Master Thesis

# Interest Rate Elasticity of Loan Demand: Evidence of a Big Notch in the Mexican Development Banking Sector

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#### I. <u>Introduction</u>

As stated by Slemrod (2010), the implementation of certain policies creates discontinuities in the level of choice sets (notches) of the target population of such policies; for instance, taxpayers or beneficiaries of social programs. The introduction of such notches causes individuals to change their behavior in response to this change in their choice sets, making it possible to elicit elasticity estimates for the individuals subject to the implemented policy. The present work retrieves interest rate elasticities of loan demand in the Mexican banking system after a substantial notch was introduced in one of the country's development banks. Through a decree passed by the Mexican Federal Government through its Ministry of Finance, this bank implemented a program for granting loans to small farmers at lower interest rates than those offered regularly by such institution. The spread between the program's interest rate and the regular rates was of between 4% and 5%, depending on the type of customer (this issue will be addressed later in this document with more detail). The interest rate differential introduces a big notch in the set of farmers' decisions, regarding the amount of debt to be contracted. On the other hand, most of the literature related to price elasticities derives behavioral responses from non-exogenous price variations, mainly due to the unavailability of microdata, which leads to biased estimates. On the contrary, one of the key strengths of the present work is the exploitation of an exogenous variation as a result of the introduction of the abovementioned social program.

The purpose of this thesis is to provide relevant agents of the economy with truthful estimates of the interest rate semi-elasticity of loan demand, so that they can implement and conduct the kind of policies inherent to their economic activities. The results obtained may therefore be informative and of interest for some of the following entities. First, for commercial and development banking institutions in Mexico, as they will be able to set interest rate schedules for their loans, taking into account reliable estimates of their customers' response to changes in the interest rate, and potentially increase their profits (commercial banks) or benefit as many people as possible (development banks). Second, for Banco de México (Mexico's central bank), as well as for other central banks, so that they can gain more knowledge on the fall in productive investment after interest rates have been raised and its consequences on inflation, and also for the central bank's conduction of monetary policy by controlling the lending levels of commercial banking and thus the process of money creation, as money is "created" by banking loans (McLeay, Radia, and Thomas, 2014). Third, the results are also of interest for both the Mexican tax authority and the Ministry of Finance and Public Credit so that they can determine the feasibility of introducing an investment tax credit (deductions) and its implications for tax revenues and reduce the distortions in labor markets caused by labor income taxes. The results can also be extrapolated to other countries (especially those with economical and institutional conditions similar to Mexico's) since, as it will be discussed below, literature on interest rate elasticities has found primarily estimates with an elastic nature and similar in magnitude across different countries, types of credits (i.e. microloans and mortgages) and level of data aggregation (micro and macrodata). The results can also be spread across Latin America given the link between the development bank in question and other development banks in the region. Finally, the results from this work can be useful for governments and development institutions who want to implement programs of this nature.

Specifically, interest rate elasticities will be retrieved by obtaining the response from the customers of the Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero (Mexican development bank that grants credits to primary economic activities, FND, for its acronym in Spanish) after this institution implemented the *Pequeños Productores* (Small Farmers) program in August 2014. This program, as mentioned above, features some appealing characteristics that incentivize FND customers to request credits below a specific loan amount (borrowing amount) set by this program, as otherwise they would not have benefited from these special features, which includes a lower interest rate. Consequently, as it will be shown later, in order to have access to the program, a significant number of customers decided to change their funding needs, concentrating a significant amount of loans just below the established borrowing amount. In other words, customers "bunch" their funding needs just below the *Pequeños Productores* borrowing limit, giving space to identify the interest rate elasticities using a relatively recent technique known as "bunching approach".

The bunching approach was first introduced by Saez (2010), who estimated compensated elasticities of income with respect to taxes by analyzing the occurrence of bunching at specific marginal tax rates within the United States income tax schedule. This approach has also found application in the field of social programs as noted by Slemrod (2010), Kleven (2016) and Skaalbones (2017). For the purpose of the present work, the methodology outlined by Saez (2010) will not be strictly followed because the marginal tax rates of the US tax schedule impose a discontinuity not in the level of the budget set (notch) of US taxpayers, but in its slope. This type of discontinuity is called a *kink*. And, as pointed out by Kleven (2016), the procedure for uncovering behavioral responses from the occurrence of bunching when notches are introduced is different than in the case of kinks. The pertinent methodology to be used in the present work was first introduced by Kleven and Waseem (2013) and later applied by DeFusco and Paciorek (2017) in an interest rate elasticity scenario. For this reason, their procedure will be strictly followed.

In essence, for the specific case of the work herein presented, the bunching approach applies as follows: with the implementation of the *Pequeños Productores* program, farmers would tend to ask for loans just below the borrowing limit, introducing a discontinuity in their budget set (notch), and creating a region where an excess of loans would be concentrated (excess bunching) at the left side of this limit, as well as a region of missing mass at the right side. This missing mass region would not exist if the program had not been introduced (a counterfactual scenario). By combining both regions it is possible to elicit the behavioral response of these development bank customers.

To conduct the analysis, a large dataset provided directly by the FND was used to obtain a main sample from which several subsamples were derived. These subsamples are intended to analyze

the specific responses from different types of FND customers and credit characteristics, such as the loan term or the type of loan. Applying the mentioned approach to the main sample and to thirteen subsamples, notable bunching was detected, finding a strong elastic loan demand with an estimate of interest rate semi-elasticity for the main sample equal to -17.44, reflecting that an increase of 1% in the interest rate leads to a decrease in loan demand of 17.44%. In the case of the subsamples, their elasticities ranged from -10.61 to -24.80. Reduced-form elasticities as in DeFusco and Paciorek (2017) were also obtained of between -6.78 and -25.23 (-13.58 in the case of the main sample). These results reflect an upper bound estimate of the interest rate semi-elasticity given that, as mentioned above, the lower interest rate is not the only benefit that the *Pequeños Productores* program offers to FND customers (as it will be discussed later, the effect of the program's additional benefits in the elasticities is negligible). The elicited semi-elasticities of several subsamples present a fair degree of robustness when sensitivity analyses are performed. Nevertheless, these are not consistent with the revised literature of interest rate elasticity of loan demand due to the sizable change in interest rates provided by the analyzed program.

The present work is organized as follows: section II provides the literature reviewed on both the bunching approach and interest rate elasticities; section III includes an outline of development banking in Mexico and the recent Financial Reform. The purpose of this section is to familiarize the reader especially with the FND and the *Pequeños Productores* program; section IV includes the theoretical approach of bunching; section V includes a description of the process undertaken to arrive to the final sample and a statistics summary; section VI presents the results of the study; section VII includes comments on the external validity and policy implications of the results, while section VIII is devoted to future research lines. Finally, section IX provides conclusions on this work.

# II. <u>Literature review</u>

This section includes the literature reviewed on the bunching approach and on interest rate elasticities. At the end of the section, the findings of two recent papers that use the bunching approach for retrieving interest rate elasticities in the housing sector are presented.

## On the bunching approach

As noted by Kleven (2016), the bunching approach has caught the attention of empirical economists in recent years. The following section will be devoted to summarizing the relevant literature about this relatively new methodology.

Although the work of Burtless and Moffitt (1984) and Friedberg (2000) observed bunching at kink points, the first study that used the bunching approach to obtain elasticity estimates was that of Saez (2010). In this paper, the author's purpose is twofold, first to find bunching evidence from taxpayers in three kink points, at certain income levels created by the United States tax schedule (specifically, the Earned Income Tax Credit (EITC)<sup>1</sup>) and, second, to obtain the compensated elasticity of income with respect to the net-of-tax rate, since, as he states, "the

<sup>&</sup>lt;sup>1</sup> The EITC is a refundable tax credit for taxpayers that have low or moderate-income levels (IRS, 2018).

amount of bunching generated by budget-set kinks is proportional to the size of the compensated elasticity of income with respect to the net-of-tax rate". Saez (2010) developed a methodology that, roughly speaking, consists of two parts. First, the histogram of the taxpayers' income is plotted (which, as it will be mentioned later in this paper, is a very helpful tool for uncovering the existence of bunching) and, second, a "main" income band (interval) around each kink point is defined, as well as two surrounding income bands. The first of the surrounding bands starts at the lower limit of the main band while the second one starts at the upper limit of the main band. For example, in the case of a kink point at an income level of  $z^*$  the main income band would be defined by  $z^* - \delta_1 z^* + \delta_2$ , whereas the two surrounding bands would be obtained by  $z^* - 2\delta_1 z^* - \delta$  and  $z^* + \delta_1 z^* + 2\delta_2$ . Finally, bunching is obtained by taking the difference between the number of individuals in the main band around the kink, and the number of individuals in the two surrounding bands. Saez (2010) found evidence of bunching at the first kink point of the EITC but mainly for self-employed taxpayers, estimating significant compensated elasticities (of income with respect to net tax rate) at the same point of -0.213 and -0.152, for all filers with one and two children, respectively. Before continuing, it is important to highlight that one difference between kink and notch designs is that when kinks are introduced in a concave (convex) budget set, bunching (region of missing mass or hole) is generated. On the contrary, notches generate both. In the same fashion and following the Saez (2010) procedure, using a very rich sample from Danish wage earners (around 18 million observations), Chetty, et al. (2011) found very small labor supply elasticities. For all wage earners they obtained labor supply elasticities of -0.01 and -0.02 for men and women, respectively, at the 30% kink point<sup>2</sup>. Taking into account self-employed taxpayers only, such authors confirmed the findings of Saez (2010) as this estimate increases in comparison to those obtained for all tax filers, which show a labor supply elasticity of -0.24. As pointed out by the authors, the Danish case was interesting because of the large tax jumps in the central part of the income distribution. On the other hand, Chetty and Kleven (2013) wrote the first paper that involves estimating structural elasticities<sup>3</sup> with a notch-based bunching design, instead of using the kink approach. By analyzing the existing notches (defined in the introduction) in the Pakistani tax system, they were able to account for optimization frictions like adjustment and search costs, inattention, hours constraints and uncertainty (which are difficult to observe and model (Chetty, 2012 and Kleven, 2016))<sup>4</sup>, addressing one of the weaknesses of previous literature on structural elasticities estimation, since as noted by Kleven (2016), these frictions drive a wedge between observed and true elasticities. Such notches cause individuals to bunch on the low tax side of the schedule, creating an area of missing mass (or hole) at the high tax side. This combination of excess bunching and missing mass led them to a new methodology that allows to uncover reliable elasticity estimates. Despite the potential behavioral change produced by notches, they found a

<sup>&</sup>lt;sup>2</sup> Specifically, the 30% kink point is where the top income bracket begins, and the net-of-tax wage decreases by 30% (Chetty, et al, 2011).

