TI 2021-055/IV
Tinbergen Institute Discussion Paper

The Effects of Usury Ceilings on Consumers Welfare: Evidence from the Microcredit Market in Colombia

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June, 2021

Abstract

Interest rate caps, also called usury ceilings, are a widely used policy tool to protect consumers from excessive charges by loan providers. However, they are often cited as a barrier for the advancement of financial inclusion, as they may reduce the incentives to provide loans to lower-income borrowers and and to invest in branching networks, particularly in remote and isolated locations. In this paper, I exploit a change in the usury ceiling applied to micro-loans in Colombia to understand the effects of this policy across geographic markets. To quantify the welfare implications of this policy, I structurally estimate a demand and supply model that incorporates the changes in size and composition of the potential market caused by this policy change, in a context where the distribution of branching networks has a crucial role in the optimal pricing strategies of loan providers. I find that the policy generated an increase in consumer surplus at the national level that is explained by greater credit availability for riskier borrowers and the expansion of branching networks in areas that were previously underserved. A counterfactual exercise reveals that the welfare gains associated to this policy depend greatly on additional investment in branching networks, as the opening of new branches in some locations is needed to compensate the consumer welfare loss associated with the subsequent increase in interest rates after the relaxation of the ceiling.

Keywords: Microfinance institutions, price ceilings, consumer welfare.

JEL Classification: L11, D43, D61, G21, G28

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1 Introduction

Access to affordable credit for the low-income population has become a worldwide spread policy in recent decades. Efforts in this direction are motivated by the premise that access to flexible and affordable funding allows individuals to develop productive projects and support the accumulation of productive assets and human capital, providing protection against unexpected shocks, and leading to an improvement in their socio-economic conditions (Cull et al., 2013).[1] From a macroeconomic perspective, financial inclusion has been associated with higher economic growth. Evidence of this link has been provided by Beck et al. (2007), who use cross-country data in the period from 1960 to 2005 to show that financial development reduces income inequality and contributes to aggregate economic growth, and Donou-Adonsou and Sylwester (2017), who find a significant effect of access to microloans on economic growth using a panel of 85 developing countries in the period 2002 to 2013.

Public and private initiatives have resulted in a broader portfolio of financial services for low-income clients. However, important barriers persist to date for the expansion of this market. Armendariz and Morduch (2007) and Cull et al. (2013) present a detailed overview of the challenges in the provision of financial services for the poor. They identify barriers on the demand side, such as scarce information that low-income clients have about the advantages of formal credit alternatives and low levels of financial literacy. On the supply side, they highlight, among other factors, the presence of higher operational costs that cannot be fully transferred to the borrower via higher interest rates due to regulatory barriers. Microfinance institutions (MFIs) operating in different countries often cite the presence of interest rate caps as a barrier that prevents them from reaching a broader segment of clients (Ledgerwood et al., 2013).

The appropriateness of this type of price regulation has been debated for decades, as it remains a widely used policy tool across countries of all income levels.[2] On the one hand, the imposition of a ceiling may lead to a shortage of formal alternatives of funding for poor clients, reducing price transparency, and even facilitating tacit collusion (Knittel and Stango, 2003; Temin and Voth, 2008; Melzer, 2011; Zinman, 2010). On the other hand,

[1] There are numerous empirical studies that have examined the link between economic welfare and credit access, with different conclusions. Banerjee et al. (2015) find that microcredit allows poor households to invest in their small businesses, although they do not find a significant impact on household consumption and other welfare measures. By contrast, Khandker (2005) and Augsburg et al. (2015) find that access to microfinance increased the standard of living of communities that receive microloans in Bangladesh and Ethiopia.

[2] See Maimbo and Gallegos (2014) and Ferrari et al. (2018) for a comparison of interest rate regulations across countries.

usury ceilings can be seen as a mechanism to limit undesirable distortions associated with third-degree price discrimination, protecting vulnerable clients against predatory practices of lenders with excessive market power (Dewatripont and Tirole, 1994; Stango and Zinman, 2015).

Several empirical studies have found that lenders in the consumer loans market may have enough market power and information about potential customers to exert this type of price discrimination.[3] The consumers' inability to evaluate all the alternatives available in the market, as well as the presence of switching costs and imperfect information about credit contracts, contributes to the market power of lenders, particularly in the case of products targeted for low-income borrowers (Agarwal et al., 2014; Stango and Zinman, 2015).

Economic theory suggests that the welfare implications of interest rate caps will depend on how much market expansion can be achieved if they are removed.[4] Theoretical contributions on the topic show that, while the presence of this type of regulation may lead to excess supply in some segments and shortages in those with higher marginal costs, the overall effect in terms of consumer and producer welfare is not necessarily harmful, and the outcome will depend on the curvature of the demand function, the distance between the ceiling and the marginal cost, and the differences in marginal costs across segments.

The type of credit rationing that is associated with the presence of interest rate ceilings is the result of an external distortion and is different from the one described by Stiglitz and Weiss (1981), where rationing arises as a result of adverse selection in a context where the only screening instrument available for lenders is the interest rate. In the situation described by the authors, allowing banks to charge interest rates higher than a certain threshold does not increase the volume of loans because lenders would interpret the willingness to pay such high fees as a signal of a high risk of default. These results rely on strong assumptions, such as the role of the interest rate as the only screening tool available, and that all productive projects have identical expected returns and differ on their risk level only. When these assumptions are relaxed, rationing is not optimal anymore in equilibrium (Meza and Webb,

[3] Galenianos and Gavazza (2019) and Stango and Zinman (2015) document high levels of dispersion in the interest rates charged for narrowly defined loan products, even after controlling for a rich set of individual characteristics potentially informative of the risk profile of the borrowers.

[4] Schmalensee (1981) uses a formal approach to prove some degree of price discrimination can be welfare improving in cases where there is a significant increase in the volume of sales in segments that could not be served under uniform pricing. His framework has been extended later by Armstrong et al. (1991), Aguirre et al. (2010), among others, to analyze the implications of price ceilings in cases where a monopolist can offer multiple products and marginal costs are allowed to differ across segments. For a detailed exposition of the topic see Stole (2007).

1987)). In the microfinance industry, financial institutions have developed strategies that allow them to gather information about the probability of success of productive projects and the borrowers' payment behavior. These screening and monitoring technologies are relatively expensive, but they allow them to overcome some of the adverse selection problems that could give origin to the equilibrium credit rationing result obtained by Stiglitz and Weiss (1981). Abundant empirical evidence indicates that banks tend to increase their volume of loans after the interest rate restrictions are relaxed, even in the context of microfinance, where the interest rates are typically very high already (Armendariz and Morduch, 2007). In line with these findings, the volume of loans and the overall profit of loan providers in Colombia (particularly microfinance institutions) increased after the interest rates were relaxed.

Whether or not lifting usury ceilings is welfare-improving is, therefore, an empirical question. While there are plenty of studies that describe the evolution of credit markets after the modification of an interest rate cap for different countries and periods (see: Temin and Voth, 2008; Benmelech and Moskowitz, 2010; Maimbo and Gallegos, 2014), only few studies provide a quantification of the welfare effects of this type of policy. Recent developments in this direction, by Cuesta and Sepulveda (2019) and Galenianos and Gavazza (2019), make use of comprehensive data sets that include detailed information on individual loan operations. Unfortunately, this information is often unavailable in low-income regions, where the development of microfinance has been significant and perhaps most relevant. This problem is sometimes exacerbated by the differences in the regulatory framework that applies to loan providers in the microfinance sector, which often translates into different information requirements and confidentiality rules.

In order to measure the welfare implications of this policy in contexts where comprehensive data on individual transactions are not available, I propose a structural model of demand and supply that can be estimated using market-level information. In the model, loan providers operate across multiple market segments and geographic locations. The model incorporates changes in the size and composition of the potential market in each location that may occur as a result of the regulatory change. It allows us to measure to what extent these changes in credit availability are due to an increase in the supply of loans of existing competitors or due to the entry of new competitors in local markets. Consistent with the practice of financial institutions in the microloans market, and motivated by data limitations that are common in this industry, I consider a scenario where price discrimination occurs based on the risk profile of the clients, but it is not perfectly observed by the econometrician.

The link between the evolution of branching networks and changes in the pricing strategies of financial institutions is a critical element of my approach that has not been considered

in the literature. The microfinance industry has become increasingly dominated by large specialized institutions that operate across multiple locations by making use of extensive networks of brick-and-mortar branches. These networks are particularly important in the microcredit market, as they facilitate the collection of reliable information about payment behavior of potential borrowers, as well as the monitoring on the performance of productive projects that have received funding. The decisions of loan providers regarding the location of their branches will have, therefore, different welfare implications for consumers across locations, depending on the impact on the local availability of credit.[5] The relaxation of the interest rate cap modifies the incentives of financial institutions to expand their branching networks towards new locations, by making it profitable to offer loans to a wider segment of clients. These effects may be significant even in contexts where financial institutions set a unique interest rate for each type of loan (client) at the national level, because the distribution of branches across geographic markets will determine their exposure to local competitive environments. In this paper, I incorporate the effects of these changes in the size and distribution of branching networks on the optimal pricing strategy of financial institutions.

My identification strategy exploits the variation of market shares and product characteristics across geographic markets, before and after the policy change, to identify the consumers' sensibility to changes in loan characteristics. My approach combines elements from several studies that estimate demand in the context of limited attention (e.g. Abaluck and Adams, 2017; Ho et al., 2017; Hortaçsu et al., 2017; Abrams, 2019), and in the presence of unobserved price heterogeneity (D'Haultfœuille et al., 2018). I combine moment conditions derived from the consumers' utility maximization and the lenders' optimal decision on interest rates, before and after the policy change, to identify changes in the price elasticity and the share of consumers with access to formal loans.

On the supply side, I focus on the optimal pricing strategies of financial institutions for a given market structure. Since I do not model the entry decision of financial institutions across geographic markets, I cannot make conclusions on the effects of changes in usury ceilings on the size and distribution of branching networks. The model, however, allows us to measure how potential borrowers value an extra competitor or branch at a local market, and how their surplus is affected by the increase in the interest rates. This information is used to evaluate to what extent the expected increase in the volume of loans generated by

[5] Bruhn and Love (2014) exploit the opening of a large multi-market bank in Mexico to analyze the effects of financial access on poverty. They find a significant effect of access to finance on labor market activity and income levels, particularly among individuals with low income, located in areas that were under-served before the entry of this agent.

the relaxation of the usury ceiling depends on additional investments on branching networks in new markets, facilitating the comparative analysis of different policy interventions.

I use the model to understand the welfare implications of a modification of the usury ceiling for microloans that took place in Colombia around 2011. This category includes loans that are designed for small entrepreneurs who do not have collateral or cannot provide reliable information about their payment behavior. The Colombian scenario is relevant in the context of microfinance because the institutional framework is comparable to that of other countries in the region, such as Bolivia, Mexico, and Chile, where the main providers of this type of loans are for-profit institutions regulated by the financial supervisory authority.[6] In Colombia, the change in the usury ceiling in 2011 occurred during a period of macroeconomic stability and was followed by a significant increase in the interest rates charged by financial institutions (7 percentage points on average), as well as by an important expansion of the branching networks.

On the supply side, I observe that the expansion in the volume of microloans that occurred after the relaxation in the usury rate was not followed by a significant increase in default risk (see Figure A.1 in the Appendix). Instead, the regulatory changes were followed by substantial increases in operational costs, salaries and provisions, that suggest a greater effort of financial institutions related with monitoring and screening activities. Overall, the profit of financial institutions increased (the average return over assets (ROA) increased from 2% in 2010 to 2.2% in 2012), particularly for those specialized in microcredit.

On the demand side, I perform a before-and-after comparison of consumer welfare to examine the effects of the relaxation of the usury rate. I find significant gains associated both with the greater availability of branches in new locations, and the increased funding for borrowers who did not have access to formal loans before the policy change. These gains exceeded the reduction in consumer surplus caused by the increase in the interest rates. When comparing the welfare gains of consumers across markets, the results indicate that those who benefited the most from the policy change were the ones located in markets where the expansion of loan operations towards riskier borrowers was accompanied by entry of new competitors.

In a counterfactual scenario where I examine the effects of relaxing the usury ceiling in the absence of additional investment in branching networks, I find that the policy is still welfare improving. Although there are markets that would experience a reduction in consumer welfare in the absence of additional branches, the overall effect is dominated by the increase

[6] In many developing countries, institutions specialized in the provision of financial services for the poor have transitioned from non-profit organizations into regulated financial institutions (Ledgerwood et al., 2013).

in consumer surplus of riskier borrowers who gain access to formal loans after the ceiling is relaxed. Nevertheless, the results suggest that there are other barriers prevent micro-entrepreneurs from considering regulated financial institutions as a source of funding, as there is a significant number of potential borrowers who seem to rely solely on informal lenders even after the policy change.

This paper is organized as follows. Section 2 provides a brief review of the related literature. Section 3 provides an overview of the characteristics of MFIs and other loan providers that interacted in the retail banking industry in Colombia in the period of analysis. Section 4 presents descriptive statistics of the data used in the estimation. Section 5 describes the consumer choice model, the supply side optimality conditions on the interest rate, and the estimation strategy. Section 6 presents the results of the structural model, introduces measures of the impact of the regulatory change on consumer welfare and discusses a counterfactual exercise where I examine the effects of the policy in the absence of additional investments in branching networks. Finally, I present some concluding remarks and potential extensions of the model.

2 Related literature

This paper contributes to different strands of the literature. First, it contributes to a growing number of studies on the effects of interest rates caps on consumer welfare. Most of the studies in this literature focus on consumer loans and payday loans (e.g. Benmelech and Moskowitz, 2010; Temin and Voth, 2008; Melzer and Schroeder, 2017; Rigbi, 2013). For example, Melzer and Schroeder (2017) and Zinman (2010) explore the effects of usury laws applied to automobile loans and payday loans in the U.S., concluding that tightening ceilings is harmful for consumers, as it reduces price transparency in the market and limits access to timely funding for vulnerable borrowers.

