first step consists of directly measuring the effect of the pandemic. We use Oxford's Stringency Index, a composite indicator that measures nine response metrics. 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.[4]

Although helpful, the Stringency Index is not enough to capture the impact of the pandemic. Remember that we are not interested in measuring the pandemic but 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

[4] https://github.com/OxCGRT/covid-policy-tracker/blob/master/documentation/interpretation_guide.md, visited November 24, 2024.

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 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). How the market impacts other banks in a given period will affect a bank. 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 these effects over the dependent variables. 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 consecutively between March and October each month.

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".[5]

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 each bank has as a proxy for the network size (and thus geographic coverage).

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

7 Results

Table 1 and Figures 10 and 11 show our estimates. 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 for up to 8 quarters after the introduction of the NSFR regulation. It then falls sharply over subsequent quarters, beyond which it stabilizes until the end of our sample period, in December of 2023.

[5] https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19#C visited November 24, 2024.

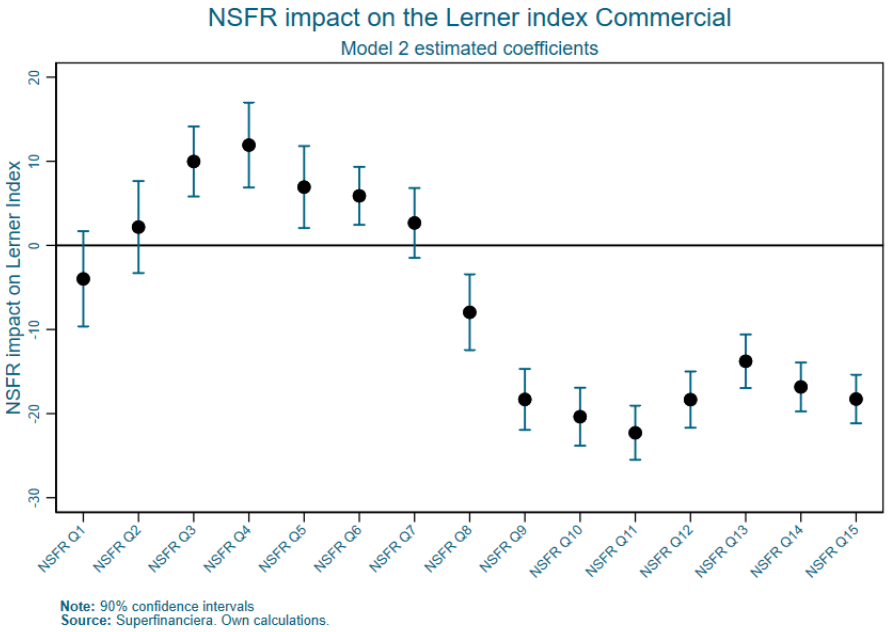

Figure 10: NSFR commercial transition period

This is the case for the Lerner index on commercial loans as well as for the index on consumption loans. Figures 10 and 11 show that both the short-term increase of the Lerner indices and the long-term fall are significant. In the short term the indexes rise 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 18 p.p (consumption) and 10 p.p. (commercial) below their levels before the introduction of the NSFR regulation.

7.1 Extensions: size and welfare

So far, the results suggest that the NSFR positively impacts the Lerner Index in the short run but negatively in the long run. The changes in banks' behavior are associated with the regulation, but they may differ depending on 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 with risk-taking, but competition restraints such tendencies (Kasman and Carvallo, 2014).

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

Table 1: Regression results

	Commercial LI		Consumption LI	
NSFR1		-4.208		1.390
		[3.408]		[2.182]
NSFR3		9.821***		15.133***
		[2.501]		[1.738]
NSFR5		6.725**		16.675***
		[2.933]		[1.913]
NSFR7		2.609		14.467***
		[2.506]		[1.773]
NSFR9		-17.872***		-6.447***
		[2.213]		[1.622]
NSFR11		-21.119***		-14.631***
		[1.962]		[1.970]
NSFR13		-13.124***		-7.280***
		[1.995]		[1.844]
NSFR15		-17.684***		-8.158***
		[1.806]		[2.065]
NSFR	-7.312***		-4.589***	
	[1.431]		[1.545]	
HHIComercial	0.022***	0.017***		
	[0.005]	[0.005]		
HHIConsumption			0.048***	
			[0.008]	
ISE	0.208***	-0.024	0.247***	-0.056
	[0.052]	[0.051]	[0.042]	[0.040]
Stringency	0.332***	0.073*	0.397***	-0.013
	[0.016]	[0.043]	[0.018]	[0.028]
Trend	-0.127***	0.077***	-0.412***	-0.374***
	[0.024]	[0.024]	[0.034]	[0.038]
Offices	-0.006	-0.004	-0.001	-0.000
	[0.006]	[0.006]	[0.006]	[0.005]
NPL_Total_i	0.444**	-0.735***	2.393***	0.667***
	[0.193]	[0.201]	[0.169]	[0.151]
Reserve Requirements	-0.001	-0.001*	-0.002***	-0.001**
	[0.000]	[0.000]	[0.000]	[0.000]
C. B. Int. Rate (growth)	-0.084**	-0.005	0.117***	0.033
	[0.042]	[0.057]	[0.032]	[0.038]
Constant	-15.385*	22.048**	-15.521*	-12.098
	[9.256]	[9.753]	[8.356]	[8.896]
Observations	2,322	2,322	2,309	2,309
R-squared	0.727	0.788	0.662	0.759
Bank FE	YES	YES	YES	YES
Quarterly FE	YES	YES	YES	YES