<sup>&</sup>lt;sup>3</sup> As defined by Heckmann (2010), a structural parameter is a parameter that is derived from empirical economic models.

<sup>&</sup>lt;sup>4</sup> An optimization friction is any difficulty that an individual faces to maximize his utility.

low response from taxpayers, given that the estimated structural elasticities using the "bunching-hole" method ranged from -0.025 and -0.28. This method has been extended to settings other than those related to taxation<sup>5</sup>.

## Interest rate elasticities

Since the results of the present work should be externally validated it is convenient to also review works on interest rate elasticities that have used not only the bunching approach, but other methodologies as well. In the following paragraphs a review of some papers on this topic is presented.

Motivated by the scarcity of empirical studies on the demand for bank loans, through the specification of a structural model for short-term bank credit in the Netherlands, Fase (1995) analyzed interest rate semi-elasticity of loan demand in this North-European country. Using a sample of 84 quarters between the period 1970-1990 he found a semi-elasticity of -1.099 under an ordinary least squares (OLS) model and -1.112 with a seemingly unrelated regression (SUR) model when coefficient restrictions were not imposed.

Another channel through which banks allocate credit to their customers is credit cards, and the data regarding its use can reveal significant information about certain characteristics of an economy; for example, consumption and saving (especially when there are liquidity constraints). Nevertheless, this data can also be useful for estimating behavioral responses of credit card users (in the form of elasticities) to changes in parameters such as the interest rate. In this sense, relying on a very rich dataset for credit card use in the United States, Gross and Souleles (2002) found that in the short run a 1% increase in the interest rate led to a reduction of 0.83% in the credit card's debt and of 1.3% in the long run.

One of the drawbacks of this study is the lack of an exogenous variation in the interest rate schedule of credit cards. However, the authors claim that the quality of the dataset and its characteristics (a panel following several credit card accounts during a large period and with little measurement error) led them to uncover real effects of credit supply in the users of this kind of service (i.e. elasticities of interest rates and credit card limits).

Not in line with this thesis, but interesting is the fact that this study rejected the Permanent Income Hypothesis, since they also found that an increase in the credit card limit has a positive and significant impact on debt and, therefore, on consumption.

In a different setup, Koivu (2009) understands that it is possible to track a higher influence of the interest rate in an economy by analyzing the dependency of loan demand on this policy instrument. China, as he considers, represents a suitable example for conducting this kind of study, since the country's monetary authority has relied on mechanisms different than interest rates for conducting monetary policy, yet, the growing Chinese economy, privatizations of state-owned firms and various financial reforms suggest that in that country the interest rate plays a

<sup>&</sup>lt;sup>5</sup> It was not possible to retrieve published work by academics in settings other than those related to taxation and interest rates. However, the theses from Escobar (2014) and Skaalbones (2017) provide two different applications of this novel methodology.

more significant role than some decades ago. To find this possible effect, Koivu (2009) estimated two Vector Error Correction Models (VECM), modelling credit demand as a function of output and interest rate. The used dataset is composed of aggregate data with monthly frequency for the January 1998-May 2007 period. The first VECM was specified for the January 1998-September 2001 period, while the second one covered the observed data from October 2001 to May 2007. As data were log-transformed, he found for the first period a positive yet non-significant semi-elasticity of 0.004, and a negative and significant semi-elasticity of -1.70 when the second VECM was specified. He concluded that the interest rate had a stronger influence as the country started to show characteristics of a market economy.

The microfinance lending scheme has provided an interesting setting for studying the behavioral response of people to exogenous variations in interest rates. First, Deheija, Montgomery and Morduch (2012) took advantage of the administrative data of a microfinance institution in the region of Dhaka in Bangladesh (SafeSave). During their study period this institution had operations in three different branches across this region, and two of them had to cope with an unanticipated change in the rates at which loans where granted to the institution's customers. These branches acted as a treatment group in their analysis. They proposed two specifications for retrieving the response of customers to the change in interest rates. They first used a difference-in-difference (DID) approach accounting for fixed effects, and then one that controlled for credit supply by using an instrument for customers' borrowing capacity of SafeSave. They also found significant elasticities between -0.73 and -1.04, and that poorer customers are more sensitive to interest rate increases than those with higher income levels, since the former presented a semi-elasticity of -0.86 in comparison to a semi-elasticity of -0.26 of the latter. A second example of people's response to interest rate increases in a microfinance setting is provided by Karlan and Zinman (2014) who estimated the long-run credit semi-elasticity for customers of the largest microfinance institution in Mexico (Compartamos Banco). Both, the authors and the aforementioned bank ran an experiment to offer randomized interest rates to the institution's customers. This experiment covered 80 regions of Mexico, 130 Compartamos Banco branches and thousands of customers, having a post-treatment period of 29 months. The experiment established a treatment and a control group. The treatment group consisted of a set of branches that offered a 20 basis point reduction in the interest rate, whereas control branches only offered an interest rate reduction of 10 basis points, assuming that other characteristics of the branches, such as the levels of screening and monitoring, were the same. The authors main findings were: i) an average semi-elasticity for different specifications of -1.9, with the customers of Compartamos Banco showing an elastic demand for credit; and, ii) that the semi-elasticities increased over the horizon of the contracted loan (-1.15 for a 1-year horizon, -1.99 for 2 years and -2.91 for the 3-year loan term). Although the interest rate semi-elasticities obtained in this study are not estimated using the bunching approach, their size can be informative for the results of this thesis.

#### The bunching approach and interest rates

The bunching approach has found application in other areas beside taxation like the study of government policies and private sector prices (including their elasticities), among other subjects (Kleven, 2016). One of these applications is the study of interest rate elasticities. In the spirit of the present thesis, two papers deserve major attention, since their main goal is to analyze behavioral responses to a change in interest rates using the bunching approach. First, Best, et al. (2015) used the mortgage interest rate schedule for uncovering mortgage debt rate elasticities. As this schedule presents several notches at the specific levels of the loan-to-value ratio (LTV)<sup>6</sup> in the United Kingdom, individuals are prone to bunch just below these thresholds. These authors observed substantial bunching at these notch points which allowed them to obtain the mentioned elasticities. For the six notches in the mortgage interest rate schedule they found six significant interest rate elasticities which ranged from -0.07 to -1.37. Then, DeFusco and Paciorek (2017), following the methodology of Kleven and Waseem (2013), estimated that an increase of one percentage point in the interest rate of the 30-year fixed-rate mortgage led individuals to lower the total mortgage demand by 1.6% to 5.2%. By using thresholds (known as conforming limits) fixed by two housing finance providers in the United States (Fannie Mae and Freddie Mac) as notch points (where a discontinuity in the mortgage interest rate occurred), the authors detected bunching by the households who contracted mortgages during the analyzed period, making it possible to estimate these significant elasticities. Because of the features of the Pequeños Productores program and its similarities with the DeFusco and Paciorek (2017) case (differentiated interest rates and a cut-off given by a loan limit which introduces a notch) the procedure implemented by these authors will be followed in the present work.

The following table summarizes the literature reviewed on interest rate elasticity of loan demand. The first columns show the author and the year of publication; the country and setting where the study took place are included in the second and third columns, respectively. Columns (4) and (5) include the method and sample used to perform the analysis, meanwhile the way how interest rate elasticity of loan demand is defined in column (6). Finally, the (range of) estimations are shown in the last column.

<sup>&</sup>lt;sup>6</sup> The loan-to-value ratio is the quotient of dividing the amount of the loan by the value of the purchased asset or investment project.

| Authors (1)                                     | Country<br>(2) | Setting<br>(3)   | Method<br>(4)  | Sample<br>(5)  | Definition of elasticity<br>(6)                          | Estimation(s)<br>(7)  |
|---|----------------|--|--|--|--|---|
| Fase<br>(1995)                                  | Netherlands    | Aggregate data of<br>short-term debt<br>and interest rates | 2 equations structural<br>model using OLS<br>and SUR <sup>1/</sup> | 84 quarters (1970-1990)  | Semi-<br>elasticity                                      | -1.12 to -0.14  |
| Gross and<br>Souleles<br>(2002)                 | USA            | Credit cards   | Data panel<br>estimation with fixed<br>effects                     | Unbalanced panel with<br>231,644 observations during<br>the Jan 1995-Jan 1998 period                   | ced panel with<br>servations during<br>5-Jan 1998 period |   |
| Koivu<br>(2009)                                 | China          | Aggregate data of<br>short-term debt<br>and interest rates | VECM <sup>1/</sup>   | Monthly data<br>Jan 1998-May 2007  | Semi-<br>elasticity                                      | -1.70   |
| Dehaija,<br>Montgomery<br>and Morduch<br>(2012) | Bangladesh     | Microlending   | Difference in<br>differences and<br>Instrumental<br>Variables      | 68,037 customers<br>observations between Jan<br>1999-Jan 2001  | Semi-<br>elasticity                                      | -1.04 to -0.26  |
| Karlan and<br>Zinman (2014)                     | Mexico         | Microlending   | Randomized interest<br>rates                                       | 2,469 disbursed loans in a 29<br>post-treatment period which<br>started on May 15, 2007                | Semi-<br>elasticity                                      | -1.15, -1.99 and<br>-2.91 for 1-, 2- and<br>3-year horizons |
| Best, et al.<br>(2015)                          | UK             | Mortgages  | Bunching approach  | 2,841,309 mortgages between 2008Q4 and 2014Q4  | Reduced form semi-<br>elasticity <sup>2/</sup>           | -1.37 to -0.07  |
| DeFusco and<br>Paciorek<br>(2017)               | USA            | Mortgages  | Bunching approach  | 1,011,345 fixed-rate<br>mortgages and 676,718<br>adjustable-rate mortgages for<br>the 1997-2007 period | Reduced form semi-<br>elasticity <sup>2/</sup>           | -1.6 to -5.2  |

Figure 1: Summary of revised literature on interest rate elasticity of loan demand.

<sup>1/</sup>OLS: Ordinary Least Squares, SUR: Seemingly Unrelated Regression, and VECM: Vector Error Correction Model. <sup>2/</sup>The reduced form (semi-elasticity) will be addressed in section IV. As observed in the figure above, even though there are significant differences between the different papers in terms of country, setting, sample and method, the estimations are in the form of semi-elasticity and most of them are of an elastic nature.

# III. <u>Mexico's overview</u>

The purpose of this section is to familiarize the reader with the following topics: the 2014 Financial Reform and its objectives regarding development banking, FND's activities and, the *Pequeños Productores* Social Program.