Most of this work adopts reduced form approaches and focuses on credit access as the main outcome. Recent papers, however, by Galenianos and Gavazza (2019) and Agarwal et al. (2014) find that usury ceilings can be beneficial for consumers as they limit the ability of banks to exert price discrimination in contexts with product differentiation and consumer inattention, without causing a significant reduction in the volume of credit. Cuesta and Sepulveda (2019) find a contrasting result in the context of the Chilean consumer credit market. They propose a structural model of demand and supply of consumer loans to provide evidence of the effects of interest rate caps on market outcomes and welfare, finding

that the adverse implications of tightening the usury ceiling on credit access dominate the consumer protection effects.

This paper is also related to a broader set of studies that explores the competitiveness in the credit market and the sources of market power, particularly in segments of low-income borrowers. Recent work by Meier and Sprenger (2010), Zinman (2010), and Nelson (2019) finds that consumers' present bias and limited search, lender concentration, and adverse selection might be behind the excessive market power exhibited by lenders in some markets. Many of these studies explore these topics in the context of the US credit card market, where recent regulation changes such as the Credit Card Accountability Responsibility and Disclosure (CARD) Act of 2009, have attracted renewed attention. The CARD act limited the ability of financial institutions to raise interest rates and other fees in response respond to new information about the borrowers. The seminal work by Agarwal et al. (2014), who finds significant welfare gains for consumers in this market has been followed by other studies that reveal partial market unraveling among subprime accounts (e.g. Han et al., 2018; Nelson, 2019).

Next, this paper joins a growing literature that uses structural models to examine the role of branching networks as a source of differentiation in the context of retail banking. My paper is related to the work of Dai and Yuan (2013), Berger and Dick (2007), and Dick (2008), who use discrete choice models to estimate consumer demand, price, and entry decisions of bank across geographic markets. Their work focuses on the effects of entry triggered by the Riegle-Neal Banking and Branching Efficiency Act of 1994 in the United States and the interaction of different types of financial institutions in local markets, such as single and multi-market banks. In a recent study, Clark et al. (2017) highlight the contribution of branching networks to the market power of multi-market agents and their role in the geographic flow of credit.

From a methodological perspective, my paper is related to a body of literature concerned with demand estimation in contexts where not all consumers are aware of all the services at their disposal (e.g. Abaluck and Adams, 2017; Hortaçsu et al., 2017; Ho et al., 2017). In these studies, the share of consumers that opt for the outside alternative exhibits some degree of inertia that is often associated with inattention, advertising expenditures or higher switching costs. Recently, Abrams (2019) examined local competition in the banking industry across geographic markets the United States by applying a demand model with consideration sets similar to the one proposed by Goeree (2008), where the probability that a consumer is aware of the services offered by a particular bank is a function of the advertising expenditure of the latter. Their model relies on very detailed information of the distance between borrowers and lending, and advertising expenditure of financial institutions across multiple geographic

markets. Here, I use similar methods to identify the share of consumers that gain access to credit from formal loan providers after the usury ceiling is relaxed. In addition, my empirical strategy takes elements from recent literature that estimates demand in the presence of unobserved price heterogeneity (D'Haultfœuille et al., 2018; Huang, 2020, e. g.). I follow the approach by D'Haultfœuille et al. (2018), who propose a method for the structural estimation of a demand and supply model with price discrimination, where information on prices is limited and takes the form of, e.g., observing list prices from catalogs or average prices.

Finally, this paper contributes to the literature that has examined the effects of usury ceilings on credit market outcomes in Colombia. Empirical work on this topic has been developed by Steiner and Agudelo (2012) and Cubillos Rocha et al. (2018). These studies use reduced-form approaches and differences in differences estimation to analyze the effects of the measure on the aggregate value of microloans and the number of clients. This paper complements this work by making use of a structural model that incorporates the changes in the composition of the potential market in the demand estimation. My approach has the advantage of allowing for the implementation of different counterfactual exercises that can provide more insights on the effects of the policy on consumer welfare across geographic markets.

3 Usury ceilings and microcredit market in Colombia

In this section, I provide a brief overview of the microfinance industry in Colombia and the changes in the regulation related to usury ceilings.

Colombia experienced a favorable macroeconomic environment between 2006 and 2014 that was accompanied by a significant expansion of the demand for loans. After a deep financial crisis at the end of the 90s that triggered the implementation of stricter regulation related to credit risk management and capital requirements for financial institutions, the banking industry experienced a process of consolidation resulting in a relatively concentrated market, where commercial banks with extended branching networks throughout the national territory enjoyed significant market power. The growth in the demand for loans is largely explained by the dynamics of non-collateral loans, including those available for small entrepreneurs. Industry reports indicate that the potential for growth in the niche of micro-loans is high, due to the high levels of informality in the labor market and the scarcity of adequate collateral among entrepreneurs (SFC, 2015). According to Estrada and Rozo (2006), these financial constraints are even more acute in rural areas, where financial services had been almost

exclusively provided by a public bank that focuses on funding for productive projects in the agricultural sector.

3.1 Microloans supply in Colombia

The oldest private financial institutions specialized in microfinance (MFIs) started operations in Colombia at the end of the 1980s. Before their entry, microloans were provided exclusively by the government through development agencies. According to Barona (2004), during the 1990s, most of these institutions were non-profit organizations that funded their loan operations with donations from private individual donors or international development agencies. Only after the financial crisis at the end of that decade, the number of non-profit organizations that offered loans to poor clients started to increase. Between 2000 and 2011, the number of institutions increased from 4 to 26. During this period, the biggest MFIs transitioned from non-profit organizations into specialized banks, while only a few traditional banks made their incursion in the microfinance sector.

The vast majority of the microloans offered by financial institutions in Colombia are individual, rather than group liability loans, and they comply with the legal definition of microcredit, introduced by the government in 2007. This definition specifies i) a maximum amount that can be borrowed by a single client (around USD 7500), ii) a cap on the total debt that the client can have with the financial system (nearly USD 36000) and iii) the charges that financial institutions can apply for additional services related to the loan (different from the interest rate).[7] These loans are typically used by small entrepreneurs to finance productive projects that involve less than ten direct employees. The average amount of a microloan in 2014 was around USD 2160 and the time of repayment was 1.4 years on average (Fernandez, 2014). Most of these loans have a monthly frequency of payments.

While some of these characteristics are similar to those of non-collateral loans offered to households, the interest rate of microloans has been consistently higher. This gap has been attributed partially to differences in how that financial institutions asses the value of the available collateral and gather information about the payment behavior of their clients. To maintain low levels of default and reduce associated loses, they often exert close monitoring of the productive projects of the clients and include additional services for entrepreneurs, such as guidance on marketing and basic accounting. The implementation of these measures is costly and often requires a higher number of employees. MFIs' branching networks have

[7]The values presented here were converted into US dollars by applying the year 2014 Purchasing Power Parity, calculated by the World Bank.

more nodes in rural areas and intermediate cities compared to those of traditional banks, and sometimes they are complemented with mobile agents with the task of reaching clients in isolated locations. Microloans are the credit product with greater geographical diversification. In 2012, 52% of these loans were given to clients in locations different from the 13 biggest cities in the country, while only 5% of the loans in other categories were given to clients outside these locations.

Although the microloans portfolio typically represents only a small fraction of the total volume of credit provided by financial institutions (3,16% in 2012), it has exhibited significant growth in recent years. The value of the portfolio nearly doubled between 2010 and 2017, while the number of clients has increased from 1.2 million to 3.3 million over the same period (Estrada and Hernandez Rubio, 2019). As of 2017, there were a few financial institutions that concentrate the majority of loan operations in the microcredit market. A public bank concentrated around 70% of the loans operations destined to the rural sector, while a dozen of private regulated financial institutions provided the majority of the loans for micro-entrepreneurs in other sectors.[8] Other entities that were not regulated by the financial supervisory authority provided 16% of the total volume of loans.[9] Nevertheless, these institutions were subject to the same regulation in terms of usury ceilings.

3.2 Interest rate ceilings

The Colombian government has implemented usury ceilings to protect vulnerable consumers of excessive charges. This regulation has existed in Colombia for decades, and it is applicable for every person or institution that offers a loan.[10] With the introduction of regulation related to the supply of microloan by supervised institutions in 2007, the government started introducing changes to the usury ceilings in order to adjust them to the particularities of this market niche, as illustrated in Figure 1. Before 2007, there was a single interest rate cap that applied for all types of loans. This ceiling was calculated as 1.5 times the average interest rate charged by regulated financial institutions for consumer and commercial loans during the previous 12 weeks. This ceiling was heavily influenced by the level and dynamics of the

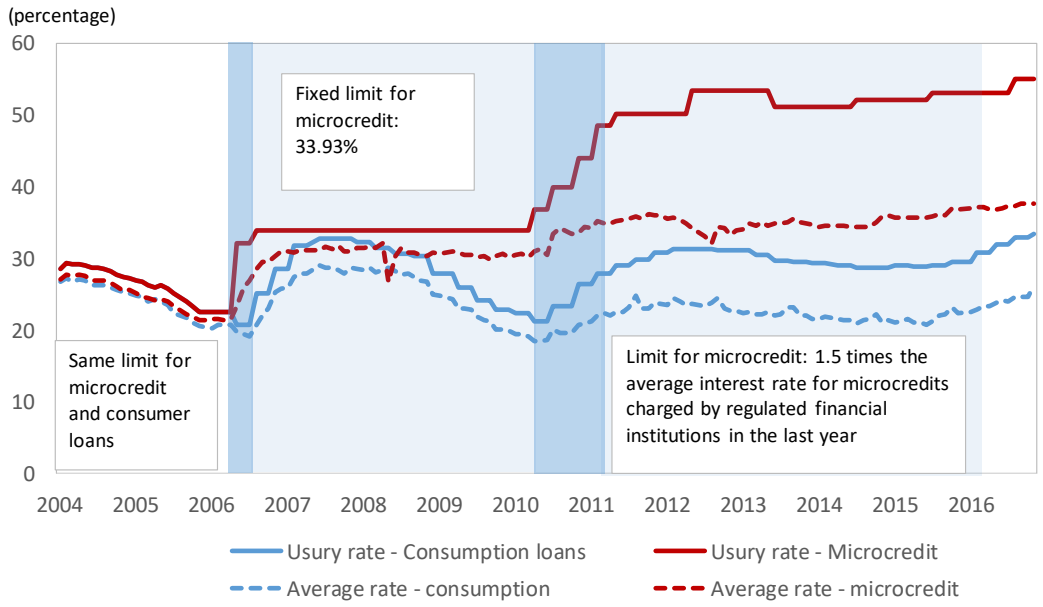
[8]Throughout this paper I refer to regulated financial institutions as those under the supervision Superintendencia Financiera.

[9]Most of these institutions concentrated their operations in a few municipalities and in some cases consumers needed to acquire some type of membership in order to become eligible to obtain a loan. Since these alternatives were not available for all consumers in the market during this period, I consider them as part of the outside option in the demand estimation.

[10]The enforcement of the usury ceiling is more challenging among informal sources of credit, where information about the conditions of the loan contracts is often unavailable.

interest rates of commercial loans, which were substantially lower than those of consumer and micro loans. In October 2007, the government defined a new interest rate ceiling that was applied to for the category of microloans exclusively. This cap remained fixed until October 2010 at a level of 33.9%, effective annual.[11] Later, after a transition period that ended in January 2011, the usury rate for microcredit was defined as 1.5 times the average interest rate charged by financial institutions for this type of loan during the previous year.

Figure 1: Effective annual usury rate 2004-2016



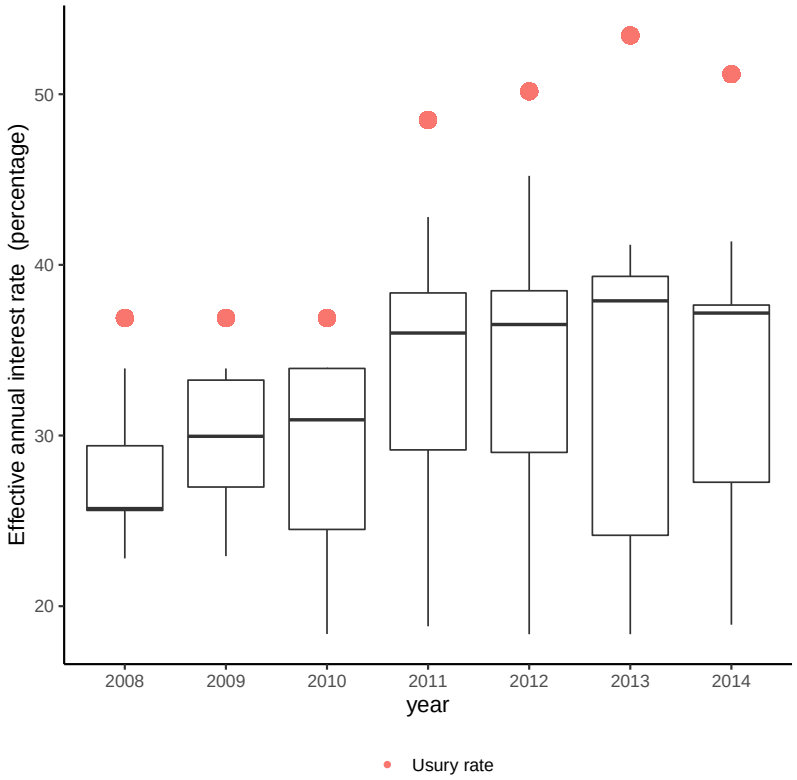
Notes: Figure 1 compares the usury ceilings and average interest rates for to micro-loans and consumer loans between 2014 and 2016. Source: Author's calculations based on information published by Superintendencia Financiera de Colombia.