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

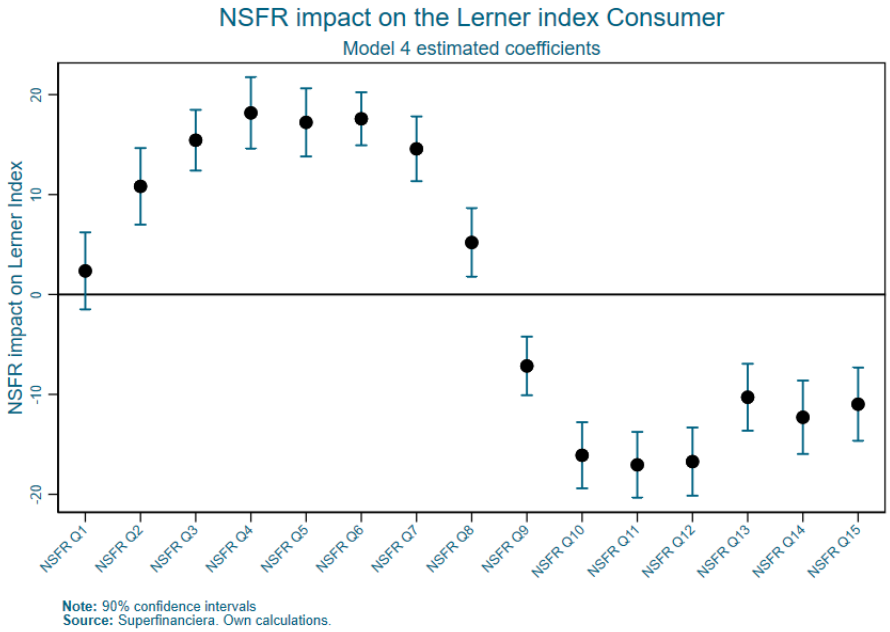

Figure 11: NSFR consumption transition period

similar results to our previous estimates. The main finding is that larger banks can 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 and negatively impacts consumers via a higher Lerner Index, but mainly 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.

8 Conclusions

Implementing Colombia's Net Stable Funding Ratio (NSFR) regulation reveals essential insights about the relationship between liquidity requirements and banking sector competition. Our analysis demonstrates three major findings that have significant implications for regulatory policy.

First, the NSFR implementation led to a distinct temporal pattern in banks' market power. In the initial eight quarters following implementation, banks exhibited increased market power as measured by the Lerner Index for commercial and consumer loans. The Lerner Index rose by 18 percentage points for consumption loans and 13 percentage points for commercial loans during this period. However, this increase proved temporary. After the initial adjustment

Table 2: Impact of size

	Commercial LI		Consumption LI		CDs	
NSFR	-7.103***	-34.731***	-4.781***	-32.673***	-4.299***	-0.625
	[1.430]	[5.207]	[1.558]	[4.684]	[0.250]	[0.714]
ln(Assets)	-3.366***	-3.154***	-3.335**	3.135**	0.417***	0.380***
	[1.190]	[1.205]	[1.354]	[1.361]	[0.133]	[0.135]
NSFR * ln(Assets)		1.697***		1.725**		-0.223***
		[0.317]		[0.276]		[0.041]
Constant	45.813**	23.928	-73.434**	-87.599	25.864***	27.327***
	[23.372]	[24.087]	[25.419]	[25.501]	[2.818]	[2.863]
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

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 dummy variable (NSFR) equal to 1 beginning in April 2020 and are zero 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.

period, market power declined sharply, stabilizing at levels 18 and 10 percentage points below pre-regulation levels for consumption and commercial loans, respectively. This pattern suggests that while banks initially leveraged their market position to manage regulatory compliance costs, competitive forces ultimately prevailed, leading to reduced market power in the longer term.

Second, bank size is a significant factor in determining how institutions respond to the NSFR regulation. Larger banks demonstrated greater ability to exercise market power during the implementation period, as evidenced by the positive and significant interaction between bank size and the NSFR implementation dummy variable. This finding aligns with previous research suggesting that larger banks may be better positioned to benefit from regulatory changes, potentially due to economies of scale in compliance and greater operational flexibility. However, this advantage appears to have come at a cost to depositors, as larger banks offered lower certificate of deposit rates during the NSFR implementation period. This highlights important distributional effects regulators should consider when designing phase-in periods for new requirements.

Third, our findings indicate that the NSFR regulation impacted different market segments. The observed patterns in the Lerner Index differed between commercial and consumption loans, with consumption loans showing more significant initial increases and substantial long-term decreases in market power. This heterogeneity suggests that the competitive dynamics and adjustment mechanisms vary across banking products and services.

Our empirical exercises allow us to analyze the competition in the Colombian banking sector further. Given our theoretical model, we can interpret the increases in the Lerner index following the implementation of NSFR in Colombia as banks having more market power in the loan market than in the deposit market.

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