# The 2014 Mexican Financial Reform

Besides the improvement of the macroeconomic indicators and of certainty, which has allowed the financial intermediaries to lend at cheaper interest rates after the 2008-2009 Great Recession, the Mexican Financial Authorities like Banco de México and the National Banking and Securities Commission (CNBV, for its acronym in Spanish) have undertaken actions like establishing a reliable electronic payments system or introducing before any other country the Basel III macroprudential regulation framework in order to ensure the sound and healthy development of the country's financial system. However, there is still a relatively low penetration of financial services among the population. Some examples in this regard are drawn from the International Monetary Fund (IMF) Financial Access Survey (2015) and the World Bank's Global Financial Inclusion Database (2017). In contrast with the rest of the OECD (2018) countries (of which Mexico is a member state), Mexico has 46.02 less automated-teller machines (ATMs) for every 1,000 people, and 1,751.51,<sup>7</sup> less deposit accounts with commercial banks for every 100,000 people. Finally, in 2017 only 5.75% of the population over 15 years old borrowed money from a financial institution in Mexico while, on average, in the rest of the member states of this multilateral organism, this figure reached 17.71%.

On January 9, 2014, President Enrique Peña Nieto enacted a Financial Reform (published on January 10, 2014 in Mexico's Official Journal of the Federation-*Diario Oficial de la Federación*) addressing the lag in financial access to the population and therefore in contributing to the country's economic growth and development.

The Financial Reform is based on the following five pillars (Gobierno de la República, 2014):

- 1) Increase competition in the financial sector.
- 2) Encourage credit allocation through development banking
- 3) Expand credit through private financial institutions.
- 4) Maintain a solid and prudent financial system.
- 5) Make financial institutions and authorities more effective.

Considering the above, development banking institutions have a relevant role in achieving the established goals of the 2014 Financial Reform. Prior to the reform, and in line with their own

<sup>&</sup>lt;sup>7</sup> In the case of the ATMs figure, the OECD average does not include the United States data since there is no available information after 2009. For the percentage of population over 15 years old that borrowed money from a financial institution there is no data for Iceland, hence it was not included in the computation of the OECD average.

mandates, most development banks followed a conservative lending strategy, focusing on low risk customers and keeping higher capitalization levels than commercial banks. In order to boost economic growth, these institutions modified their strategies, starting to assist those individuals which had not been assisted by traditional banking. This change in strategy entailed modifying the legal framework that rules development banking in order to implement policies that contribute to productive activities, the creation of value, the growth of the farming sector, and to encourage families' savings. The most substantial changes to the legal framework related with these development policies are: i) to clarify the mandates of development banks so that these institutions serve strategic sectors of the economy that have limited access to financial services and funding options, ii) to flex the institution's "organic laws" and the rest of their ruling legal framework, iii) to state the obligation of creating financial inclusion programs for micro, small and medium enterprises (SME's), small farmers, young entrepreneurs, focusing on gender equality, and iv) to promote environmental sustainability within the institution's operations (Gobierno de la República, 2014).

In the case of the FND, one main channel for fulfilling the Financial Reform objectives is through the implementation of the *Pequeños Productores* social program.

## FND: Current situation and the Pequeños Productores social program

## FND: current situation

With the introduction of the 2014 Financial Reform and its objectives, Financiera Rural changed its name to Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero (FND). This new denomination emphasizes the integral objectives of the institution in supporting the country's primary sector and economic activities that are undertaken in rural areas<sup>8</sup>. Likewise, the Financiera Rural's Organic Law underwent modifications and became more flexible in order to meet the Financial Reform's purpose and objectives. The new Organic Law was enacted on January 10, 2014.

As a decentralized body of the Federal Public Administration, sectorized in the Ministry of Finance and Public Credit, and having its own legal personality and capital, the FND's objective is to "help carry out the State's priority activity of promoting the development of agricultural, forestry, fishing activities and all other economic activities linked to the rural environment, in order to raise productivity, as well as to improve the standard of living of its population" (Cámara de Diputados del H. Congreso de la Unión, 2014a, page 1).

The FND is allowed to perform the following activities: i) to grant credit in a sustainable manner, ii) to provide other financial services to producers and rural financial intermediaries, iii) to execute the rural financing-related programs as set by the Federal Government's Budget of Expenditures, iv) to promote national and international institutions oriented to invest on and finance productive projects that promote rural development, v)to operate with the Federal, State

<sup>&</sup>lt;sup>8</sup> The English translation is *National Agricultural, Rural, Forestry and Fishing Development Fund* and is categorized by the CNBV as a development organism, not a bank, but for the purposes of this study it will be considered in this way.

and Municipal governments the programs that are coordinated by the aforementioned institutions, and vi) to provide training activities and advice to producers so that they can better use their credit resources, as well as to those who decide to establish themselves as Rural Financial Intermediaries.

The FND is able to provide the abovementioned services in the 32 states of the country through a network of 95 agencies distributed in five regional coordinations (North, North-West, Center-West, South and South-East) and the following types of loans (FND 2016b-f):

- 1) Enabling credit: this type of loan is used for the acquisition of commodities, materials, and direct operating expenses, as well as to cover working capital needs, to finance mainly one productive (farming) cycle. Therefore, the loan term is often smaller than a year.
- 2) Fixed-assets credit: is destined to finance producers to acquire, replace or substitute machinery or equipment and other fixed assets. According to the FND's Manual of Credit Policies and Norms, this type of loan is destined to finance medium- and longterm investments (for terms longer than one year).
- 3) Simple credit: its purpose is to finance working capital requirements, for the production of goods and the provision of services and fixed assets. This type of loan is granted when the customer does not specify a destination (enabling or fixed assets) of the resources.
- 4) Current account credit: this type of credit has the distinctive feature of not having a specific destination: it can be used to cover immediately short-term liquidity and/or working capital so as to not interrupt the productive activity. The customer can dispose several times of the credit limit, restoring the loan in a revolving form as it pays for the financing. The mechanics of this loan can be compared to a credit card as the customer credit line is used when needed, repaying the principal and the accrued interest of the amount used.
- 5) Pledge credit: provides liquidity to the institution's customers, supports them in their commercialization activities, and finances the working capital of producers when they give as collateral the documentation that certifies the custody of merchandise or goods by a General Bonded Warehouse<sup>9</sup>.
- 6) Accessory loans: this type of credit refers to smaller loans that are "attached" to the FND customer's main loan and are granted at a normal interest rate (11% or 11.5%).

The maximum term for credits is as follows: i) enabling: 24 months if the loan will be used for financing one agricultural cycle and 10 years if the loan will fund multiple agricultural cycles; ii) fixed assets: up to 15 years; iii) simple: up to 24 months; iv) current account: 12 months; and v) pledge: 6 months.

<sup>&</sup>lt;sup>9</sup> As defined by Mexico's General Law of Organizations and Auxiliary Activities of Credit, a general bonded warehouse is an institution in charge of storing, maintaining, managing, controlling, distributing and commercializing goods or merchandise under its custody, including those in transit (Cámara de Diputados del H. Congreso de la Unión, 2018b).

It is important to note that the FND asks for credit guarantees (collaterals) in their loan transactions depending on the credit type. For enabling and fixed-asset credit, a natural guarantee is required, which is the product of the farmer's investment. For simple and current account loans, the FND asks for real guarantees, which can be either liquid (cash or short-term securities) or real estate or pawned/pledged goods. As it will be discussed later, the difference in the requested credit guarantees could have relevant implications on the obtained semi-elasticities.

Finally, in order to attain one of its main tasks, the FND is currently carrying-out (among others) the following programs (FND, 2018):

- 1) *Cobertura de precios* (Price hedging program): the FND gives its customers an *accessory* credit associated to a productive project, covering up to the full price of the option (either put or call) and commission fees.
- 2) *Programa de Financiamiento para Empresas de Intermediación Financiera* (Financing Program for Financial Intermediary Companies): the FND provides credit lines for those firms that disperse credits to individuals or firms that carry out primary activities or those related to the rural sector.
- 3) *Programa de Financiamiento para Pequeños Productores* (Financing Program for Small Farmers): This program will be discussed in the following subsection.

## Programa de Financiamiento para Pequeños Productores (Financing Program for Small Farmers)

This program was designed "to strengthen the economy of small rural producers and contribute to improve their welfare and reduce their poverty levels" (FND, 2017). It was implemented by the Mexican Federal Government through the FND for attending the second pillar of the 2014 Financial Reform, specifically in the agricultural sector in Mexico.

This program was announced on August 20, 2014 in the city of Guadalajara by current President Enrique Peña Nieto (this announcement was accompanied by the change in name of the institution). During his intervention, the president highlighted that with such program it would be possible to offer an interest rate of one digit, that female farmers would have an additional benefit in interest rate (a 0.5 percentage point discount), and that the granting of loans would be faster because the FND was not going to ask loan solicitors for a real guarantee. These features intend to provide more support to the Mexican rural areas and make Mexico one of the largest food producers in the world (Animal Político, 2014).

The Pequeños Productores program has the following characteristics:

• Amount to fund: Up to 45,000 UDIs<sup>10</sup>. Anything above this quantity will be considered a "traditional" loan, which are granted under the Agricultural, Livestock, Aquaculture

<sup>&</sup>lt;sup>10</sup> The UDI is an account of unit that was created by presidential decree on April 1995 during the 1994-1995 Mexican crisis. Its value depends on inflation (during inflation times its value increases proportionally to this macroeconomic indicator and vice versa during deflation periods), so investments denominated in UDIs (like bonds or investment funds) are attractive during periods of high or increasing inflation. Its value is determined daily by Banco de México. Mortgage loans and other mercantile acts (like FND loans) are denominated in this account of

Forestry and Fishing Production<sup>11</sup> portfolio. During the analyzed period, this amount was equivalent to  $\notin 12,793.08^{12}$ .

In the case of agricultural firms, the maximum is 45,000 UDIs per shareholder. The total amount for firms cannot exceed 600,000 UDIs (13 shareholders).