Figure 2 presents the distribution of the interest rates (national weighted average) charged by regulated financial institutions. As shown in the figure, the interest rate ceiling applied until September 2010 was binding at least for some of the regulated loan providers. The distribution of the interest rates after the policy change exhibited a shift in the mean and greater dispersion. Banks with the lower interest rates before the policy change maintained them at similar levels or even reduced them after the usury ceiling was modified. These institutions kept a small participation in the microcredit market, and their microloans also

[11]The inflation rate in Colombia has remained in one digit levels since 2000. Between 2010 and 2012 the average annual inflation rate was 2.95% (based on information of the consumer price index published by Banco de la República (Central Bank of Colombia).

represented small fraction of their total loans portfolio, even after the policy change. In contrast, entities specialized in this market niche increased their interest rates significantly after the ceiling was relaxed.

Figure 2: Distribution of interest rate of microloans

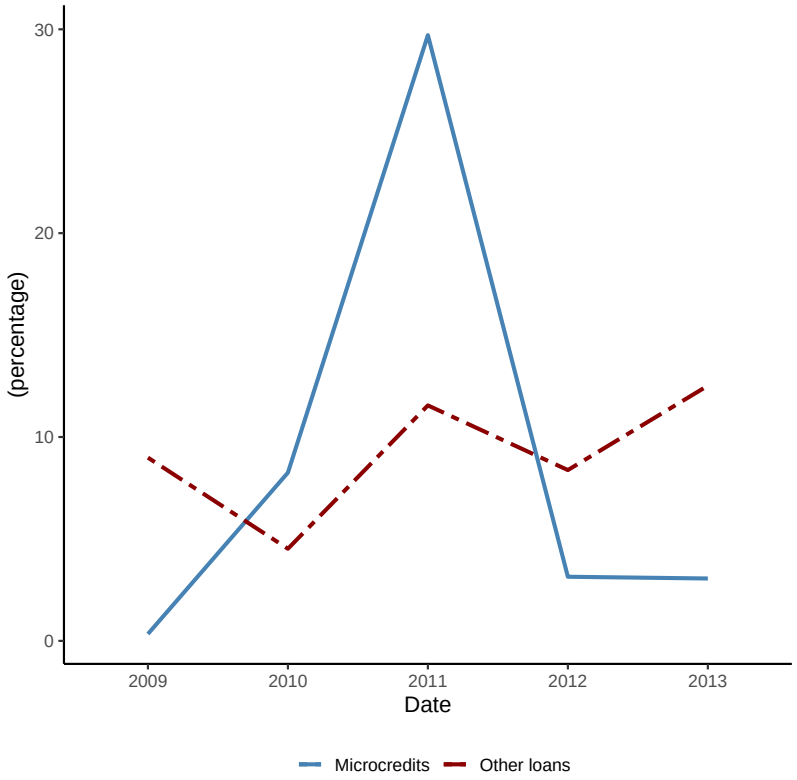


Notes: Distribution of interest rates of new microloans across private financial institutions (national weighted averages per year). The red dots correspond to the mean usury ceiling for this type of loan in each year . Source: Author's calculations based on information published by Superintendencia Financiera de Colombia.

The increase in the interest rates was accompanied by a rise in the outstanding value of the microloans portfolio of private regulated loan providers, as shown in Figure 3. From 2011 to 2013 the annual growth rate of this portfolio exceeded the one registered in other loan categories. Interestingly, this expansion did not translate into a significant increase in the default risk of loan providers, as seen in Figure A.1 in the Appendix. The portfolio quality ratio (share of the outstanding portfolio that registers a delay in the payment of more than 30 days) of the cohorts of microloans generated in 2012, after the relaxation of the usury rate, was only slightly higher than the one observed in 2010 and lower than the ratio observed for the cohorts of 2007 and 2008. Financial institutions however, increased their loan provisions substantially between 2010 and 2012, which might be indicative of their willingness to expand their loan operations towards riskier segments of the market after the

policy change.

Figure 3: Annual nominal growth of the microloans portfolio. 2008-2013



Notes: The red solid line corresponds to the average annual growth of the outstanding value of the gross microloans portfolio of private financial institutions regulated by Superintendencia Financiera. Calculations include only those institutions with a microcredit porfolio that represents more than 1% of their total loan portfolio. The blue dotted line represents the annual growth rate of the portfolio comprised by other loan categories. Source: Author's calculations based on information published by Superintendencia Financiera de Colombia.

In addition, the relaxation of the usury ceiling was accompanied by a significant expansion of the branching networks. The entry of new competitors and the branching expansion of incumbents increased the availability of micro-loans in small and intermediate markets. Table 1 presents the the number of cities with new competitors between 2008 and 2014. As seen from Table, financial institutions expanded their branching networks substantially in 2011 and 2012, particularly in cities of intermediate size (between 50.000 and 500.000 inhabitants).

Table 1: Number of cities with new branches, by population size.

	2008	2009	2010	2011	2012	2013	2014
Less than 50000	0	0	1	0	2	1	1
50.000 to 100.000	0	4	6	5	3	6	3
100.000 - 500.000	0	6	15	7	19	9	8
500.000 - 1'000.000	0	2	4	3	4	0	0
More than 1'000.000	0	2	4	3	3	0	0

Notes: Total number of markets with new competitors compared to previous year, by year and market size. Source: Source: Author's calculations based on information published by Superintendencia Financiera de Colombia.

4 Data

Information regarding the bank/loan characteristics, such as the number of branches and the value of the loan portfolio of all financial institutions is published by the Colombian financial supervisory authority (Superintendencia Financiera), while the demographic variables per market were taken from the Municipalities Panel Data Set from Universidad de los Andes, which contains information from several official sources.

I consider information of all the private financial institutions regulated by Superintendencia Financiera with a microloans outstanding portfolio that represents more than 0.1% of their total loan portfolio. I also include in the analysis the biggest non-profit organizations specialized in microfinance (these institutions transitioned into regulated banks between 2008 and 2011). I focus on private financial institutions only, because the microloans originated by public institutions are often guaranteed by the government and their conditions on interest rate and repayment may differ substantially from those provided by the private sector. The loans originated by public entities are concentrated in the agricultural sector. The data set contains information of 12 out of 26 financial institutions in the period 2019 to 2013. The outstanding value of the microloans portfolio of the institutions included represented 95.67% of the value of microloans provided by private loan providers in 2012.

4.1 Financial institutions

Table 2 presents summary statistics of the characteristics of these financial institutions at the national level. The average interest rates charged for new microloans in September 2010 ranged from 18,4% to 33.9% (the usury ceiling at the time). While the average deposits rate

was relatively similar across financial institutions (between 2.6% to 6.5%), there is significant dispersion across loan providers in terms of their administrative costs and salaries. The differences in the risk management strategies of financial institutions might explain this discrepancy. For example, loan providers that specialize in microfinance exhibit greater administrative costs and typically charge higher interest rates.

Table 2: Descriptive statistics of financial institutions at the national level.

Statistic	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
			September 2010			
Interest rate	0.294	0.049	0.184	0.245	0.339	0.339
Salaries*	0.539	0.453	0.000	0.196	0.744	4.486
Provisions Rate*	0.018	0.024	0.000	0.001	0.050	0.093
Required reserve**	0.095	0.029	0.023	0.084	0.118	0.118
Deposits rate	0.034	0.007	0.026	0.028	0.034	0.051
Microloans as share of own portfolio	0.264	0.394	0.005	0.007	0.528	0.986
Administrative costs*	0.371	1.075	0.046	0.075	0.325	13.364
Previous NGO (dummy variable)	0.228	0.420	0	0	0	1
Bank (dummy variable)	0.874	0.333	0	1	1	1
Number of observations	451					
			September 2012			
Interest rate	0.346	0.070	0.184	0.290	0.385	0.452
Salaries*	0.625	0.612	0.017	0.178	0.886	4.321
Provisions Rate*	0.021	0.026	0.000	0.001	0.054	0.093
Required reserve**	0.084	0.025	0.042	0.059	0.097	0.119
Deposits rate	0.045	0.009	0.034	0.037	0.047	0.065
Microloans as share of own portfolio	0.316	0.415	0.003	0.006	0.917	0.975
Administrative costs*	0.330	0.892	0.042	0.085	0.223	10.053
Previous NGO (dummy variable)	0.280	0.449	0	0	1	1
Bank (dummy variable)	0.866	0.341	0	1	1	1
Number of observations	515					

Summary of descriptive statistics of the characteristics of financial institutions observed at a national level in 2010 and 2012. Source: Author's calculations based on information published by Superintendencia Financiera de Colombia.

*: Values expressed as a percentage of the outstanding value of the loans portfolio.

**: Values expressed as a percentage of the outstanding value of the deposits.

4.2 Period of analysis

As shown in Figure 1, there is a transition period between the old regulation, that fixated the usury ceiling at 33.93% (effective annual), and the new regulation, that defined the usury rate as 1.5 times the average interest rate charged by regulated financial institutions in the category of microloans in the last 12 months. This period lasted between October 2010 and December 2011. I took September 2010 as the period before the policy change. Anticipation of the policy change does not seem likely on the demand side, as potential borrowers in the segment of microloans are typically not sophisticated in terms of their financial decisions an often exhibit low levels of financial literacy. On the supply side, the number of new loans originated in the months previous to the policy change did not decrease compared to previous periods, suggesting that financial institutions did not strategically restrain the supply of microloans before the relaxation of the usury ceiling. The information available in every geographic location corresponds to the value of the outstanding portfolio, rather than to new loan operations only. In order to make sure that this value fully reflects the new conditions applied by financial institutions after the usury ceiling was modified, I took September 2012 as the period after the policy change.

4.3 Geographic markets

The data set contains information of all municipalities in Colombia, where there was at least one branch of a private regulated financial institution at some point between 2019 and 2013 (832 municipalities out of 1122). It includes big urban centers, with a population above 3 million inhabitants, as well as small villages with less than two thousand inhabitants.

My empirical strategy assumes that consumers only consider financial institutions with at least one branch in their vicinity. Using municipality as a proxy for local markets can be problematic, as it is likely that entrepreneurs travel to their closest urban center to request a loan from financial institutions that do not have a branch in their municipality. Since information about the precise location of consumers is not available, I define geographic markets as clusters of municipalities with a maximum distance between them of 40km.[12] This distance is consistent with other studies on the banking industry that measure the average distance that consumers are willing to travel in order to ask for a loan (Berger and Mester (2003)). The resulting number of markets is 134.

[12]The distance between municipalities corresponds to the traveling distance obtained using a Google Maps API.

Table 3 presents the summary statistics of demographic characteristics and market structure. As seen in the table, there is great dispersion in terms of the total population, the share of the population in rural areas and GDP per capita across markets. The number of branches and banking correspondents (BCs) also differs greatly across locations.[13] The microcredit market is highly concentrated, as suggested by the number of competitors in each location. In more than 25% of the markets, there were only two private regulated institutions that offered microloans, with just one branch per entity. Other institutions that offer microloans, such as non-profit organizations and savings associations, were mostly concentrated in urban markets.

Between 2010 and 2012, there was a significant expansion of the branching networks as can be seen in the change in the number of competitors, branches and banking correspondents. 202 new branches were opened during this period in 84 locations, while 55 markets experienced an increase in the number of competitors. During the same period, financial institutions expanded radically their banking correspondents network. The average number of banking correspondents per 100 thousand inhabitants almost quintupled, rising from 1.1 in 2010 to 5.12 in 2012. Table 9 in the Appendix presents the summary statistics of the characteristics of financial institutions that change across markets. The most important changes between 2010 and 2012 are the increase in the number of markets with at least one branch and the in the density of banking correspondents. Between 2010 and 2012 the number of banking correspondents per 100.000 inhabitants increased from 0.3 to 1.33.

[13]Banking correspondents are authorized representative individuals of a financial institution. They provide basic financial services to the people like cash transactions (both deposit and withdrawal) and facilitate wire transfers.

Table 3: Descriptive statistics of geographic markets.

Variable	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Adults	337,886.10	695,332.60	8,237	64,757.8	285,373	4,237,450
GDP per capita (USD-PPP2014)	32,801.96	70,624.58	267	2,940.5	26,489	397,114
Entrepreneurs	12,110.44	8,036.77	961	5,955	16,198	39,800
Rural productive units	59.45	39.68	1.00	29.10	78.17	197.90
Distance to closest urban center (km)	0.45	0.17	0.05	0.33	0.60	0.80
Market structure 2010						
Public bank	0.98	0.13	0	1	1	1
Banks offering microcredit	3.70	2.47	1	2	6	12
Microfinance NGOs	3.32	4.49	0	1	4	28
Total number of branches	17.76	64.25	1	2	12	635
Banking correspondents	20.65	40.60	0.00	0.33	20.08	218.50
Market structure 2012						
Public bank	0.99	0.12	0	1	1	1
Banks offering microcredit	3.84	2.65	1	2	6	12
Microfinance NGOs	3.04	4.30	0	1	3	33
Total number of branches	17.68	64.39	1	2	12	665
Banking correspondents	95.94	115.00	0.00	0.81	136.31	517.00

Notes: Descriptive statistics of demographic characteristics of local markets in 2010 and 2012. Source: Author's calculations based on information published by Superintendencia Financiera de Colombia.

4.4 Market shares

In order to obtain a measure of the market share of each financial institution, it is necessary to define first the size of the potential market. That is, the potential outstanding value of the microloans portfolio in each market. For this purpose, I use information from several surveys by Departamento Administrativo Nacional de Estadistica (DANE) and Superintendencia Financiera.

I started by building a measure of the number of potential borrowers in the market (N_{mt}). I define the set of potential borrowers as all individuals who may need loan to start a productive project or carry on economic activities, either from formal or informal sources. To estimate the number of potential small entrepreneurs in each market, I used information from the GEIH Survey and the Micro-establishments Directory developed by Departamento Administrativo Nacional de Estadistica (DANE). I included in my definition of potential borrowers all small entrepreneurs that already have a formally registered micro-establishment (up to nine employees) and all adults who are either unemployed or have an informal occupation (this definition excludes self-employed professionals, and patrons and employees of micro-establishments with more than 5 employees). This measure of market size allows to account for potential entrepreneurs who need funding in order to start their own business and it also recognizes the existence of many small business that do not have a formal registry. Also, it takes into account that financial institutions often require proof of an employment contract in order to become eligible of other credit alternatives, such as credit card and consumer loans.

I used a survey performed by Superintendencia Financiera in 2014 that asked individuals and micro-entrepreneurs in different geographic locations about the use of financial services (SFC, 2015), to estimate the share of potential entrepreneurs that need a loan. This survey consists of two different questionnaires, one for individuals (households) and one for micro or small entrepreneurs, and it is representative for three types of municipalities: big cities and urban centers, intermediate urban municipalities, and rural towns. The survey asked whether individuals or micro-entrepreneurs have requested a loan in the previous 12 months. Among the response alternatives the survey includes different funding sources, from friends and family, informal sources like loan sharks and thrift stores, to formal loan lenders like financial institutions or traditional banks. The survey also asked to those who claimed not to have asked for a loan in the previous year, the reason behind this decision. Among the response alternatives, the survey includes the option "I am not interested, I did not need one, I have not asked for it". Other options include "I have asked for a loan but it has been denied", "I believe that my request will be denied", "I do not comply with the

requirements", and other alternatives indicative of mistrust of available sources of funding and financial constraints. Based on the response alternatives included in the survey, This question permits to identify clearly the proportion of borrowers who did not need a loan, from those who were not able to obtain funding for other reasons.

As seen in the second column of Table 4, there is a meaningful share of the population that relies on sources different from the formal financial sector to obtain funding. These sources include family members and friends, as well as informal lenders. The third column presents the proportion of individuals who, according the their responses in the survey, did not asked for a loan in the previous year because they did not need it. I will assume later in the estimation procedure that the shares shown in the Table are identical among markets belonging to the same category (big cities, intermediate urban, and small markets).[14]

Table 4: Sources of funding of entrepreneurs and individuals - 2014

Type of municipality	Financial inst.	Other	No need of a loan
Individuals			
Big urban markets	0.181	0.255	0.564
Intermediate markets	0.158	0.183	0.659
Rural/remote markets	0.154	0.1500	0.699
Entrepreneurs			
Big urban markets	0.187	0.241	0.572
Intermediate markets	0.356	0.155	0.489
Rural/remote markets	0.296	0.160	0.545

Notes: Share of individuals and entrepreneurs who obtained their funding from financial institutions or other sources, by market size. Source: Author's calculations based on the Demand for Financial Services Survey by Superintendencia Financiera de Colombia (SFC, 2015).

I calculate the potential size of market m in year t, S_{mt}, using the number of potential small entrepreneurs defined above (N_{mt}), the proportion of them who need a loan (s_m^{loan}) according to the survey by Superintendencia Financiera, and the average value of the microloans portfolio per capita observed in different types of markets (big cities, intermediate urban

[14]This survey was taken in 2014 (after the ceiling was on the interest rates was removed). The structural model that I propose in Section 5 allows to measure in retrospective the share of borrowers who could have been constrained by the existence of the interest rate ceiling, that is, the proportion of borrowers who needed a loan, but were not able to obtain it because financial institutions were not willing to provide credit at the maximum interest rates allowed by the regulation.

locations, and small markets), $\bar{l}_{mt}$.[15] The calculation is as follows:

$$S_{mt} = N_{mt}\bar{l}_{mt}(s_m^{\text{loan}}).$$

Let L_{jmt} denote the value of the microcredit portfolio of the loan provider j in market m in year t. The market share of this lender will be given by

$$s_{jmt} = \frac{L_{jmt}}{S_{mt}}.$$

The potential market is comprised of 2.9 million small entrepreneurs and corresponds to a credit volume of 10.4 billion dollars. For comparison, Estrada and Hernandez Rubio (2019), estimate a potential market of 4.7 million entrepreneurs. The main difference with their estimates is explained by my decision to exclude agricultural productive projects and consider only the fraction of entrepreneurs who do not need a loan according to the survey mentioned above.

5 Model

As discussed in the previous section, the relaxation of a usury ceiling was followed by a rise in the interest rates and the volume of loans provided by financial institutions. The later effect might have occurred as financial institutions started providing loans to new segments of clients in existing geographic markets, or via additional investments in their branching networks, which allowed them to expand their operations in new geographic markets. These investments have important implications in terms of consumer welfare because the availability of microloans often requires proximity between the client and a brick-and-mortar branch. In practice, clients typically need to approach a traditional branch to complete the procedures related to the loan request. Similarly, financial institutions that provide microloans often exert close monitoring of the productive projects that receive funding, including on-site assessment of the conditions of the productive projects by bank agents. These activities become prohibitively expensive if the client is too far from the branching network.

[15] I assume the share of entrepreneurs that require a loan does not change as a result of the policy change. Instead, I assume that this change only affects the decision of entrepreneurs to request the loan from formal or informal sources.

In estimating the demand for microloans, it is important, therefore, to account for changes in the interest rate, but also those in other service characteristics such as the size of branching networks and the availability of other transaction channels in the vicinity of the borrowers. To capture these effects in the demand estimation, I use a discrete choice model, where the decision of the consumers is simplified to one in which they select the preferred financial institutions among those who have at least one branch in their local market. Although this approach does not take into account the effects of the interest rate on the size of the loans demanded by potential borrowers, it seems reasonable in the market of microloans, given the small dispersion in the size of the loans observed in this market.[16]

Furthermore, I assume that banks do not price discriminate across geographic markets. Instead, they set a unique interest rate that applies to all their consumers of the same type in all locations. This pricing strategy is consistent with the usual practice of financial institutions in Colombia as well as in other countries, where banks use a reference interest rate in multiple markets and make adjustments based on the client risk profile rather than the local market structure (Berger and Dick (2007)).

5.1 Demand side

The microloans market is one in which financial institutions have the possibility to charge different interest rates depending on the characteristics of the clients. Due to data limitations, I am not able to fully capture the heterogeneity in interest rates charged by loan providers. However, the approach that I propose here allows us to capture some of the changes in the composition of the loan portfolio generated by the relaxation of the usury ceiling. I divide the potential borrowers in the microloans market into three segments: the first one (Segment 1) is constituted by all entrepreneurs that are aware of all the credit alternatives available in the market and could obtain a loan from a private regulated institution at an interest rate lower than $\bar{r}_b$; these entrepreneurs are more likely to have a safer profile and may represent lower marginal costs for the loan supplier. The second segment (Segment 2) corresponds to those attentive borrowers that can only obtain loans at rates higher than $\bar{r}_b$, but lower than $\bar{r}_a$, the usury ceiling after the policy intervention. The third segment of borrowers corresponds to those individuals who are either not attentive or are not able to obtain loans even under the new usury ceiling.

[16] The legal definition of microcredit includes a maximum size of the loan (around US3500 as of 2012) and a maximum amount of debt that a client can have with the financial system at a given period . Banks often specify a minimum loan size. Furthermore, I do not observe a significant increase in the average size of a micro-loans after the policy change.

Before the policy change, the aggregate demand for microloans is composed of borrowers that belong in Segment 1, whereas after the policy change, borrowers from Segment 1 and Segment 2 can demand loans. I assume that there is no price discrimination within these two segments. This is a simplifying assumption motivated by the limitations in the availability of data. If more detailed information about individual transactions is available, it is possible to extend this framework to account for additional market segments.

The utility that an individual i, located in market m and belonging to segment d, derives from choosing a financial institution j can be written as

$$u^d_{ijmt} = \delta^d_{jmt} + \epsilon_{ijmt},$$

where δ^d_{jmt} is the mean utility of consumers in segment d and ϵ_{ijmt} is a term that captures individual preferences and follows a type I extreme value distribution. The mean utility satisfies

$$\delta^d_{jmt} = \beta_0 + \boldsymbol{\beta}^d \boldsymbol{X}^d_{jmt} + \alpha^d r^d_{jmt} + \xi_{jm}, \tag{1}$$

where $\boldsymbol{X}^d_{jmt}$ is a vector of characteristics of the bank and ξ_{jm} is a term that captures other aspects unchanged across segments and over time that are not observed by the econometrician. Suppose that there are only two periods: before and after the policy change ($t = \{b, a\}$). According to this specification, preferences of consumers can vary across segments but are constant over time.

Abaluck and Adams (2017), Ho et al. (2017) and Hortaçsu et al. (2017) study situations where the alternatives under study are not available for all consumers, and instead, there is a fraction of consumers whose only alternative is the outside option. In these studies, the probability that consumers choose a particular alternative is calculated, therefore, as the product of the probability that consumers belong in the segment with access to the complete choice set, and the probability that they select that alternative, given that they participate in the choice problem. The first probability is often determined by observed characteristics of the consumers and their environment, while the choice conditional on participation is often modeled using a logit model.

Let ω^1_{bm} be the portion of entrepreneurs in market m that belong to Segment 1 before the policy change. This value is assumed to be dependent on observable characteristics of the market, such as demographics and the availability of alternative (informal) sources of funding. Given the assumptions on ϵ_{ijmt}, the share of bank j in market m before the policy

change can be expressed as

$$\begin{aligned} s_{jmb} &= \omega^1_{mb} s^1_{jmb} \\ &= \omega^1_{mb} \left(\frac{e^{\beta_0 + \alpha^1 r^1_{jmb} + \boldsymbol{\beta}^1 \boldsymbol{X}^1_{jmb} + \xi_{jm}}}{1 + \sum_{k=1}^{K^1_{mb}} e^{\beta_0 + \alpha^1 r^1_{kmb} + \boldsymbol{\beta}^1 \boldsymbol{X}^1_{kmb} + \xi_{km}}} \right), \end{aligned}$$

where K^1_{mb} is the number of banks in that offer loans in the segment of safer borrowers in market m before the policy change. In consequence, the share of the outside option is given by

$$s_{0mb} = \omega^1_{mb} s^1_{0mb} + (1 - \omega^1_{mb}),$$

where $s^1_{0mb} = \frac{1}{1 + \sum_{k=1}^{K^1_{mb}} e^{\beta_0 + \alpha^1 r^1_{kmb} + \boldsymbol{\beta}^1 \boldsymbol{X}^1_{kmb} + \xi_{km}}}$.

I assume that the fraction of safer borrowers ω^1_{mb} will depend on a vector of characteristics of the market, $\boldsymbol{Z}_{mb}$, such as distance to closest urban center, percentage of population in rural areas, public safety conditions, the presence of a public bank and number of non-regulated institutions that offer loans to entrepreneurs. I modeled ω^1_{mb} using a standard binary logit,

$$\omega^1_{mb} = \frac{e^{\boldsymbol{\rho}^1 \boldsymbol{Z}_{mb}}}{1 + e^{\boldsymbol{\rho}^1 \boldsymbol{Z}_{mb}}}. \tag{2}$$

This specification is similar to the one used by Hortaçsu et al. (2017), and it can be interpreted as a reduced-form representation of the determinants of inattention. There are plenty of reasons, both on the demand and the supply side, that explain why formal financial institutions might not constitute a relevant source of funding for a portion of potential borrowers, including low levels of financial literacy, distrust for financial institutions, inexperience with formal financial services or long distances between branches and potential clients. Therefore, I do not interpret the initial magnitude of ω^1_{mb}, before the policy change, as the degree of financial exclusion generated solely by the usury ceiling. Instead, I argue that the change in the portion of potential borrowers that participate in the choice problem after usury ceiling is relaxed can be informative of the degree of market expansion that can be associated with the policy change.

Abaluck and Adams (2017) shows that this model is equivalent to a standard logit model with an additional inertia term through which the utility of each alternative depends on the characteristics of rival products. Provided that enough determinants of probability of participating in the choice problem are observed, it is possible to separately identify ξ_{jm} and ω^1_{mb} based on the asymmetry in the response of the market shares of available banks to

changes in the characteristics of the outside option, relative to the response of the share of the outside option to changes in the characteristics of banks.

After the policy change, financial institutions can profitably provide loans to a new segment of potential borrowers who were previously excluded due to the initial usury ceiling. Therefore, the market share of bank j in market m will be given by

$$s_{jma} = \omega^1_{ma} s^1_{jma} + \omega^2_{ma} s^2_{jma}, \tag{3}$$

where $\omega^2_{ma} = \frac{e^{\boldsymbol{\rho}^2 \boldsymbol{Z}_{ma}}}{1+e^{\boldsymbol{\rho}^2 \boldsymbol{Z}_{ma}}}$, and $\omega^1_{ma} + \omega^2_{ma} \leq 1$.

The market shares in each segment, s^1_{jma} and s^2_{jma}, are obtained using the logit formula:

$$s^d_{jma} = \frac{e^{\beta_0 + \alpha^d r^d_{kma} \boldsymbol{\beta}^d \boldsymbol{X}^d_{jma} + \xi_{jm}}}{1 + \sum_k^{K^d_{ma}} e^{\beta_0 + \boldsymbol{\beta}^d \boldsymbol{X}^d_{kma} + \xi_{km}}},$$

where K^d_{ma} is the number of banks who offer loans in segment d and market m after the policy change.