- Interest rate: fixed at 7.0% (6.5% for female customers). For traditional loans under the Agricultural, Livestock, Aquaculture Forestry and Fishing Production portfolio, the prevailing interest rate is 11.0% for those customers that have contracted a loan with the FND more than once (preferential customers), and 11.5% for those who engage for the first time in a loan transaction with the institution (non-preferential customers). These "traditional" interest rates are paid for the entire loan amount and not only for the excess amount of the 45,000 UDIs borrowing limit and do not depend on the size of the loan, its term, the customer's gender, or its location. This difference in interest rates leads to spreads (between *Pequeños Productores* loans and traditional loans) of between 400 basis points (4%) and 500 basis points (5%) depending on the type of customer. These interest rates were kept during the entire analyzed period.
- Eligible types of credits: enabling, simple, current account, and fixed assets.
- Credit guarantees (collaterals): only natural guarantees. This means that customers who ask for simple and current account credits under the *Pequeños Productores* program do not need to provide real guarantees. According to the FND, this particularity, along with the lower interest rate, has made the program quite attractive.
   In case of enabling and fixed-asset loans, the type of guarantee remains unchanged with respect to traditional loans.
- Less documentation requirements for the loan solicitors in comparison to traditional loans. The additional documentation that is requested for traditional loans is linked with the real collateral information (i.e. real estate valuation and address details, information regarding the customer's personal endorsement, etc). Thus, this information is not needed for enabling and fixed-asset traditional loans as well as all types of loans granted under the *Pequeños Productores* program.

According to the latter, since real collaterals and documentation related with them is not needed for enabling and fixed-asset loans, and as a note for the reader, all elasticities elicited exclusively from these types of loans are purely interest rate ones, as they do not contain the effect of the change in real collateral requirements as in the case of simple and current account loans.

unit (Gutierrez Sánchez, 2001). At the date of its creation, its value was equal to one Mexican peso (MXN). The average value for UDIs during the analyzed period was 5.3036 MXN.

<sup>&</sup>lt;sup>11</sup> This is the name that the FND gives to the set of loans different from those granted under the *Pequeños Productores* program that are destined to fund the different stages of the production chain (FND, 2018).

<sup>&</sup>lt;sup>12</sup> The average exchange rate (EUR/MXN) was 18.6556 during the 2014-2016 period. This means that, on average, one euro was equivalent to 3.5175 UDIs during the same window of time.

Furthermore, the FND asks loan solicitors about the destination of the credit<sup>13</sup> (i.e. corn, coffee, harvesting tools, etc.), and if they have own resources to partially fund the project or other financial support from other sources (FND, 2016).

It is important to emphasize that one customer can have simultaneously more than one *Pequeños Productores* loans if, and only if, the accumulated amount of these credits is less than 45,000 UDIs, limiting arbitrage opportunities. This fact does not present challenges in the interest rate elasticity estimations, since the dataset do not identify the customers and their accrued debt, as every loan is treated as if it was contracted by a new customer.

Finally, as noticed above, there is a large spread between the interest rate for the *Pequeños Productores* program and the Agricultural, Livestock, Aquaculture Forestry and Fishing Production portfolio one (traditional interest rate), as well as less documentation requirements and lower credit guarantees. This feature will make it possible to obtain the behavioral responses of FND customers to the implementation of the *Pequeños Productores* program and then their interest rate elasticity, which is the objective of the present study.

#### On credit risk indicators

By disposition of the CNBV, the FND's risk management unit must track the evolution of the concentration of their loans portfolio, as well as measure and assess its credit risk. To accomplish these tasks, this department uses the following credit risk indicators:

- 1) Probability of default (PD): it measures the probability of a debtor failing to pay for the borrowed amount (Banco de México, 2005).
- 2) Exposure at default (EAD): it is the pending debt when default occurs (Banco de México, 2005).
- 3) Loss-given-default (LGD): refers to the amount that a creditor loses in case of default from the customer and it is measured as a proportion of the exposure at default (Banco de México, 2005).
- 4) Expected loss: it is the mean of the profits and losses distribution and it is given by the product of the first three credit risk indicators (Banco de México, 2005).

Besides measuring and tracking these indicators in an aggregate way, the FND risk management unit does it also by type of credit, loan term and regional coordination levels. The following tables contain the abovementioned credit risk indicators at these three levels and, as it will be observed later, the results of the interest rate semi-elasticities can be partially explained by these indicators.

<sup>&</sup>lt;sup>13</sup> After the loan is granted, the FND monitors if the borrowed money was used for the established purpose. If the money was destined for a different purpose, the FND asks for the money back and penalizes the debtor with a fine.

| Region          | Zone<br>classification | Probability<br>of default | Loss given<br>default | Exposure at<br>default | Expected<br>loss |
|-----------------|------------------------|---------------------------|-----------------------|------------------------|------------------|
| (1)             | (2)                    | (3)                       | (+)                   | (3)                    | (0)              |
| North           | Non-priority           | 7.1%                      | 49.0%                 | 86.9%                  | 3.0%             |
| North-West      | Non-priority           | 6.4%                      | 48.3%                 | 81.0%                  | 2.5%             |
| Centre-<br>West | Non-priority           | 10.7%                     | 42.7%                 | 84.8%                  | 3.9%             |
| South           | Priority               | 12.0%                     | 53.2%                 | 83.4%                  | 5.3%             |
| South-East      | Priority               | 15.6%                     | 61.1%                 | 82.7%                  | 7.9%             |
| Source: FND.    |                        |                           |                       |                        |                  |

Figure 2: Credit risk indicators by region (2006-2015).

The region-level credit risk indicators show that loans in priority zones are riskier than in more prosperous regions, and that the FND expects to have more losses in these regions as the expected loss indicator is considerably higher in the south and south-east regional coordinations. The result of the expected loss is mainly driven by the loss-given-default and the probability of default since the exposure is similar across regions.

| Type of<br>credit<br>(1) | Credit<br>classification<br>(2) | Default<br>probability<br>(3) | Loss given<br>default<br>(4) | Exposure at<br>default<br>(5) | Expected<br>loss<br>(6) |
|--------------------------|---------------------------------|-------------------------------|------------------------------|-------------------------------|-------------------------|
| Fixed assets             | Fixed assets                    | 39.9%                         | 74.5%                        | 78.2%                         | 23.2%                   |
| Working<br>Capital       | Non-fixed assets                | 11.1%                         | 38.7%                        | 84.5%                         | 3.6%                    |
| Simple                   | Non-fixed assets                | 26.8%                         | 53.1%                        | 74.1%                         | 10.5%                   |
| Current<br>account       | Non-fixed assets                | 5.1%                          | 61.5%                        | 96.0%                         | 3.0%                    |
| Source: FNI              | ).                              |                               |                              |                               |                         |

Figure 3: Credit risk indicators by type of credit (2006-2015).

In comparison with non-fixed asset loans (working capital, simple and current account), the behaviour of fixed asset loans reveals a significant deterioration of credit risk indicators. Considering the expected loss indicator, on fixed-asset loans the FND expects to lose 23.20 Mexican pesos for every 100 Mexican pesos lent, but only 3.00 Mexican pesos on current account loans. Default probability is also considerably higher for this kind of loans. So, it is evident that fixed-asset loans are riskier than other types of loans.

| Loan term    | Default<br>probability | Loss given<br>default | Exposure at<br>default | Expected<br>loss |  |
|--------------|------------------------|-----------------------|------------------------|------------------|--|
| (1)          | (2)                    | (3)                   | (4)                    | (5)              |  |
| Short-term   | 8.0%                   | 42.2%                 | 86.5%                  | 2.9%             |  |
| Medium-term  | 17.1%                  | 55.1%                 | 80.4%                  | 7.6%             |  |
| Long-term    | 25.7%                  | 68.7%                 | 73.0%                  | 12.9%            |  |
| Source: FND. |                        |                       |                        |                  |  |

Figure 4: Credit risk indicators by loan term (2008-2015).

As expected, because uncertainty increases with time horizons, long-term loans show a higher default probability and expected loss than short- and medium-term loans.

Since they can be helpful to explain the resulting semi-elasticities, the above figures have been included in the present work.

# IV. <u>Theoretical approach</u>

This recent approach which retrieves behavioral responses and estimates elasticities through discontinuities in incentives recognizes two types of designs: kink point-based, and notch point-based. The difference between both designs is that for kink points, the discontinuities are observed in the **slope** of the agent's choice sets and for notches, in the **level** of choice sets (Kleven, 2016).

Since the *Pequeños Productores* program introduces a notch in the choice sets of farmers and agricultural firms, in this section the bunching approach for notches will be outlined using this social program's characteristics. This methodology will be followed for the empirical component of this study.

Hypothetically, due to the large spread in interest rates that exists between the *Pequeños Productores* program and the Agricultural, Livestock, Aquaculture, Forestry and Fishing Production portfolio, and the lower collateral and laxer documentation requirements, the program gives incentives to FND's customers to borrow money below the 45,000 UDIs cut-off, creating a region of missing mass (hole) just to the right side of the cut-off, and a sharp region (excess bunching) of credits concentrating at and to the left of the cut-off. The next paragraphs are devoted to show how this combination of excess bunching and the hole in the loan-size distribution leads to obtain behavioral responses, as well as elasticities, when a notch is introduced.

First, following DeFusco and Paciorek (2017) a two-period model is presented where in the first period a farmer is willing to start a farming project/investment with a price p that can be funded by a loan (l) at an interest rate r, which does not depend on the size of the loan. In the second period, the farmer finishes paying the loan and can now devote his remaining wealth to consuming in other concepts.

The farmer will face the following problem where he maximizes his utility, which depends on consumption during the first period ( $C_1$ ) and during the second period ( $C_2$ ):

$$max\{U(C_1, C_2)\} = U(C_1) + \varphi U(C_2)$$
(1)

$$C_1 + p = y + l \tag{2}$$

$$C_2 = z - (1+r)l$$
 (3)

$$0 \le l \le p \tag{4}$$

Where z is the income derived from the project given as a function of its price,  $\varphi \in (0, 1)$  is a measure for the farmer's patience, where a higher value of  $\varphi$  means that a farmer values more the future (i.e. the farmer is more patient), while y is the first period's income.

In line with Kleven and Waseem (2013) and DeFusco and Paciorek (2017), let us assume that farmers present preferences given by a quasi-linear and iso-elastic utility function of the form:

$$U(C) = \frac{1}{1 - \xi} C^{1 - \xi}$$
(5)

For the purposes of this analysis it is convenient to include the following simplifying assumptions:

- a) Heterogeneity in the model depends on the discount factor  $\varphi$  that is smoothly distributed throughout FND's customers with a smooth density function of  $f(\varphi)$ .
- b) Parameters y, p and  $\xi$  are constant across farmers.
- c) Farmers have a loan-to-value (LTV) ratio less than or equal to 100%.

The smooth density function  $f(\varphi)$  will lead to a smooth baseline distribution of the size of the FND's loans.