5.2 Supply side

In modeling the optimal pricing of financial institutions, I abstract from the information problems typically encountered in the context of retail banking, such as adverse selection and moral hazard, that can have important implications in the optimal pricing strategies of loan providers. This is a strong assumption, which could be relaxed in future research if more detailed data on default rates becomes available.[17] Preliminary exploration of the data at the national level reveals that the relaxation of the usury ceiling did not lead to a sustained increase in the default rates of the microloans portfolio (See Figure A.1). Instead, loan providers seem to have adjusted their expenditure in provisioning, operative costs and salaries, indicating that they might have resorted to additional monitoring to manage the potential increase in credit risk after the usury ceiling was relaxed. This evidence suggests that financial institutions in the microcredit market have mechanisms in place that allow them to solve the adverse selection problem to some extent.

I focus here on the effect of branching networks on the optimal pricing strategies of loan providers that operate across multiple geographic locations. I consider a situation where

[17] Recent work in this direction has been done by Cuesta and Sepulveda (2019) and Nelson (2019). These studies make use of administrative data sets that contain detailed information on individual loan transactions and borrowers' credit history.

they set interest rates based mostly on the risk profile of their borrowers, with no spatial discrimination pricing. This assumption is not incompatible with the presence of substantial differences in the average interest rates across geographic markets, which have been broadly documented in different contexts (e.g. Hannan and Prager, 2006; Brevoort and Hannan, 2006; Petersen and Rajan, 2002; Bellucci et al., 2013), nor does it ignore the ways in which the distance between lenders and borrowers can impact prices and credit availability. Agarwal and Hauswald (2010) finds that once the analysis accounts for proprietary information related to the borrowers' payment behavior, the distance between borrowers and lenders becomes irrelevant as a predictor of the interest rate. These findings, along with those provided by Petersen and Rajan (2002), are in line with information-based theories but are not supportive of discriminatory spatial pricing.

There is some agreement in the literature regarding the effect of competition on pricing in the banking industry. However, the relevant definition of geographic markets differs depending on the context. Degryse and Ongena (2005) find that interest rates are sensitive to the number of competitors in the vicinity of the borrowers. In contrast, Hannan and Prager (2006) find evidence in favor of homogeneous pricing in the deposit market by multi-market banks throughout states and even across broader geographic areas in the US, with interest rates being closely correlated state-wide competitive conditions. Similarly, Heitfield and Prager (2004) find that small banks set their interest rates based on the local market competitive conditions, while large multi-market banks set homogeneous prices across broader geographic areas. The authors attribute the presence of uniform pricing to the growth in Internet advertising, which allows borrowers to get more information about rates charged across geographic markets. By quoting uniform rates, rather than local market-specific ones, multi-market banks avoid adverse reactions from consumers that would be offered a relatively unattractive rate due to their location.

By surveying the internet websites of financial institutions in Colombia and interviewing some industry representatives informally, I could confirm that pricing practices in the microloans segment are similar to those found in large multi-market banks in the US, in the sense that interest rates for this particular type of loans are usually set at the national level (this practice is also documented by Armendariz and Morduch (2007) in the context of microfinance in different countries). This pricing strategy might be related to the multi-market nature of all financial institutions included in the sample and the costs associated with allowing differentiated rates across regions. As a result, pricing strategies seem to be more affected by competitive conditions at the national level. Furthermore, regulation on price transparency by Superintendencia Financiera introduced in 2008 created additional incentives for banks to provide very detailed information on interest rates applicable to stan-

dardized products on their websites. As a result, financial institutions advertise different types of microloans that differ in their interest rates, repayment periods, and borrowers conditions such as collateral availability or previous experience with formal financial institutions, but do not depend explicitly on the location of the borrower. As mentioned in the previous subsection, heterogeneity in the borrowers' risk profile is captured here by the presence of two segments of potential borrowers in the period after the policy change.

According to this, a bank j that operates across M markets in year t will obtain an aggregate profit that can be written as

$$\Pi_{jt}(r_{jt}) = \sum_{m=1}^{M} S_{mt} \sum_{d=1}^{1,2} \omega_{mt}^{d} s_{jmt}^{d} (r_{jt}^{d} - c_{jmt}^{d}),$$

where S_{mt} is the size of each geographic market. Lenders choose the interest rate that maximizes their profit, subject to the constraint on the interest rate imposed by the usury ceiling. The interest rate that lenders will charge in Segment 1, r_{jt}^{1*}, will be given by

$$r_{jt}^{1*} = \min \left\{ \frac{\sum_{m=1}^{M} S_{mt} \omega_{mt}^{1} s_{jmt}^{1} (\alpha^{1} c_{jmt}^{1} (1 - s_{jmt}^{1}) - 1)}{\alpha^{1} \sum_{m=1}^{M} S_{mt} \omega_{mt}^{1} s_{jmt}^{1} (1 - s_{jmt}^{1})}, \bar{r}_{t} \right\}, \tag{4}$$

where $\bar{r}_t$ is the usury ceiling in year t. The optimal interest rate for the second segment is calculated for the period after the policy change only, and it can be written in a similar way, as

$$r_{ja}^{2*} = \min \left\{ \frac{\sum_{m=1}^{M} S_{ma} \omega_{am}^{2} s_{jma}^{2} (\alpha^{2} c_{jma}^{2} (1 - s_{jma}^{2}) - 1)}{\alpha^{2} \sum_{m=1}^{M} S_{ma} \omega_{ma}^{2} s_{jma}^{2} (1 - s_{jma}^{2})}, \bar{r}_{a} \right\}. \tag{5}$$

I assume that the marginal cost in the segment of safer clients, c_{jmt}^{1}, depends on a set of bank characteristics $\boldsymbol{W}_{jmt}^{1}$ which may vary across banks, markets and periods, and it is given by:

$$c_{jmt}^{1} = e^{\boldsymbol{\gamma} \boldsymbol{W}_{jmt}^{1} + \eta_{jmt}}, \tag{6}$$

where η_{jmt} is an independent unobserved term that follows a normal distribution with variance σ_{η}^{2}. I assume that the difference in marginal costs across segments is a constant. Therefore, the marginal cost in segment 2 (after the policy change) can be written as

$$c_{jma}^{2} = e^{c_{jma}^{1} + \lambda}. \tag{7}$$

Since the difference in marginal cost among segments is assumed to be constant, it is not possible to identify the intercept of the utility function for both segments. According to D'Haultfœuille et al. (2018), it is possible to rationalize any price gap between groups of consumers, constant across j, by differences in marginal costs or the intercept of the utility function. In consequence, I assume that this intercept is the same across market segments.

5.3 Observed interest rates and market shares

I do not observe the portion of consumers that belongs to each market segment. Instead, the only information available corresponds to the aggregate market share of each loan provider in every location. Furthermore, information about specific characteristics of the loan products offered to each segment, most critically, the interest rate, is not available. Regarding this critical variable, I only observe a weighted average of the interest rate at the national level.

I assume that there is no unobserved price heterogeneity in the period before the policy change, consistent with the premise that only consumers from Segment 1 have access to the loans from regulated loan providers at this time. In turn, after the policy change, the observed price becomes a weighted average that includes the prices in both segments. The observed interest rate r_{ja} can be written as follows:

$$r_{ja} = s^1_{ja} r^{1*}_{ja} + s^2_{ja} r^{2*}_{ja}, \tag{8}$$

where s^1_{ja} and s^2_{ja} are the market shares of bank j in each segment at the national level after the regulatory change.

5.4 Estimation procedure

D'Haultfœuille et al. (2018) developed an algorithm for demand estimation that can be used in situations where the researcher can not observe perfectly the price and the market share of competitors across different segments of consumers. In some cases, only a known function of these quantities, such as a weighted average, is available. This model is particularly useful for contexts where firms can exert third price discrimination. They show that identification can be achieved by relying on supply-side moment conditions, in cases where there is only one vector of prices that is consistent with the observed market shares in each segment and the marginal cost structure. They can recover the optimal prices charged in each segment in cases where either the market shares in each segment are observed, or in cases where the characteristics of the consumers used by sellers to price discriminate are known. The convergence of the algorithm holds when there is not too much heterogeneity between groups of customers in terms of their price sensitivity.

In the context studied here, the portion of consumers that belong to each segment is not observed. Instead, I use the information of the periods before and after the policy change

to estimate these proportions. Then, I combine the demand and supply moments obtained before the policy change with those obtained with information after the usury ceiling is relaxed to estimate both the optimal interest rates and the market shares of loan providers in each of the two segments defined previously. The algorithm used to recover the parameters that describe the consumer preferences the determinants of the marginal costs of financial institutions is explained below.

5.4.1 Algorithm to retrieve interest rates and market shares in each segment

The algorithm can be divided into two stages that correspond to the periods before and after the policy change. According to the model, before the usury ceiling was modified, there was only one segment of borrowers with access to loans from formal lenders. Since it is assumed that there is no unobserved price heterogeneity in this period, I use a method similar to the one proposed by Berry et al. (1995), to recover an estimate of the unobservable term that affects the borrowers' utility. In the second stage, I use these estimates, along with the algorithm proposed by D'Haultfœuille et al. (2018), to recover the unobserved market shares and optimal prices that financial institutions charge in each segment after the policy change.

To simplify notation, I will denote the vectors of observed interest rates and market shares for all m markets in year t as $\boldsymbol{r}_t$ and $\boldsymbol{s}_t$. Similarly, $\boldsymbol{\xi}$ will denote the vector of unobserved characteristics of loan providers that impact the utility of the consumers, which are assumed to be constant over time. Furthermore, $\boldsymbol{X}_t$, $\boldsymbol{Z}_t$ and $\boldsymbol{W}_t$ will denote matrices that contain the observed information in year t of product characteristics per loan provider and market, demographic characteristics of the markets, and instruments that will be used in the estimation. Lastly, the unobserved interest rates and market shares in each segment, before and after the policy change, are functions of the vector of parameters Θ and the vector of unobservable characteristics that are valued for consumers $\boldsymbol{\xi}$, that will be denoted by $\boldsymbol{r}_t^d(\Theta, \boldsymbol{\xi})$ and $\boldsymbol{s}_t^d(\Theta, \boldsymbol{\xi})$, with $d \in \{1, 2\}$ and $t \in \{a, b\}$.

1. *Initial setting*

   (a) In order to estimate the optimal interest rate in each period, I will use a set of G vectors of random draws taken from a standard normal distribution. Let $\boldsymbol{\eta}_t^g$ denote a specific vector of random draws used to estimate the optimal interest rate in year t. A typical element of this vector, η_{jmt}^g, multiplied by σ_0^η (initial value of the parameter that captures the standard deviation of the unobservables), represents a random shock that affects the marginal cost of lender j in market m

(see equations ((6)) and ((7))). The number of random draws used in each stage is 100. These sets of random draws are set once at the beginning of the algorithm, and they are not renewed after each evaluation of the objective function at a new parameter's values.

(b) Consider a vector Θ_0 with initial values for the parameters of interest,

$$\Theta_0 \equiv \{\alpha_0^1, \alpha_0^2, \beta_0^0, \boldsymbol{\beta}_0^1, \boldsymbol{\beta}_0^2, \boldsymbol{\rho}_0^1, \boldsymbol{\rho}_0^2, \boldsymbol{\gamma}_0, \lambda_0, \sigma_0^\eta\}.$$

(c) As it will become clear below, I need to define initial values for the interest rates applied to each market segment after the policy change, $\hat{\boldsymbol{r}}_a^1(0)$ and $\hat{\boldsymbol{r}}_a^2(0)$. I used the vector of observed the interest rates after the policy change $\boldsymbol{r}_t$ as starting values for the two segments.

2. *Stage 1: Before the policy change:*

(a) The first step consists of calculating the share of consumers that belong to Segment 1 according to equation (2), using the initial values of the parameters and the matrix $\boldsymbol{Z}_b$.

(b) Consistent with the assumption of no unobserved price heterogeneity before the policy change, I use the observed values of the interest rate, $\boldsymbol{r}_b$ and other product characteristics $\boldsymbol{X}_b$ to estimate the vector of market shares that correspond to Segment 1, $\hat{\boldsymbol{s}}_b^1(\Theta_0)$, using the simple logit formula.

(c) The usual logit inversion $(\ln \boldsymbol{s}_t - \ln \boldsymbol{s}_0)$ can not be used to retrieve an estimate of the vector of unobservables, $\boldsymbol{\xi}$, in this case.[18] Instead, I solve numerically for the mean utility of the borrowers of this segment, $\bar{\boldsymbol{\delta}}_b^1(\Theta_0)$ by evaluating the following equation recursively:

$$\boldsymbol{\delta}_b^1(\Theta_0, n+1) = \boldsymbol{\delta}_b^1(\Theta_0, n) + \ln \boldsymbol{s}_b - \omega_b(\Theta_0) \ln \hat{\boldsymbol{s}}_b^1(\Theta_0, n),$$

where n denotes a step in the iterative process. Berry et al. (1995) shows that for the duple $(\hat{\boldsymbol{s}}_{\boldsymbol{b}}, \Theta)$, the operator defined by the equation above is a contraction mapping with modulus less than one. Therefore, given an initial value for $\boldsymbol{\delta}_b^1(\Theta_0, 0)$, I can obtain $\boldsymbol{\delta}_b^1(\Theta_0, 1)$ and substitute back until convergence. Let $\bar{\boldsymbol{\delta}}_b^1(\Theta_0)$ be the level of borrowers' utility that satisfies the convergence criterion. Using

[18] This is because the utility that consumers obtain from the outside option in this model ultimately depends on the characteristics of all the products available in the market. See Abaluck and Adams (2017) for details.

this vector, I obtain estimates of $\boldsymbol{\xi}$ and of the vector of market shares in segment 1, $\tilde{\boldsymbol{s}}_b^1(\Theta_0)$, by solving equation (1), as follows:

$$\tilde{\boldsymbol{\xi}}(\Theta_0) = \bar{\boldsymbol{\delta}}_b(\Theta_0) - \beta_0^0 - \alpha_0^1 \boldsymbol{r}_b - \boldsymbol{\beta}_0^1 \boldsymbol{X}_b,$$

$$\tilde{\boldsymbol{s}}_b^1(\Theta_0) = \frac{e^{\bar{\boldsymbol{\delta}}_b(\Theta_0)}}{1 + \sum e^{\bar{\boldsymbol{\delta}}_b(\Theta_0)}}.$$

(d) The next step consists of calculating the marginal cost for each vector of random draws, $\boldsymbol{u}_b^g$ and the parameter σ_0^η that captures the standard deviation of the random shocks, according to equation (6). Then, the optimal interest rate for each vector or random draws, $\hat{\boldsymbol{r}}_b^1(\Theta_0, \boldsymbol{u}_b^g)$, is calculated using the estimated market shares from the previous step (equation ((4))).