Let us consider the case when the *Pequeños Productores* program introduces a notch point in the interest rate policy for the FND's customers at a 45,000 UDIs loan amount (l). The social program's differentiated interest rate (6.5% or 7.0% depending on the customer's gender) along with the other characteristics has an effect on the institution's interest rate policy, set now by:

$$r(l) = r + \Delta r \cdot \mathbf{1}(l > \bar{l}) \tag{6}$$

Where,  $\Delta r$  is the spread between the *Pequeños Productores* program interest rate and the FND's traditional loan interest rate, where  $1(l > \overline{l})$  indicates a traditional loan, as  $\overline{l}$  represents the *Pequeños Productores* borrowing limit (45,000 UDIs).

Combining the restrictions from equations (2) and (3) it is possible to arrive to the farmer's lifetime budget constraint:

$$C = C_1 + C_2 = y + z(p) - p - l \cdot [r + \Delta r \cdot (l > \overline{l})]$$
(7)

Rewriting z(p) - p as  $\pi(p)$  is possible to obtain the lifetime budget constraint as a function of the project's profits:

$$C = C_1 + C_2 = y + \pi(p) - l \cdot [r + \Delta r \cdot (l > \bar{l})]$$
(8)

What happens with farmer's preferences before and after the notch introduction is shown in Figure 5. First off, the loan size (l) is located in the X-axis, meanwhile the farmer's consumption level in both periods (C) is plotted in the Y-axis. The figure also contains the budget constraint before and after the notch is introduced, which can be identified by its respective slope (-r prior to the notch and  $-(r + \Delta r)$  after its introduction). They are decreasing as overall consumption (C) will diminish as the farmer contracts larger loans. Finally, the farmer's preferences can be drawn by the indifference curves L and H, where farmer L who presents a higher patience, and therefore, lower funding needs (as he prefers to pay a smaller amount of interests during the second period, given his higher valuation of the future), applies for a loan with size  $\bar{l}$ , either with or without the notch's existence. On the other hand, farmer H (with less patience) will contract at period 1 a loan with size  $\overline{l} + \Delta \overline{l}$  prior to the notch. However, due to the notch's introduction in period 2, the farmer will present a behavioral change (given by the indifference curve  $H_1$ ), so he will keep the same utility level by locating either at the 45,000 UDIs threshold or at the best interior point further than this cut-off. Farmers with funding needs in the interval  $(\bar{l}, \bar{l} + \Delta \bar{l})$  will present the same behavioral response as farmer H (when the notch is introduced), causing the loan size distribution to show excess bunching at the 45,000 UDIs cut-off and a hole (region of missing mass) to the right side of this cut-off. The density of this distribution is defined as  $g_1(l)$ .

Figure 5: Representation of the farmer's problem.



The excess bunching mentioned in the last paragraph can be defined by the following expression:

$$B = \int_{\bar{l}}^{\bar{l} + \Delta \bar{l}} g_0(l) dl \approx g_0(\bar{l}) \,\Delta \bar{l} \tag{9}$$

Where B is the amount of bunching,  $g_0(\bar{l})$  is the loan size distribution that would have existed if the notch had not been introduced (counterfactual loan size distribution). This integral finds support in the bunching interval  $(\bar{l}, \bar{l} + \Delta \bar{l}]$  and represents all the farmers that would contract a loan over the 45,000 UDIs threshold in the pre-notch scenario, but as a result of the introduction of the differentiated interest rate by the *Pequeños Productores* program (along with other benefits offered by the program), they will now take a cheaper interest rate. As noted, the integral can be approximated by  $g_0(\bar{l})$  times  $\Delta \bar{l}$ , being  $\Delta \bar{l}$  the behavioral response to the interest rate generated by the cut-off. By estimating the first two parameters  $\hat{B}$  and  $\hat{g}_0(l)$  it is possible to solve for  $\Delta \bar{l}$ and then arrive to the relevant behavioral response.

## Estimation of $\hat{B}$ and $\hat{g}_0(l)$

As stated above, to obtain the parameters of interest in the present work it is necessary to estimate the amount of bunching and a counterfactual density of the loan's size. Both parameters will be derived at some extent by a counterfactual distribution of the amount of the FND's loans. This distribution will reflect the case that there is no notch in the institution's interest rate policy.

Consequently, a procedure for its estimation have to be followed in the fashion of Kleven and Waseem (2013) and DeFusco and Paciorek (2017).

The first step of this procedure is to obtain logarithms for the empirical loan size distribution and then normalize each observation, centring the distribution at the 45,000 UDIs threshold. As close is the value of a loan to the 45,000 UDIs cut-off, when normalized, it will approximate to zero (i.e. a loan equal to 45,000 UDIs will have a value of zero when normalized). Second, to generate the counterfactual distribution it is necessary to pass from a loan-level to a "bin"-level database. In order to achieve this, the normalized (log) loan amounts need to be grouped into the loan amounts  $l_j$ , so that  $j = -J, \ldots, L, \ldots, 0, \ldots, U, \ldots, J$ . Each element of j represents a bin, being 0 the bin whose upper limit is equal to 45,000 UDIs (when normalized). On the other hand,  $l_j$  is the (log) loan amount at the centre of each bin (j). For example, if bin j = U has a lower bound of 0.04 and an upper bound of 0.06 normalized (log) loan values, the centre (log) loan amount will be given by  $l_U = \frac{0.04+0.06}{2} = 0.05$ . By counting the number of loans in each bin, the bin-level distribution will be ready. This count of loans will be denoted by  $n_j$ . The following step is to exclude a region around the threshold, considering those observations in interval  $[l_L, l_U]$  that have the restriction  $l_L < 0 < l_u$ . A regression for the count of loans in the defined bins is then estimated. Such regression has the following form:

$$n_j = \sum_{i=0}^p \beta_i (l_j)^i + \sum_{k=L}^U \gamma_k \mathbf{1}(l_k = l_j) + \varepsilon_j$$
(10)

As observed, two terms in the right-hand side of (10) are introduced. The first is a p-th degree polynomial for the loan size, while the second one is a dummy variable for the bins not included in the loan amount distribution. The predicted values of the estimated regression, excluding the effect of the dummies in the excluded region, will produce the needed counterfactual bin-level distribution on which is possible to rely for obtaining  $\hat{B}$  and  $\hat{g}_0(l)$ , as shown below:

$$\widehat{n}_{j} = \sum_{i=0}^{p} \widehat{\beta}_{i} (l_{j})^{i}$$
(11)

After obtaining the counterfactual distribution of the loan size, the following step is to retrieve the so called *bunching estimates*, which are nothing else than the difference between the observed and the counterfactual bin counts in the interval that were excluded at and to the left of the cutoff.

$$\hat{B} = \sum_{j=L}^{0} (n_j - \hat{n}_j) = \sum_{j=L}^{0} \hat{\gamma}_j$$
(12)

Simultaneously, the missing mass or hole is given by the following expression:

$$\widehat{M} = \sum_{j>0}^{U} (n_j - \hat{n}_j) = \sum_{j>0}^{U} \widehat{\gamma}_j$$
(13)

Finally, by solving the approximation for B provided in equation (9) it is possible to obtain the "behavioral response of the marginal bunching individual<sup>14</sup>" (DeFusco and Paciorek, 2017, p.220), measured as a percentage deviation from the 45,000 UDIs as shown below:

$$\Delta \hat{l} = \frac{\hat{B}}{\hat{g}_0(l)} \tag{14}$$

As for equation (9),  $\hat{g}_0(l)$  is an estimation of the counterfactual density of loans, where the denominator  $\hat{g}_0(l)$  is given by the sum of the loans in the excluded region at and to the left of the cut-off divided by the difference of the centre values  $(l_j)$  of bin 0 and bin L-1.

$$\hat{g}_0(l) = \frac{\sum_{j=L}^0 (\hat{n}_j)}{|l_0 - l_{L-1}|} \tag{15}$$

The denominator acquires this form in order to consider the entire area given by bins 0 to L as the excluded region. This can be better explained with the following graphical example:

Figure 6: Example of how the denominator of counterfactual density is determined.



<sup>&</sup>lt;sup>14</sup> As defined by Kleven (2016), the marginal bunching individual is the one that choses point  $\overline{l} + \Delta \overline{l}$  prior to when the notch is introduced; and when it is introduced, such individual shifts down to point  $\overline{l}$ .

Figure 6 plots an example of how to determine the denominator of expression (15). The X-axis shows the distribution of the differences between the (log) loan size and the (log) *Pequeños Productores* 45,000 UDIs borrowing limit, while the Y-axis plots the number of loans in each bin. Assuming that the excluded region is set to be the area ranging from bin 0 to bin -2, where the latter can be named bin L, bin -3 is therefore equal to bin L-1. Thus, the denominator of expression (15) is given by the difference, in absolute terms, of the centre value of bin -3 ( $l_{-3}$ ) and the centre value of bin 0 ( $l_0$ ). As shown in Figure 6, this excluded area is equivalent to measuring from the border between bin 0 and bin 1 to the border between bin -2 and bin -3 (as denoted by the legend "Equivalent excluded area" in the graph).

Intuitively, since  $\sum_{j=L}^{0} (\hat{n}_j)$  is the density in the excluded region at the left of the borrowing limit of the entire density of the counterfactual loan size distribution, it has to be weighted by the difference between the centred (log) loan size at the *Pequeños Productores* borrowing limit ( $l_0$ ) and the centred (log) loan size at bin L-1 ( $l_{L-1}$ ) in order to obtain  $\hat{g}_0(l)$ .

Reliable bunching estimates are obtained when the difference  $\hat{B} - \hat{M}$  is minimized, as this confirms that the excess mass is (almost) equal to the missing mass due to the presence of bunching. This is achieved first by choosing the bin at the left-hand side of the notch j = L. Such bin will be the one when bunching  $(\hat{B})$  starts to be evident in the histogram of the normalized (log) loan distribution, and then j = U will follow endogenously from  $\hat{B} = \hat{M}$ .

Inspired by Kleven (2016) and Kleven and Waseem (2013), the bunching approach can be represented graphically as follows:



Figure 7: Graphical representation of the bunching approach.

The first panel shows the case where heterogeneity is only given by the level of patience of the farmer ( $\varphi$ ), while the second multidimensional heterogeneity is allowed (y, p and  $\xi$  non-constant across farmers). The X-axis contains different loan amounts of both empirical and counterfactual distributions while the Y-axis shows their densities. The blue line denotes the empirical distribution of loans whereas the curved line the counterfactual one (dashed in the first

panel and bold in the second one). Next, both bunching and missing mass, represented by the grey areas, are contained in an excluded range in interval  $[l_L - l_U]$ . Finally, the normalized threshold is given by  $l_0$ . In the first case, the obtained estimation under equation (14) should be interpreted as the exact change in the loan amount for the marginal bunching individual. And when y, p and  $\xi$  are heterogenous across farmers, the estimation of  $\Delta \hat{l}$  leads to the average response among marginal bunching individuals (DeFusco and Paciorek, 2017).

#### Identifying assumptions

Finally, to obtain reliable and valid behavioral response estimates, the bunching analysis must fulfill the following identifying assumptions (Kleven and Waseem, 2013 and DeFusco and Paciorek, 2017):

- A smooth behavior of the true counterfactual loan distribution. This means that jumps in the empirical loan distribution are explained only by the introduction of the notch, in this case, the *Pequeños Productores* program features. DeFusco and Paciorek check for violation of this assumption by examining changes in loan distributions at the moment when the cut-off (conforming mortgage limit) in their study changes from year to year. In the present work, this test cannot be conducted because the notch (45,000 UDIs) has always been the same during the analyzed period.
- 2) The marginal bunching farmers are well defined in terms of their counterfactual loan size (i.e. provided that the notch has not been introduced).
- 3) The excess mass  $(\hat{B})$  at and to the left of the 45,000 UDIs threshold is equal to the "hole"  $(\hat{M})$  produced by the introduction of the notch. This is achieved by minimizing the difference between  $\hat{B}$  and  $\hat{M}$ . As Kleven and Waseem claim, this is a weak assumption, which is relaxed in their analysis and in the DeFusco and Paciorek's (2017) work.

#### From behavioral response of bunching individuals to semi-elasticity.

The final step of the methodology is to transform the (average) behavioral response of the marginal bunching individuals to an elasticity. This can be performed by using the formula:

$$\epsilon = \frac{\Delta \hat{l}}{r(\bar{l} + \Delta \hat{l}) - \hat{r}} = \frac{\Delta \hat{l}}{\Delta \hat{r}}$$
(16)

Where  $\Delta \hat{l}$  in the numerator is the average response of the marginal bunching individuals as given by equation (14), while in the denominator,  $r(\bar{l} + \Delta \hat{l})$  is the interest rate when the contracted loan amount is above the 45,000 UDIs borrowing limit and  $\hat{r}$  is the *Pequeños Productores* interest rate. The difference (spread) between such interest rates is given by  $\Delta \hat{r}$ , representing the average price change. This relationship leads to an interest rate **semi-elasticity** of loan demand, from which we are able to know how much in percentage points the loan demand would decrease if the interest rate is raised by one percentage point (i.e. from 7% to 8%). Henceforth, this definition of semi-elasticity will be defined as "traditional" semi-elasticity.

The denominator of the specification provided by equation (16) reflects a jump in the average price. Nevertheless, to be able to compare the obtained results with the estimations from Best et al. (2015) and DeFusco and Paciorek (2017), the reduced form semi-elasticity needs to be obtained as well. According to Kleven (2018), the reduced form semi-elasticity is used because the factor driving the individual's response is a jump in the average price (in this case, the interest rate). So, in order to have a jump, not in the average but in the marginal price, the reduced form semi-elasticity transforms the introduced notch into a hypothetical kink, which is achieved by using an implicit marginal interest rate. This implicit marginal rate reflects the (implicit) marginal cost that marginal bunching farmers face when the *Pequeños Productores* borrowing limit (our notch) is introduced (DeFusco and Paciorek, 2017).

This reduced form is outlined in the work of DeFusco and Paciorek (2017). Let:

$$l - \bar{l} \cdot r^*(l) = l \cdot (\hat{r} + \Delta \hat{r}) - \bar{l} \cdot \hat{r}$$
<sup>(17)</sup>

Where  $r^*(l)$  is the implicit marginal interest rate when a farmer contracts a loan over the borrowing limit, considering the discontinuity in interest rates (*Pequeño Productores* program interest rate vis à vis the "traditional" loans interest rate). Isolating  $r^*(l)$  it is possible to obtain:

$$r^*(l) = \hat{r} + \Delta \hat{r} + \Delta \hat{r} \cdot \frac{\bar{l}}{l - \bar{l}} = r(\bar{l} + \Delta \hat{l}) + \Delta \hat{r} \cdot \frac{\bar{l}}{l - \bar{l}}$$
(18)

Expression (18) establishes that the implicit marginal interest rate for loans over 45,000 UDIs depends on the "traditional" loans interest rate  $(\hat{r} + \Delta \hat{r}) = r(\bar{l} + \Delta \hat{l})$  and a term that relates the interest rate spread with the ratio of the borrowing limit and the amount in excess of such limit  $(l - \bar{l})$ . This term increases if the interest rate spread moves upward and diminishes when l rises, therefore  $r^*(l)$  will be bigger when the borrowed amount is just above the borrowing limit.

Finally, by substituting the estimated  $r^*(l)$  instead of r in expression (16), the reduced form proposed by DeFusco and Paciorek can be obtained:

$$\epsilon = \frac{\Delta \hat{\bar{l}}}{r^*(\bar{l} + \Delta \hat{\bar{l}}) - \hat{r}} = \frac{\Delta \hat{\bar{l}}}{\Delta \hat{r}^*}$$
(19)

#### V. Data

Without the correct data features, the bunching approach has a limited change of retrieving a valid measure of the individual's response to a set of incentives. As Kleven (2016) claims, large datasets potentially can disclose the occurrence of bunching when a notch point is introduced. However, not only the use of large datasets is a sufficient condition for the data to provide

reliable bunching estimates, but also that these have little measurement error. Administrative data fulfill these requirements.

The data used in the present analysis is provided directly by the FND's Risk Management Unit and it is composed by 226,491 loans and its characteristics for the January 2014- December 2016 period. More recent data was not included in the dataset because in the beginning of the second quarter of 2017, the FND changed its interest rate policy by raising the *Pequeños Productores* program interest rate and introducing floating interest rates for other FND's services. If considered, the obtained elasticities would be upward-biased because of a smaller spread between the new *Pequeños Productores* Program interest rates and that corresponding to traditional loans. These 268,951 loans represent the entire population of loans between 0 and 700,000<sup>15</sup> UDIs. Including observations larger than 700,000 UDIs does not provide additional value to the analysis, as such loans are far away from the 45,000 UDIs threshold. Therefore, therefore it is plausible that loans of this size may not be considered in the excluded region, at the right side of this cut-off.

Each loan has the following characteristics:

- Loan identification number
- Date of origination
- Loan amount in UDIs
- Corresponding interest rate
- Type of loan: i) enabling, ii) simple, iii) current account, and iv) fixed assets.
- Loan term (in days)
- Type of customer: i) firm, ii) individual
- Gender (if customer is not a firm)
- Region: i) North, ii) North-West, iii) Center-West, iv) South and v) South-East

Nevertheless, in order to perform a smoother analysis, it was necessary to reduce the number of observations, ending up with a sample of 177,950 loans. The procedure for obtaining this sample was as follows:

- 1) Only loans originated from August 20, 2014 onwards were considered, excluding the observations prior this day. This, because the *Pequeños Productores* program began to operate on this day after President Enrique Peña Nieto's announcement.
- 2) Disregard firm observations since, as mentioned above, for the *Pequeños Productores* program the condition for granting a loan to firms is that each stakeholder can ask for a maximum amount of 45,000 UDIs. As the database does not present information regarding the number of stakeholders per firm, it is not possible to derive some parameters that reveal information about the requested amount per stakeholder and conduct the bunching analysis at firm level.

<sup>&</sup>lt;sup>15</sup> Loans over 700,000 UDIs are approved by higher authorization instances (FND's Credit Committee), requiring further documentation for granting the loan.

- 3) Only those loans granted at an interest rate corresponding to the *Pequeños Productores* program (6.5% for women and 7.0% for men) and to the traditional loans granted by the FND (11.0% or 11.5% depending on whether the client was preferential or not) were considered. However, all customers were treated as preferential, since, according to the FND, a significant number of customers requests a second loan).
- 4) Finally, the dataset presents some loan observations under the 45,000 UDIs threshold which were granted at a regular interest rate. Such observations are accessory loans (for more information, refer to page 12) and amount to 24,568 (10.85% of the complete dataset). Observations of this nature were also drawn from the final sample.

# On bunching prior to the *Pequeños Productores* program introduction and anticipatory effects

Despite the fact that the loans originated prior to August 20, 2014 were not considered in the main sample, it is helpful to rely on observations prior to this date in order to observe the potential existence of bunching as well as to discard any anticipatory effects derived from the introduction of the *Pequeños Productores* program.

First, it is important to verify whether bunching is not observed at the 45,000 UDIs cut-off prior to the introduction of the *Pequeños Productores* program; otherwise, the fact that a notch was introduced with such program cannot be considered. To verify this it is convenient to use a histogram of the difference between the (log)loan amount and the (log) *Pequeños Productores* borrowing threshold:

Figure 8: Difference between (log)loan amount and (log) *Pequeños Productores* borrowing threshold (prior to August 20, 2014).



Although several spikes are observed in the graph, the last bin prior to the *Pequeños Productores* borrowing limit (represented by number zero in the X-axis), where bunching should be expected after the start of the program, is not large with respect to other bins, containing only 89 loans from a total of 3,684 loans. It can be argued that bunching can be observed in the second last bin at the left of this threshold. However, although its height is considerable, it only contains 69 more loans than the last bin prior to the 45,000 UDIs limit. As it will be seen in the histograms of the main sample and the proposed subsamples, this difference is negligible. Furthermore, this argument can be attenuated by the fact that the first five bins to the left of the *Pequeños Productores* program cut-off contain only 13% of all the loans granted before August 20, 2014. Additionally, as the bunching approach suggests, histograms should present a missing area (hole) at the right-hand side of the corresponding threshold. As shown in Figure 8, this hole is not present, while the opposite behaviour of a prominent amount of mass is observed at the right of the borrowing limit.

Second, if anticipatory effects were present, FND customers would prefer to postpone investment decisions until the *Pequeños Productores* program began operating and the number of loans granted by the FND would show a high downward jump mainly during the months of June and July, followed by a peak immediately after the program's implementation. Additionally, the behaviour during the first eight months of 2014 would be different to 2015 and 2016. However, the following graphs reveal a different behaviour:



Figure 9: Loans granted by the FND (2014-2016).<sup>1/</sup>

<sup>1/</sup>Loans below 700,000 UDIs.

<sup>1/</sup>Loans below 700,000 UDIs.