(e) The estimated aggregate interest rate across simulations for the period before the policy change is

$$\hat{\boldsymbol{r}}_b^1(\Theta_0) = \frac{1}{G} \sum_g^G \hat{\boldsymbol{r}}_b^1(\Theta_0, \boldsymbol{u}_b^g).$$

3. *Stage 2: After the policy change*

(a) The first step is to calculate the marginal cost in the two segments for each vector of random draws $\boldsymbol{u}_a^g$. Let us denote these vectors by $\boldsymbol{c}_a^1(\Theta_0, \boldsymbol{u}_a^g)$ and $\boldsymbol{c}_a^2(\Theta_0, \boldsymbol{u}_a^g)$.

(b) The market shares in each segment, $\hat{\boldsymbol{s}}_a^1(\Theta_0, 0)$ and $\hat{\boldsymbol{s}}_a^2(\Theta_0, 0)$, are calculated using the initial guess of the interest rates in each segment after the policy change, $\hat{\boldsymbol{r}}_a^1(0)$ and $\hat{\boldsymbol{r}}_a^2(0)$, and the vector $\hat{\boldsymbol{\xi}}(\Theta_0, 0)$, obtained in the previous stage.

(c) I proceed to find the estimates for the optimal interest rates in each segment, $\hat{\boldsymbol{r}}_a^1(\Theta_0, \boldsymbol{u}_a^g, 1)$ and $\hat{\boldsymbol{r}}_a^2(\Theta_0, \boldsymbol{u}_a^g, 1)$, using $\hat{\boldsymbol{s}}_a^1(\Theta_0, 0)$, $\hat{\boldsymbol{s}}_a^2(\Theta_0, 0)$, and the estimates of the marginal costs for each segment obtained in the previous step. Let $f(\hat{\boldsymbol{s}}_a^d(\hat{\boldsymbol{r}}_a^d(\Theta_0, \boldsymbol{u}_a^g, n))$ denote the function that returns the vector of optimal interest rates for each segment, according to equations (4) and (5). These vectors of interest rates are subsequently used to obtain a new estimate of the market shares in each segment, $\hat{\boldsymbol{s}}_a^1(\Theta_0, \boldsymbol{u}_a^g, 1)$ and $\hat{\boldsymbol{s}}_a^2(\Theta_0, \boldsymbol{u}_a^g, 1)$. This process can be summarized by the following expressions:

$$\hat{\boldsymbol{r}}_a^1(\Theta_0, \boldsymbol{u}_a^g, n+1) = f(\hat{\boldsymbol{s}}_a^1(\hat{\boldsymbol{r}}_a^1(\Theta_0, \boldsymbol{u}_a^g, n))$$
$$\hat{\boldsymbol{r}}_a^2(\Theta_0, \boldsymbol{u}_a^g, n+1) = f(\hat{\boldsymbol{s}}_a^2(\hat{\boldsymbol{r}}_a^2(\Theta_0, \boldsymbol{u}_a^g, n)),$$

D'Haultfœuille et al. (2018) show that the sequence of interest rates $\hat{\boldsymbol{r}}_a^1(\Theta_0, \boldsymbol{u}_a^g, n)_{n\in\mathbb{N}}$ and $\hat{\boldsymbol{r}}_a^2(\Theta_0, \boldsymbol{u}_a^g, n)_{n\in\mathbb{N}}$, defined by the equations above, converge to $\hat{\boldsymbol{r}}_a^1(\Theta_0, \boldsymbol{u}_a^g)$ and $\hat{\boldsymbol{r}}_a^2(\Theta_0, \boldsymbol{u}_a^g)$, at least for a set of values of Θ_0 close to the vector of true parameters Θ.[19]

(d) I obtain estimates of the optimal interest rates, $\hat{\boldsymbol{r}}_a^1(\Theta_0)$, $\hat{\boldsymbol{r}}_a^2(\Theta_0)$, and market shares in each market segment, $\hat{\boldsymbol{s}}_a^1(\Theta_0)$, $\hat{\boldsymbol{s}}_a^2(\Theta_0)$, by taking the average of the values obtained in the previous step across vectors of random draws.

(e) Finally I calculate the aggregate market share $\hat{\boldsymbol{s}}_a(\Theta_0)$ and the aggregate price of each bank $\hat{\boldsymbol{r}}_a(\Theta_0)$ using equations (3) and (8).

5.4.2 Demand and Supply Moments

Once I have recovered estimates of the vector of unobservable characteristics $\boldsymbol{\xi}$ and of the interest rates and market shares before and after the policy change, I use moments based on the exogeneity of a set of instruments $\boldsymbol{W}_t$. In the period before the policy change, the demand side moments are based on the estimates $\hat{\boldsymbol{\xi}}(\Theta)$, whereas in the period after the policy change the moments are based on the differences between the observed market shares the ones estimated with the model:

$$E(\hat{\boldsymbol{\xi}}(\Theta)\boldsymbol{W}_b) = 0$$
$$E((\boldsymbol{s}_a - \hat{\boldsymbol{s}}_a(\Theta))\boldsymbol{W}_a) = 0$$

Following Abaluck and Adams (2017) approach I also use the asymmetries in the response of the market shares of financial institutions and the market share of the outside option, before and after the policy change in order to identify the share of borrowers that belong to each segments. Therefore, I include moments that are based on the change in the market shares observed one period before the policy was introduced (between 2009 and 2010), and the changes in market shares one period after the policy change took place (between 2012 and 2013), as follows:

$$E((\boldsymbol{s}_b - \boldsymbol{s}_{b-1}) - (\hat{\boldsymbol{s}}_b(\Theta) - \hat{\boldsymbol{s}}_{b-1}(\Theta))\boldsymbol{W}_{b-1}) = 0$$
$$E((\boldsymbol{s}_{a+1} - \boldsymbol{s}_a) - (\hat{\boldsymbol{s}}_{a+1}(\Theta) - \hat{\boldsymbol{s}}_a(\Theta))\boldsymbol{W}_a) = 0$$

[19] A situation of persistent non -convergence may indicate that there are very substantial differences in consumers' preferences across groups.

The assumption that ξ is invariant over time is crucial for identifying all the estimates pertaining to the period after the regulatory change, including the share of potential customers constrained due to the presence of the interest rate ceiling. This is an strong assumption, given that financial institutions are likely to offer new services that may result more attractive for clients after the relaxation of the usury ceiling.

Nevertheless, in the context studied here any additional service provided by lenders in each market is likely to imply changes in the variables included in the estimation, such as the number of employees, branches, and BC, particularly in a context where the development of internet and mobile platforms was still incipient. I do observe an increase in these variables before and after the policy change. On the supply side, I control for variables that change across time and financial institutions and have an impact on the marginal costs, such as the deposits rate and expenses on salaries, operative costs, and provisions. These variables capture a substantial portion of the additional spending that financial institutions may have had to incur to provide loans to riskier borrowers immediately after the usury rate relaxation. Consequently, the estimated optimal interest rates charged in the period after the policy change incorporate potential increases in the marginal costs and markup related to additional services.

On the supply side, the sample moments are based on the differences between the observed and the estimated interest rates:

$$E((\boldsymbol{r}_b - \hat{\boldsymbol{r}}_b(\Theta))\boldsymbol{W}_b) = 0$$
$$E((\boldsymbol{r}_a - \hat{\boldsymbol{r}}_a(\Theta))\boldsymbol{W}_a) = 0$$

5.5 Instruments

Instruments frequently used in the literature are variables that shift either the marginal costs or the markup, with little direct impact on the observed characteristics of the product that consumers appreciate. In the case studied here, a variable that can be interpreted as a cost shifter is the legal reserve percentage required by the central bank.[20] I build other instruments based on characteristics of competitors that operate in markets of similar characteristics but belonging to other provinces, such as the number of competitors, branches, employees per branch, and their degree of specialization in microfinance. I measure this last variable by

[20]The legal reserve requirement set by the central bank each period is a percentage of certain types of deposits that banks must hold at the central bank without remuneration. Although this percentage is the same across banks, the resulting amount of reserves that a bank must hold at the central bank depends on the composition of the deposits of each financial institution.

computing the average share of microloans within their aggregate portfolio at the national level. These instruments are variables that have an impact on the markup that lenders obtain in local market, but are not likely to have a direct impact on the utility that consumers get from a particular alternative.

The model specification includes characteristics of the product, such as the number of branches and banking correspondents per thousand inhabitants, as well as the number of employees per branch. These characteristics are endogenous since financial institutions have incentives to open extra branches or to hire additional employees in markets where there is a strong demand for their loans. To solve for the potential endogeneity, I use the number of branches, employees and BCs of the bank in similar markets in other provinces as instruments for these product characteristics. Table 10 presents the summary statistics of the instrumental variables used in the estimation.

5.5.1 Supply side

Among the bank characteristics that determine the optimal interest rate, I included administrative costs, such as salaries and other costs related with the operation of the branching network (number of branches per market and number employees per branch), as well as the deposits interest rate, calculated as the value that was paid for concept of interests to the bank debtors in a year as a percentage of the loan portfolio. Since some of the variables included in the estimation are likely to be endogenous, I use instruments based on the characteristics of competitors.

6 Results

Table 5 presents the parameters that determine the preferences of consumers and the share of potential borrowers in each segment. Consumers who had access to formal loans before the policy change exhibit a similar sensitivity to the interest rate than those in the second segment. The availability of branches in the market is appreciated by consumers in the two segments, particularly by those who did not have access to loans before the policy was introduced. By contrast, the number of banking correspondents has a negative impact on the utility of consumers that belong to the second segment and is not significant for those in the safer one. This difference might be explained by the fact that the largest banking correspondents' networks have been developed by banks and other financial institutions that

are not specialized in microfinance. This transaction channel is perhaps more important in the deposit market, where MFIs are not strong competitors, as it facilitates payments and transfers from existing saving accounts.

The lower segment of the table contains the parameters that determine the share of consumers in each segment. The results indicate that markets with lower GDP per capita and higher share of population in rural areas have a greater share of borrowers with access to loans from private regulated institutions. One explanation for this result is that entrepreneurs from the rural sector tend to have greater experience with credit operations in general, as they routinely use loans and other financial services from the government in their business activity. Agricultural productive projects receive partial default insurance provided by the government, which make them relatively more attractive for private banks. The results for the second segment indicate that microfinance institutions have a greater potential of expansion in areas with higher income, that are relatively close to big urban centers, where public funding might be insufficient to cover the demand for loans by small entrepreneurs. This result is consistent with the pattern of entry observed between 2009 and 2014, when microfinance institutions located their new branches in intermediate cities.

The estimated parameters that describe the marginal cost of financial institutions are presented in Table 6. As expected, the effect the deposits rate and the administrative costs are positive and significant. By contrast, the salaries variable has a negative and significant impact on the marginal cost. Institutions that have specialized in microcredit, that is, those with a higher share of their loan portfolio composed by microcredit, tend to have lower costs associated with microloans. The parameter λ captures the average difference in marginal cost between segments has a large standard error and cannot be considered significant.

Figure 4 presents the distribution of the estimated share of consumers that belongs to each segment across geographic markets. As seen in the figure at the top, the share of low-cost consumers differs greatly across markets. In the median, 15.15% of the potential borrowers could choose to request a loan from formal financial institutions at an interest rate lower than the initial usury ceiling. The figure in the bottom panel presents the distribution of the share of consumers that gained access to formal loans from these lenders after the interest rate ceiling was modified. The median share of potential borrowers in this segment was 13.31%. The figure shows that, while the relaxation of the usury ceiling increased access to funding provided by private financial institutions, there is a significant portion of the potential consumers that do not include formal funding alternatives in their choice set even after the policy change.

Table 5: Demand Side

Variable	Segment 1	Segment 2
Consumer preferences		
Intercept	-3.2278**	
	(0.2378)	
Interest rate	-7.2247**	-7.0505**
	(0.3317)	(1.0891)
Branches per capita	4.187**	11.0455**
	(0.9293)	(2.4139)
Banking correspondents per capita	-0.0268	-0.9608**
	(0.0181)	(0.2334)
Employees per branch	-0.0159	-0.4512**
	(0.013)	(0.0722)
Share of borrowers in each segment		
Intercept	3.614**	-0.8109
	(1.5822)	(0.5217)
Adult population (log)	-0.5759**	0.0131
	(0.1124)	(0.0279)
GDP per capita (log)	0.4261*	-0.1813**
	(0.2341)	(0.0524)
Distance to closest urban center	-0.6823**	-0.0408
	(0.063)	(0.0411)
Population in rural areas	-0.0725	1.4643**
	(0.7543)	(0.2316)
Brand dummies	Yes	Yes
Sample size	966	966

Notes: Standard-errors are robust to heteroscedasticity and computed using the standard formula for GMM. Significance levels: , **: 5%, *: 10%.