The first panel shows the number of loans granted each month from January to December in the period 2014-2016. The second panel shows the seasonally-adjusted series<sup>16</sup>. Regular series show that in the months prior to the program's implementation, the FND granted more loans than in the first quarter of 2014. If anticipatory effects were present, this behaviour would not have been observed, as farmers would prefer to wait until the program is implemented and benefit from its advantages (interest rate, less collaterals and laxer documentation), and the

<sup>&</sup>lt;sup>16</sup> The X-13ARIMA-SEATS seasonal adjustment method was used.

number of loans placed by the institution would be, for instance, similar to those during the months of February or March. Moreover, there would be evidence of a sharp increase in the number of credits granted during the second half of August and during September due to the program's implementation. However, these numbers are similar to the number of loans granted in July. Seasonally-adjusted series confirm this as there is a steady behaviour of the number of loans granted during the period from April to September 2014. Furthermore, customers began to react to the program until October 2014. The number of loans granted started to increase for the following reasons: i) the beginning of the Autumn-Winter agricultural cycle that starts on October 1 and ends in January 31, when farmers need external funding to fulfill their sowing plans, and ii) that every year the FND increases the number of loans granted during the last quarter of the year in order to meet its annual loan-placement objective.

After comparing across years, despite the general increase of loans granted in 2015-2016, it is is possible to observe a similar behaviour of the series on both panels, especially between 2014 and 2015, which further discards the occurrence of anticipatory effects.

Although the 2014 Financial Reform was enacted in January 2014, the Mexican government did not reveal neither through the Ministry of Finance and Public Credit nor through the FND its plan for implementing this reform in the Mexican agricultural sector, making it difficult for farmers to anticipate the government's decision and to adjust their demand for funding, as observed in the graph above. If farmers would have anticipated the introduction of the program, a higher number of loans would have been contracted during the first months of the program's implementation and, hence, the amount of bunching would have increased, leading to higher interest rate elasticities.

Although not in the scope of this thesis but as a topic of interest for further research, the figure above shows that the program attracted several farmers, accomplishing its purpose of increasing financial inclusion, as credit placement exhibited significant growth in 2015 and 2016. As it will be discussed later, this explains the magnitude of the obtained semi-elasticities.

## Categorizing the final sample

To enrich the analysis and better exploit the information included in the database, several subsamples were considered by dividing the main sample into different categories. The categorization was done as follows:

- By gender: one subsample that included male customers and one including only female customers.
- By zone: due to the low development and margination of some of the country's areas, the FND has categorized the South and South-East regions of Mexico as "priority" zones. All credits in these regions where therefore regrouped into one subsample (priority subsample) while the loans granted in the rest of the country where regrouped in the "non-priority" subsample. Other than being informative, this will allow us to know if people in less prosperous regions have higher behavioral responses to an increase in the interest rate as demonstrated by Deheija, Montgomery and Morduch (2012). The

estimations for these subsamples can be relevant in terms of policy implications, for instance, in how financial institutions should set interest rates in different regions taking into account the response from inhabitants to an increase in this variable, in order to place more funds and maximize profits (in the case of commercial banking) or maximize welfare (in the case of development banking), and the implementation of sound credit programs by the federal government.

- By type of loan: although enabling and fixed assets are the FND's most popular types of loans, one subsample was constructed for each one of them since no change is observed in the collateral scheme for these loans with the introduction of the *Pequeños Productores* program. This strategy will lead to obtain pure interest rate elasticities. Then, another subsample named "non-fixed assets"<sup>17</sup> was built by including in the enabling loan subsamples all observations from simple and current account loans, with the aim of glimpsing at the effect of collaterals in the elasticity estimates. This will be done by considering the enabling loans elasticity as a reference. In other words, if the "non-fixed assets" elasticity is larger than that of the enabling loans, the resulting difference can be considered as the real collateral's contribution to the obtained elasticities. Nevertheless, it can also be the result of other factors such as the contribution of those fixed-asset loans categorized as simple loans. These results will be explained in detail in section VI.
- By loan term: the FND categorizes loan terms as follows: i) short term: loans with a term of between 0 and 1 year, ii) medium term: loans with a term of between 1 and 3 years, and iii) long term: any loan with a term larger than 3 years<sup>18</sup>. The subsamples were obtained following these definitions.
- By year of origination of the loan: the samples were divided by the years on which every loan was granted (or was "originated", as known in the credit lending jargon). The obtained subsamples contain those credits granted during 2014 (from August 20 to December 31), 2015 and 2016. This subsampling was implemented to know if learning effects from the *Pequeños Productores* program users are present.

These categories can already be observed in the figures of the credit risk indicators subsection.

With these subsamples and following the procedure of DeFusco and Paciorek (2017), histograms, bunching estimates and interest rate semi-elasticities were obtained. The results will be shown in the sections below.

#### Summary statistics

Figures 10 and 11 show the basic statistics for the loan amount and the loan term of the final (sub)samples, respectively, and their lecture is straightforward: column (1) shows the number of observations per sample and subsample; column (2) presents the share of loans by category;

<sup>&</sup>lt;sup>17</sup> This name was chosen to differentiate the fixed assets subsample versus the subsample composed by all observations from other types of loans. However, it is not a subsample that contains strictly only non-fixed asset loans because, as stated above, there are simple loans destined to fund also investments in fixed assets.

<sup>&</sup>lt;sup>18</sup> According to the Manual of Credit Policies and Norms, fixed-asset loans are qualified as medium- and long-term loans.

columns (3) and (4) show the mean and standard deviation parameters; and, finally, columns (5) to (9) include minima, maxima and different other measures of position for the defined categories of both variables.

|                                | Summary statistics of amount granted (UDIs) |                   |                 |          |           |         |          |          |  |           |
|--------------------------------|---|-------------------|-----------------|----------|-----------|---------|----------|----------|--|-----------|
|                                |   | Observations      | Share (of the   | Mean     | Standard  | Minimum | 1st      | Median   | 3rd  | Maximum   |
|                                |   |                   | sample)         |          | deviation |         | quartile |          | quartile   |           |
|                                |   | (1)               | (2)             | (3)      | (4)       | (5)     | (6)      | (7)      | (8)  | (9)       |
| Selected                       | l sample                                    | 177,950           | 100%            | 44,590.6 | 52,971.1  | 287.5   | 20,709.0 | 36,726.5 | 43,514.3   | 697,860.6 |
| Condon                         | Male  | 141,341           | 79%             | 45,249.9 | 54,150.3  | 920.9   | 20,278.2 | 36,776.0 | 43,555.5   | 697,860.6 |
| Ochder                         | Female                                      | 36,609            | 21%             | 42,045.1 | 48,063.9  | 287.5   | 22,278.5 | 36,708.4 | 43,339.0   | 694,304.6 |
| Zono                           | Priority                                    | 79,941            | 45%             | 40,791.6 | 44,703.9  | 1,365.2 | 21,463.5 | 36,952.3 | 43,108.7   | 695,994.8 |
| Zone                           | Non-priority                                | 98,009            | 55%             | 47,689.2 | 58,678.9  | 287.5   | 19,640.0 | 36,493.2 | (8) $5 43,514.3 (6)$ $43,555.5 (6)$ $4 43,339.0 (6)$ $3 43,108.7 (6)$ $2 43,835.2 (6)$ $3 43,607.1 (6)$ $42,866.3 (6)$ $7 43,398.7 (6)$ $5 43,283.0 (6)$ $1 43,543.4 (6)$ $0 43,672.8 (6)$ | 697,860.5 |
|                                | Fixed assets                                | 50,111            | 28%             | 42,811.7 | 37,661.9  | 3,375.7 | 32,534.5 | 41,508.8 | 43,607.1   | 694,304.6 |
| Type of loan                   | Enabling                                    | 115,735           | 65%             | 40,709.7 | 51,737.4  | 999.4   | 16,401.9 | 31,698.6 | 42,866.3   | 695,994.8 |
|                                | Non-fixed assets <sup>2/</sup>              | 127,839           | 72%             | 45,287.9 | 57,862.8  | 287.5   | 17,232.7 | 33,561.7 | 43,398.7   | 697,860.5 |
|                                | Short term<br>(0-1 years)                   | 107,242           | 60%             | 44,447.2 | 58,466.4  | 287.5   | 15,258.9 | 30,687.5 | 43,283.0   | 697,860.5 |
| Term                           | Medium term<br>(1-3 years)                  | 23,119            | 13%             | 47,270.6 | 50,498.2  | 3,895.1 | 28,689.2 | 42,021.1 | 43,543.4   | 695,994.8 |
|                                | Long term<br>(>3 years)                     | 47,589            | 27%             | 43,611.9 | 39,316.9  | 3,375.7 | 33,076.3 | 41,609.0 | 43,672.8   | 680,554.9 |
| XX C                           | 20141/                                      | 21,213            | 12%             | 47,597.8 | 58,170.8  | 287.5   | 17,837.3 | 38,535.4 | 43,898.9   | 674,481.9 |
| Year of                        | 2015  | 78,197            | 44%             | 42,309.3 | 51,198.5  | 999.4   | 18,941.1 | 34,708.7 | 43,225.5   | 695,994.8 |
| origination                    | 2016  | 78,540            | 44%             | 46,049.7 | 53,141.4  | 920.9   | 23,922.4 | 38,781.2 | 43,958.6   | 697,860.6 |
| <sup>1</sup> /Includes loans g | granted from Aug                            | ust 20, 2014 to I | December 31, 20 | 14.      |           |         |          |          |  |           |

Figure 10: Summary statistics of amount granted (UDIs).

<sup>2</sup>/12,104 loans are either simple or current account loans.

In terms of concentration, the "zone" and the "year of origination" (in the case of the years 2015 and 2016) categories present a relatively equal share of the subsample while the rest show a very high bias towards one of the groups of each category. For the mean, the main sample is just 409.4 UDIs below the 45,000 UDIs threshold. It is noteworthy that the subsamples also present means very close to the cut-off, being this an indication of the potential bunching in each of the samples. As observed in column (4), the distribution of loans is highly spread. Finally, considering the selected sample and despite that there is a prominent difference between the smallest and the largest loan, the interquartile range<sup>19</sup> equalling 22,805.3 UDIs is noteworthy. As for the subsamples, their interquartile ranges exhibit a similar trend. As it will be shown later with histograms, this can be explained by the implementation of the *Pequeños Productores* program.