The structural model allows us to estimate the optimal interest rate for both segments. As seen in Figure 5, the optimal interest rates are higher in the segment of low-cost borrowers, compared to the period before the policy change. However, not all financial institutions would choose to set their interest rates in Segment 1 above the initial usury ceiling. The increase on the interest rates in those cases could be explained by an increases in the marginal costs (the deposit rates increased between 2010 and 2012, and increasing competition from other lenders in the market could have required additional expending on advertising), as well as by changes in branching networks that could have resulted in greater market power.

Table 6: Supply side: Marginal cost

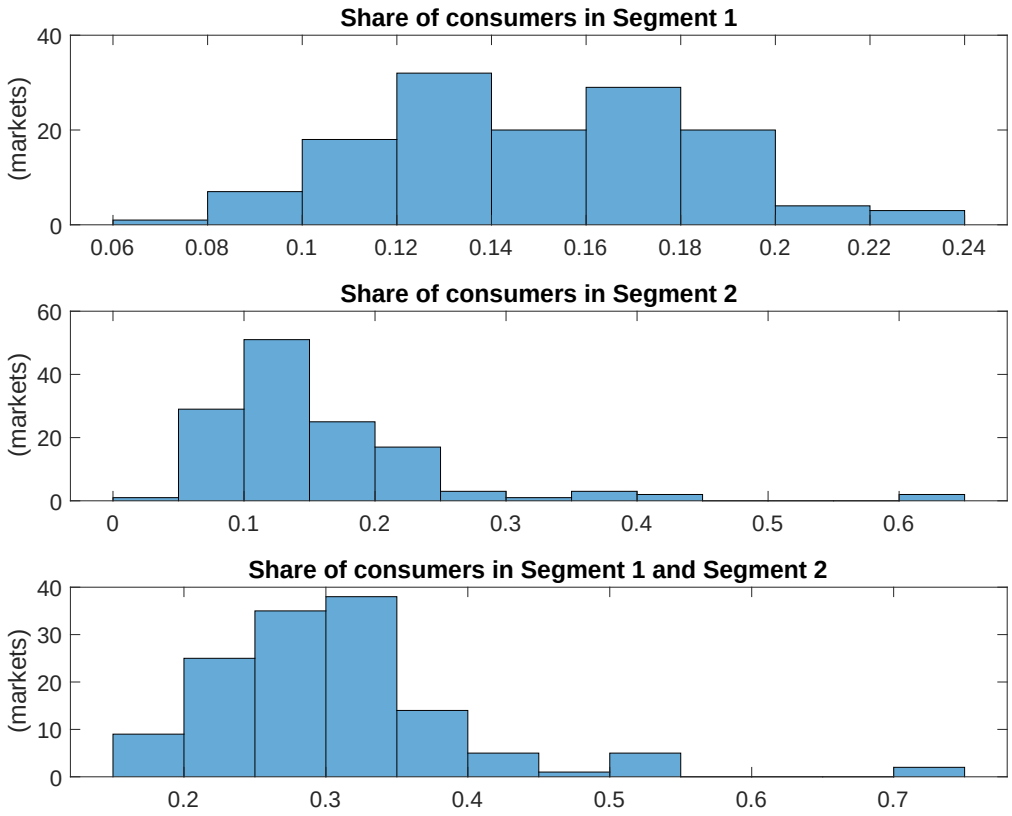
Variable	Estimate
Intercept	-1.8645**
	(0.122)
Salaries	-0.9364**
	(0.3668)
Loans provisions rate	1.0879
	(2.4683)
Required reserve	1.7742
	(2.7725)
Deposits rate	9.7955**
	(2.7529)
Microcredits share (own portfolio)	-3.8189**
	(1.5567)
Administrative costs	0.0951**
	(0.028)
λ	0.5262
	(0.4531)
σ_u	0.0968
	(0.9022)
Brand dummies	Yes
Sample size	966

Notes: Standard-errors are robust to heteroscedasticity and computed using the standard formula for GMM. Significance levels: **: 5%, *: 10%.

The fact that the average interest rate registered by some financial institutions at the national level remained low after the usury ceiling was relaxed could signal the presence of very high costs of providing loans to Segment 2, which could not be covered even with rates as high as the new interest rate ceiling. I observe that the institutions with the lowest interest rates did not increase their market share in the microloans markets, nor microloans became more important in the composition of their own loan portfolio. This suggest that they continue focusing exclusively on clients belonging to Segment 1.

Figure A.3 in the Appendix presents the estimated share of consumers in each segment who would choose to borrow a loan from a financial institution instead of choosing the outside option before and after the policy change. In the first segment, there is a significant increase in the share of consumers choosing one financial institution rather than the outside option. This share is lower in the second segment, where only 4,97% of the potential borrowers chose

Figure 4: Distribution of the share of consumers in each segment across markets



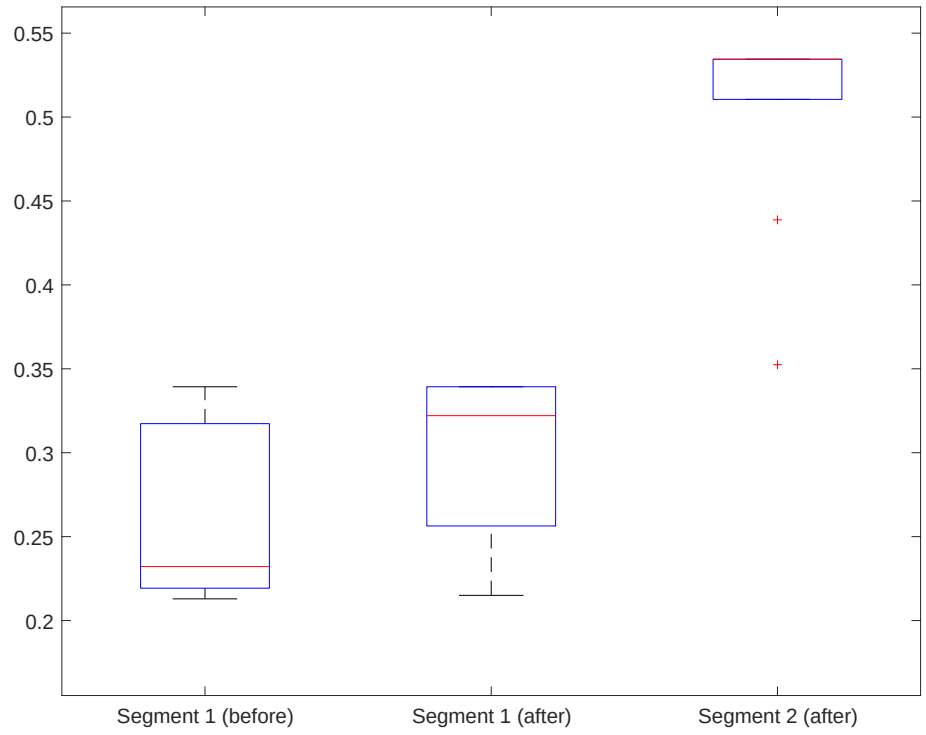
Notes: The top figure presents the distribution of the share of borrowers with access to loans before the policy change. The figure at the bottom presents the distribution of the share of consumers who obtain access after the usury ceiling is relaxed.

to borrow from a bank rather than from an informal source.

6.1 Consumer Surplus

To explore the effects of the relaxation of the usury ceiling on consumers' welfare, I carry out a calculation of the welfare changes between 2010 and 2012. Following the approach of Small and Rosen (1981) in the context of the discrete choice problem modeled here, welfare effects are measured as the expected equivalent variation of the changes in product characteristics. This term is defined as the amount of money that would make consumers in market m indifferent, in expectation, between facing the two choice sets (before and after the policy change). Let $\boldsymbol{EV}$ denote the vector that contains the expected variation of the changes for

Figure 5: Estimated interest rates before and after the policy change in each segment



Notes: Distribution of the optimal interest rates that financial institutions would charge in each segment.

all markets.

$$\boldsymbol{EV} = \boldsymbol{\Gamma}_a(\boldsymbol{r}_a, \boldsymbol{X}_a, \Theta) - \boldsymbol{\Gamma}_b(\boldsymbol{r}_b, \boldsymbol{X}_b, \Theta),$$

where $\boldsymbol{\Gamma}_t(\boldsymbol{r}_{mt}, \boldsymbol{X}_{mt}, \Theta)$ denotes the level of consumer surplus in year t. A typical element of this vector, Γ_{mt}, is calculated as,

$$\begin{aligned}\Gamma_{mt}(\boldsymbol{r}_{mt}, \boldsymbol{X}_{mt}, \Theta) &= \sum_{d}^{1,2} \hat{\omega}_{mt}^{d} S_{mt}^{d} \\ &= \sum_{d}^{1,2} \hat{\omega}_{mt}^{d} \ln(\sum_{k}^{K_{mt}^{d}} exp(\delta_{jmt}(\boldsymbol{r}_{mt}, \boldsymbol{X}_{mt}, \Theta))/\alpha^{d}.\end{aligned}$$

Table 8 presents the results of this calculation for markets that experienced entry between 2010 and 2012, and those which did not, by market size. The first panel presents the change in consumer welfare for borrowers that belong to the low-cost segment. The borrowers that were located in markets without new competitors experienced a small welfare loss, particularly those located in bigger markets. The greater gains in this segment are experienced by consumers in smaller markets where new competitors opened branches. The second panel corresponds to consumers that gain access to formal loans after the relaxation of the usury rate. As seen in the table, the consumers with the lowest welfare gains are those located in markets with a population greater than 100.000 inhabitants that did not experienced entry, whereas the greater gains are registered in small markets. The average size of a microloan around the time of the policy was around USD 2.160 according to Fernandez (2014). With a welfare gain of USD 0.022 per each 1 USD borrowed, such as the estimated for Segment 2 in small markets, a borrower carrying a loan of average size would experience an annual benefit of USD 47.52. By contrast, a borrower with a loan of this size, belonging to the first segment and located in a big market that did not experience entry would experience an annual loss of USD 23.3.

Overall, the average change in consumer welfare was small but positive for all market types/entry status combinations, a result that suggests that the market expansion generated both by the entry of financial institutions in new locations, and the expansion in the volume of loans due to the provision of financial services in the segment of high-risk consumers, exceeded the reduction in welfare associated to the increase in the interest rate.

Table 7: Average change in consumer surplus by market size

	less than 50.000 inhabs.	50.000-100.000 inhabs.	More than 100.000 inhabs.
		Segment 1	
Entry	0.0194	0.0091	-0.0044
No Entry	-0.0064	-0.0104	-0.0108
		Segment 2	
Entry	0.0221	0.0125	0.0228
No Entry	0.0359	0.0281	0.0130
		All borrowers	
Entry	0.0065	0.0033	0.0018
No Entry	0.0059	0.0012	0.0009
		Number of Markets	
Entry	11.0000	18.0000	17.0000
No Entry	36.0000	23.0000	20.0000

Notes: The values in the table correspond to the average consumer welfare change from 2010 to 2012 across geographic markets, expressed in monetary units per each US dollar borrowed, based on the equivalent variation calculation by Small and Rosen (1981).

6.1.1 Counterfactual exercise: the importance of branching networks investment

Previous calculations on consumer welfare are based on the assumption that the growth observed in the number of branching networks and employees is a consequence of the changes in the usury ceilings. However, other factors that might have affected the investment in branching networks at the local level, such as economic growth or improvements in public infrastructure and safety.

Since I do not model the entry decisions of financial institutions at the local level, my estimates can only provide an upper bound on the policy effects on consumer welfare. Nevertheless, I propose a simple counterfactual exercise that can help us to understand how much of the consumer welfare can be attributed solely to the change of the interest rate after the ceiling was relaxed. In the counterfactual scenario, I assume that the branching networks remain as they were before the policy change. The optimal interest rates are adjusted accordingly.

Table 8 compares the changes in consumer welfare in the observed and counterfactual sce-

narios. Each entry corresponds to the average change in consumer surplus across markets within each category. As seen from the Table, the welfare gains are closely linked to the expansion of branching networks of financial institutions. The overall gains from the policy in the absence of new branches is close to zero in all types of markets. Consumers in the Segment 1 experience a greater welfare loss in the counterfactual scenario, particularly those located in bigger markets. In these markets, the increase in market expansion created by the relaxation of the usury rate is smaller than the one estimated for smaller and intermediate markets. Consumers in the second segment, that is, borrowers that gained access to credit after the policy change, would experience a welfare gain, although smaller than the one obtained in the original scenario. In smaller markets the gains are 45,2% of the ones they would experienced in the scenario with new branches, whereas in the biggest markets the welfare gains would be reduced by almost 90%. Furthermore, the number of locations that would experience a consumer welfare loss increases from 49 to 92 in the scenario without branching network expansion. These results indicate that new branches play a crucial role in the expansion of loans towards new clients, even in intermediate and big markets.

Table 8: Average change in consumer surplus per type of market.

	Scenario 1: Observed after policy change	Scenario 2: No additional branches/employees
Less than 50.000 inhabitants		
Total	0.0060	0.0008
Segment 1	0.0002	-0.0039
Segment 2	0.0318	0.0144
50.000-100.000 inhabitants		
Total	0.0025	-0.0000
Segment 1	-0.0004	-0.0082
Segment 2	0.0223	0.0076
More than 50.000-100.000 inhabitants		
Total	0.0017	-0.0011
Segment 1	-0.0065	-0.0131
Segment 2	0.0197	0.0018

Notes: This table compares the changes in consumer surplus at the national level in two scenarios, expressed in monetary units per each US dollar borrowed, based on the equivalent variation calculation by Small and Rosen (1981). The first one uses the observed characteristics before and after the policy change. The second one compares the consumer surplus before the policy change with a scenario where the usury ceiling is relaxed and there is no change in the number of branches, banking correspondents or employees.

7 Concluding remarks

In this paper, I have developed a structural model of demand and supply to explore the implications of a modification of the usury ceiling applied to microloans in Colombia. The model explores a scenario where large multi-market institutions offer loans to borrowers with different loan profiles. By considering firms that compete across multiple geographic markets, I focus on the role of branching networks in the optimal pricing strategies of loan providers, in an industry where credit access is still closely linked to the presence of a traditional branch in the vicinity of the borrower. This is a crucial element of the analysis of interest rate regulation that has not been considered in the literature, and it is vital to understand the consumer welfare implications of the policy in the context of microfinance. In Colombia, the relaxation of the usury ceiling was accompanied by a significant expansion of the branching networks of loan providers, thereby exposing consumers to significant changes in terms of local credit availability and a potential increase in interest rates, that could have also obeyed to additional investments in branching networks from loan providers.

One advantage of my approach is that it can be carried out in the absence of detailed individual information on loan transactions. Data availability is often scarce in the context of microfinance, because loan providers often operate under different regulatory frameworks and supervisory authorities face limitations to gather detailed information of clients from remote or poor geographic areas, where microfinance institutions concentrate their operations. Notwithstanding, estimating the effects of this policy using market-level information comes with additional challenges, as it is necessary to account for potential changes in the size and composition of the potential market that might be unobserved. The relaxation of an interest rate cap opens the possibility for financial institutions to offer their services to a segment of borrowers that could not have access to loans due to their risk profile or their geographic location. Ultimately, the degree of market expansion will determine whether the policy is welfare enhancing despite the predictable increase in the interest rates.

I estimate a structural model that takes into account that there is a fraction of borrowers that is excluded from the choice problem, due in part to the presence of a usury ceiling in the period before the policy change. Market expansion and changes in the pool of borrowers, generated as a result of the relaxation of the rate ceiling, is incorporated by allowing for unobserved price heterogeneity in the period after the policy change. This approach makes it possible to recover the changes in demand sensitivity to product characteristics such as the interest rate and the number of branches and banking correspondents in local markets.

I use the model to understand the changes in consumer welfare that occur as a result of the

policy change. The results indicate that welfare gains associated with this policy depend greatly on additional investments on branching networks. The entry of new competitors is important in small markets, where opening a branch can represent a dramatic change in the availability of financial services. At the same time, additional branches and banking correspondents in intermediate and big markets provide a valuable service to consumers, helping to compensate the welfare losses associated with the increase in interest rates, particularly for safer borrowers who already had access to formal loan before the usury ceiling was removed. Branching networks expansion after the usury ceiling modification accounts for nearly 90% of the consumer welfare gains in the biggest markets.

These consumer welfare gains that followed the relaxation of the usury ceiling do not seem to have occurred in economic detriment of financial institutions, who experienced an increase in their profit, particularly in the case of microfinance institutions.

These findings open new avenues for future research, as it becomes clear that the welfare gains are closely linked to the distribution of branching networks across geographic markets. From the borrowers' perspective, the presence of a branch has important implications in terms of credit access, while for financial institutions, branching networks have an essential role in their optimal pricing strategies by determining their exposure to different local competitive environments. By modeling the decision to enter in different locations, it would be possible to build other counterfactuals that allow us to compare the local welfare implications of alternative policies. These analyses can provide better guidance for the public and private initiatives that aim to diminish inequality in the access to financial services and promote economic development in the poorest regions.

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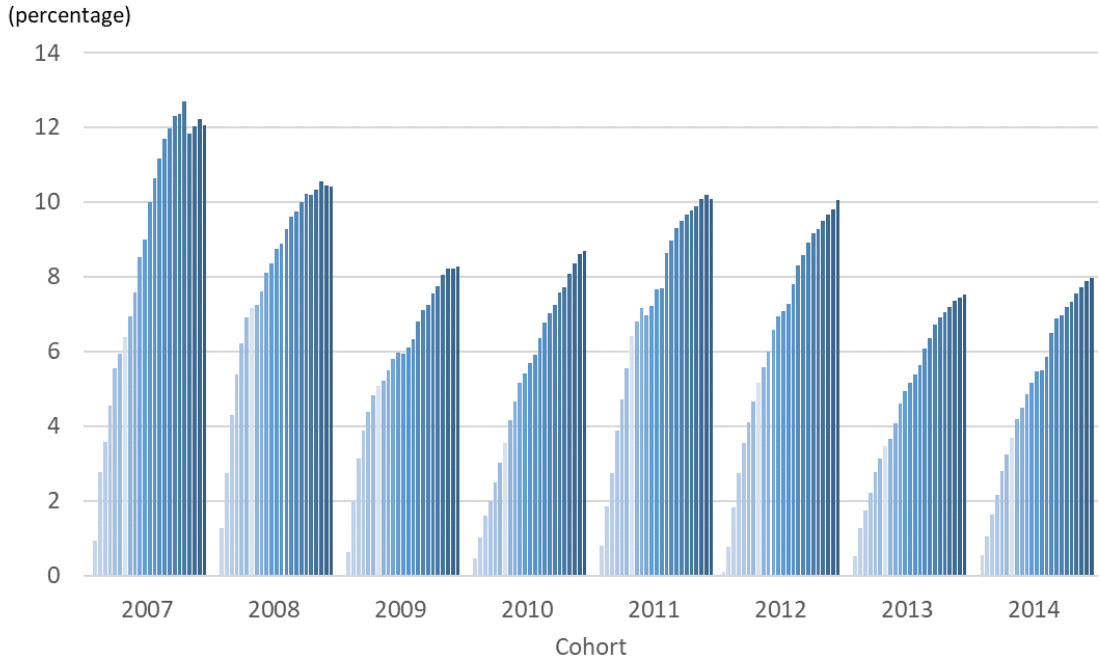
A Appendix

Figure A.1: Portfolio at risk ratio, by cohort. 2008-2014



Notes: The portfolio at risk ratio is calculating by dividing the outstanding balance of all microloans with arrears over 30 days, by the outstanding gross loan porfolio. Source: Superfinanciera Financiera de Colombia.

Table 9: Information of bank characteristics per market

Statistic	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
			September 2010			
Interest rate	0.29	0.05	0.18	0.24	0.34	0.34
Branches per capita	0.11	0.09	0.001	0.05	0.15	0.67
Banking correspondents per capita	0.30	2.27	0.00	0.00	0.02	45.30
Number of employees per branch	11.03	8.12	0.00	7.00	13.00	98.00
Previous NGO (dummy variable)	0.23	0.42	0	0	0	1
Bank (dummy variable)	0.87	0.33	0	1	1	1
			September 2012			
Interest rate	0.35	0.07	0.18	0.29	0.38	0.45
Branches per capita	0.11	0.10	0.001	0.05	0.15	0.67
Banking correspondents per capita	1.33	3.85	0.00	0.00	1.19	65.27
Number of employees per branch	11.18	8.74	1.00	6.00	13.25	118.00
Previous NGO (dummy variable)	0.28	0.45	0	0	1	1
Bank (dummy variable)	0.87	0.34	0	1	1	1

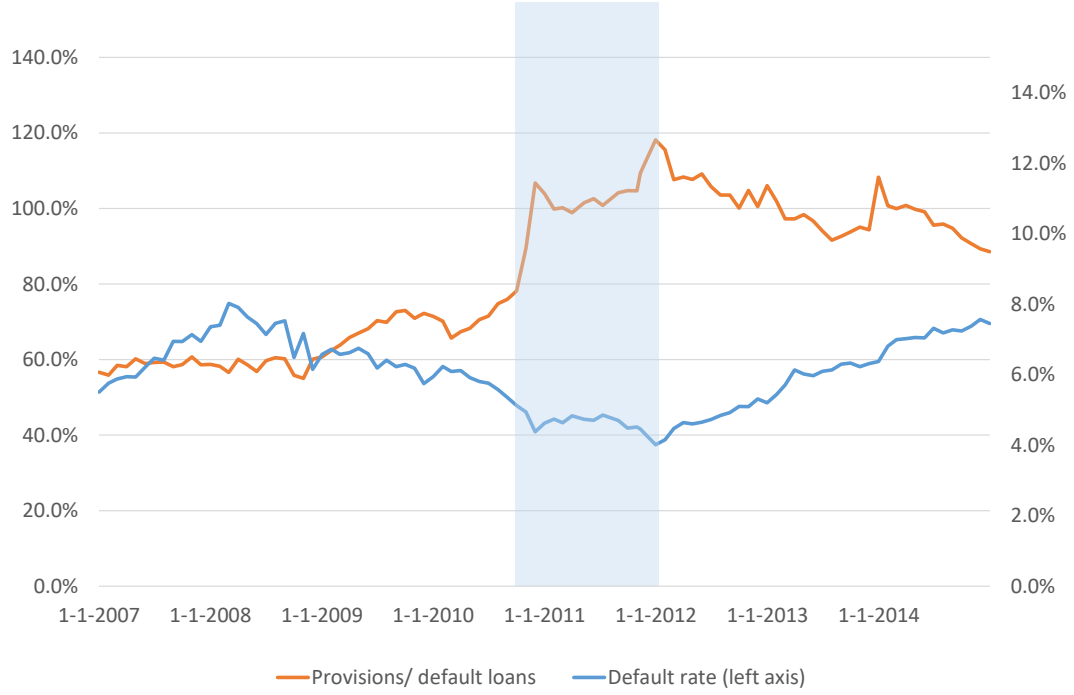
Notes: Summary of descriptive statistics of the characteristics of financial institutions that change across local markets in 2010 and 2012. Branches and banking correspondents density is measured as the number of branches/banking correspondents per 100.000 inhabitants. Source: Author's calculations based on information published by Superfinanciera Financiera de Colombia.

Table 10: Instruments used in the supply equation

Variable	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
			December 2010			
Branches of same bank in similar markets	0.06	0.05	0.00	0.02	0.08	0.28
Branches of competitors in similar markets	2.84	2.01	0.09	1.06	4.19	8.80
BCs of same bank in similar markets	0.14	0.25	0.00	0.00	0.18	0.97
BCs of competitors in similar markets	6.98	12.12	0.00	0.0005	9.36	76.68
Competitors microloans share (own portfolio)	0.24	0.34	0.01	0.03	0.67	0.83
Interest rate of similar banks	0.29	0.01	0.25	0.29	0.30	0.32
			December 2012			
Branches of same bank in similar markets	0.06	0.05	0.00	0.02	0.09	0.28
Branches of competitors in similar markets	3.08	2.35	0.12	1.02	4.71	10.46
BCs of same bank in similar markets	0.69	0.80	0.00	0.00	1.36	3.07
BCs of competitors in similar markets	38.97	44.38	0.00	0.02	68.25	190.51
Competitors microloans share (own portfolio)	0.29	0.37	0.02	0.02	0.80	0.84
Interest rate of similar banks	0.33	0.02	0.22	0.32	0.34	0.36

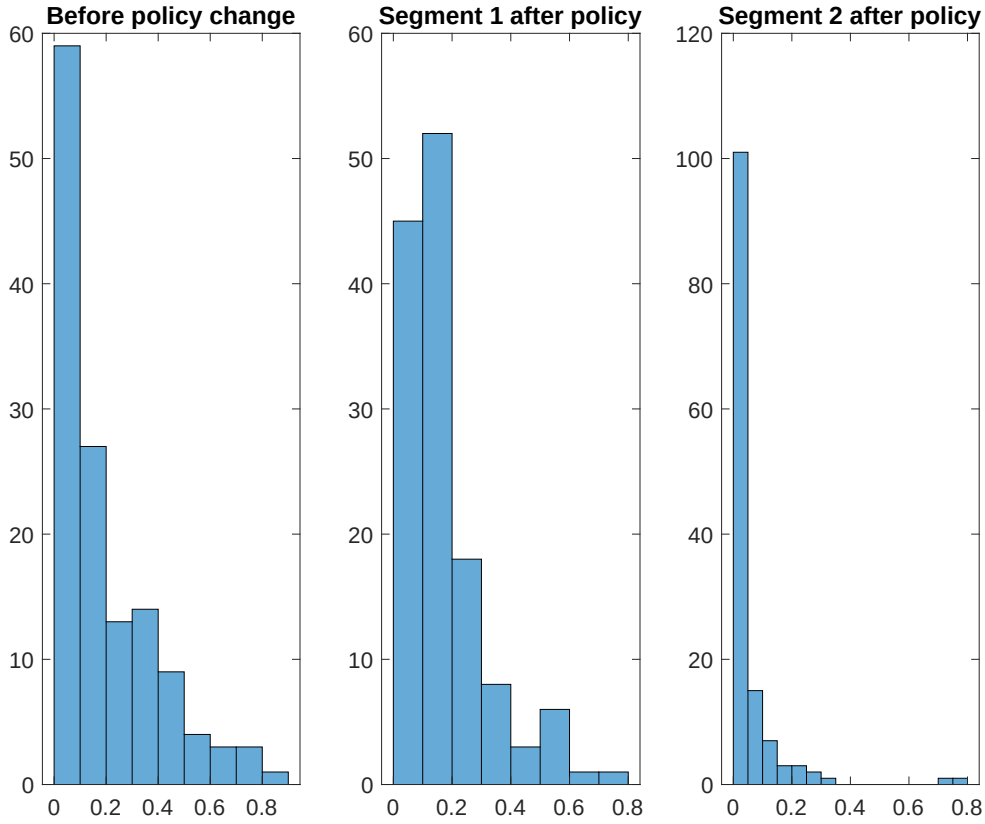
Notes: Summary of descriptive statistics of instruments used in the estimation. Source: Author's calculations based on information published by Superfinanciera Financiera de Colombia.

Figure A.2: Average loan provisions rate and default rate of microloans. 2008-2014



Notes: Author's calculations based on information published by Superfinanciera Financiera de Colombia.

Figure A.3: Distribution of the share of consumers who choose to borrow a loan from a financial institution across markets



Notes: Segment 1: consumers with access to loan before the policy change. Segment 2: consumer that gained access to loans after the policy change (at an interest rate higher than the usury ceiling).