<sup>&</sup>lt;sup>19</sup> The interquartile range is a measure of the difference between the observation in the 3<sup>rd</sup> quartile (or 75<sup>th</sup> percentile) and the observation in the 1<sup>st</sup> quartile (25<sup>th</sup> percentile).

| Summary statistics of loan term (days)  |                                |              |               |         |           |         |          |        |          |         |
|---|--------------------------------|--------------|---------------|---------|-----------|---------|----------|--------|----------|---------|
|   |                                | Observations | Share (of the | Mean    | Standard  | Minimum | 1st      | Median | 3rd      | Maximum |
|   |                                |              | sample)       |         | deviation |         | quartile |        | quartile |         |
|   |                                | (1)          | (2)           | (3)     | (4)       | (5)     | (6)      | (7)    | (8)      | (9)     |
| Selected  | l sample                       | 177,950      | 100%          | 682.7   | 670.4     | 20      | 221      | 310    | 1,561    | 3,696   |
| Condor  | Male                           | 141,341      | 79%           | 680.9   | 669.2     | 20      | 220      | 310    | 1,550    | 3,696   |
|   | Female                         | 36,609       | 21%           | 689.5   | 675.0     | 49      | 224      | 309    | 1,600    | 3,654   |
| Zone  | Priority                       | 79,941       | 45%           | 786.2   | 700.0     | 20      | 242      | 397    | 1,817    | 3,522   |
| Zone  | Non-priority                   | 98,009       | 55%           | 598.3   | 632.9     | 43      | 206      | 277    | 471      | 3,696   |
|   | Fixed assets                   | 50,111       | 28%           | 1,711.4 | 282.6     | 38      | 1,739    | 1,818  | 1,827    | 3,696   |
| Type of loan  | Enabling                       | 115,735      | 65%           | 281.9   | 94.0      | 42      | 214      | 266    | 345      | 1,067   |
|   | Non-fixed assets <sup>2/</sup> | 127,839      | 72%           | 279.4   | 129.7     | 20      | 200      | 256    | 338      | 3,550   |
|   | Short term<br>(0-1 years)      | 107,242      | 60%           | 242.7   | 63.7      | 20      | 190      | 235    | 287      | 365     |
| Term  | Medium term<br>(1-3 years)     | 23,119       | 13%           | 481.6   | 153.5     | 366     | 390      | 456    | 469      | 1,095   |
|   | Long term<br>(>3 years)        | 47,589       | 27%           | 1,771.9 | 133.5     | 1,096   | 1,770    | 1,820  | 1,827    | 3,696   |
| N/ C  | 20141/                         | 21,213       | 12%           | 576.3   | 604.7     | 20      | 211      | 274    | 466      | 3,550   |
| Year of   | 2015                           | 78,197       | 44%           | 621.3   | 635.7     | 42      | 214      | 287    | 641      | 3,649   |
|   | 2016                           | 78,540       | 44%           | 772.5   | 708.8     | 28      | 239      | 345    | 1,786    | 3,696   |
| <sup>1</sup> /Includes loans granted from August 20, 2014 to December 31, 2014. |                                |              |               |         |           |         |          |        |          |         |

Figure 11: Summary statistics of loan term (in days).

<sup>2/</sup>12,104 loans are either simple or current account loans.

The main sample statistics show that, on average, a FND loan has a "life" of 682.7 days (around 1.9 years). The loan term ranged from 20 days to 10.12 years. It is interesting that even though the institution's operation rules allow for lending money to projects with terms of up to 15 years, no credits of maturity longer than 10.12 years were observed during the period. Also, the range between the median and the third quartile is very large (125 days). This is due to the very small number of days within such interval (for more detail, see histogram in the appendix).

For the gender category the statistics are very similar between men and women. For instance, there is a negligible difference of 8.6 days in the mean and 5.8 days in the standard deviation. After combining these statistics with those obtained for the loan amount it is possible to make inferences about the average preferences of both genders. As stated above, the mean of the loan term is almost equal for women than for men, while there is an important difference in the average loan amount (3,204.8 UDIs larger for men). This means that women have a more conservative investment profile (less exposure in terms of contracted loan amount in the same investment horizon), supporting the fact that women are more risk averse than men in terms of investment (Armendáriz de Aghion and Morduch, 2005). This can also be supported by the standard deviation difference of the loan amount (54,150 UDIs in the case of men as compared to 48,063.9 UDIs for women).

Now, in the zone category the mean of the loan term of the priority areas is larger than two years (2.15 years) and remarkably higher than the mean loan term of non-priority zones (31.4% higher), showing also a bigger standard deviation. An explanation of the difference between the loan term and the size of the credit in both zones (both indicators higher in priority zones) is that as South and South-East regions lag versus the rest of the country, they need to undertake larger investments in order to converge to human development of non-priority areas, and they are doing so<sup>20</sup>.

As for the type of loan category, it is important to notice that fixed-asset loans have on average a longer life (4.69 years) than enabling and non-fixed asset loans (0.77 years both), making the customer more prone to default as uncertainty increases with the credit horizon, entailing higher risks for the FND as well.

In the case of the loan term categories, the standard deviation for loans with a life larger than three years is smaller than that of medium term loans.

Finally, for the "year of origination" category, judging by the mean and other statistics like the maximum, it can be inferred that FND customers were more willing to engage in longer loan transactions as they had more knowledge about the benefits of the *Pequeños Productores* program.

<sup>&</sup>lt;sup>20</sup> The following two-sided mean tests were performed to verify the statistical difference in the means of the relevant variables: i) men's loan amount versus women's loan amount; ii) men's loan term versus women's loan term; iii) priority zones' loan amount versus non-priority zone's loan amount; iv) priority zones' loan term versus non-priority zones' loan term. The null hypothesis ( $\mu_1 = \mu_2$ ) was the only hypothesis not rejected for the gender loan amount test. Tests were performed with a confidence level of 99%.

# VI. Empirical results

The results of the application of the bunching approach will be shown in this section as follows: first, the histogram for the selected sample will be displayed as it is an important element for revealing bunching evidence; the results from applying the bunching approach for the main sample and the thirteen subsamples will then be presented, including the interest rate elasticities to loan demand; and, finally, a sensitivity analysis testing the robustness of these estimations will be performed, along with its results.

## Sampling distribution

Figure 12 presents the histogram of the normalized loan amount for the main sample. This graph is helpful to suggest the existence of bunching caused by the notch introduction (Kleven, 2016). It also gives an indication of the causal effect of the *Pequeños Productores* program on FND customers.





The histogram shows the normalized (log)loan amount for each bin-level observation and the normalized (log)borrowing limit. These differences are grouped in 80 bins with a range of 0.0974. Following DeFusco and Paciorek (2017), there are some free parameters that the researcher must choose in order to estimate equation (14). One is the number of bins and then its width. The number of bins was thus decided by visual examination, trying with several number of bins within the interval [60, 100]. Eighty bins were noticed to make bunching more evident, making
the process of defining an excluded range at and to the left of the threshold more straightforward. Subsequently, the bin width was defined using the formula<sup>21</sup>:

$$\frac{Min_{normalized \ loan \ amount} + Max_{normalized \ loan \ amount}}{Number \ of \ bins} = \frac{(-5.032 + 2.741)}{80} = 0.0974 \quad (20)$$

As it can be observed in the histogram, the normalized loan amount distribution presents a smooth behaviour from the -1.997 normalized UDIs until the fourth bin from the left side of the 45,000 UDIs threshold denoted by 0 in the histogram's X-axis; then, a sharp jump is evident in the last three bins before the borrowing limit (especially in the last one). Of relevance is the missing mass at the right side of the cut-off as a consequence of the notch introduced by the *Pequeños Productores* program, revealing that several farmers were willing to ask for loans larger than 45,000 UDIs in the pre-notch scenario. Nevertheless, such behaviour is expected given the large spread between the *Pequeños Productores* program's interest rate and the traditional loans granted by the FND.

In terms of concentration, the last three bins where bunching is observed contain 72,196 loans (46,892 only in the first bin at the left of the threshold), representing around 40.5% of the entire sample, whereas the first three bins at the right side of the cut-off amount contain only 6,558 loans (approximately 3.7%).

This behaviour is common across the different subsamples, presenting in all cases sharp peaks in the first two or three bins to the left side of the 45,000 UDIs threshold. For more detail on the corresponding histograms of each of the subsamples, refer to the appendix.

# Obtaining behavioral responses and semi-elasticities

By confirming the existence of excess bunching not only in the main sample, but also in the thirteen proposed subsamples, the next step is to obtain the behavioral responses of FND customers to the notch introduction and therefore the desired interest rate semi-elasticities.

Still following DeFusco and Paciorek (2017), there are some other parameters besides the number of bins and the bin width that are discretionary to the researcher to make the estimation of the counterfactual distribution and then retrieve the behavioral responses of FND customers after the *Pequeños Productores* program was implemented. These parameters are, first, the excluded region where excess bunching and the missing mass hole is observed, and, second, the order of the polynomial, both included in equation (10). These parameters should ensure that the difference between  $\hat{B}$  and  $\hat{M}$  is (almost) equal to zero.

The parameters used to obtain the FND's behavioral responses and the interest rate semielasticities are as follows: i) 80 bins; ii) a bin width of 0.0974; iii) an excluded region at and to the left-hand side of the borrowing limit of two bins in the case of medium-term loans, four for those loans granted in 2014 (August 20 to December 31) and three for the rest of the datasets;

<sup>&</sup>lt;sup>21</sup> This is the standard formula for obtaining the bin width of a histogram. For further reference, consult basic statistics works like that of Anderson et al. (2008).

and iv) a polynomial order that varies between 5 and 12. For the main sample and each subsample, the order depends on which counterfactual distribution minimizes the difference  $\hat{B} - \hat{M}$ . Like the polynomial order, the number of excluded bins at the right-hand side is defined when  $\hat{B} - \hat{M}$  is (almost) zero. This number ranges from 11 to 19.

Finally, as several densities of the excluded region to the left side of the 45,000 UDIs threshold and different polynomial orders are tested to ensure that the excess bunching is (approximately) equal to the missing mass, the results below will be defined as the *preferred specifications* of the analysis.

Thus, Figure 13 shows the empirical loan size distribution along with the counterfactual one constructed with an 8<sup>th</sup> degree polynomial.



Figure 13: Empirical and counterfactual distributions for the main sample.

The graph above shows in the X-axis the normalized loan amount while the Y-axis measures the number of loans for the empirical distribution (defined as the blue line) and the counterfactual one (given by the red line). As expected, the empirical distribution reflects the behaviour of the histogram above, presenting a notably high peak (excess bunching) in the left vicinity of the *Pequeños Productores* borrowing limit and the missing mass created by those customers who preferred not to get engaged in credit liabilities over 45,000 UDIs because of the cheaper interest rate. Note that at the right side of the cut-off the combination of both distributions creates an area similar in density to the excess bunching. This area is the hole originated by the notch introduction ( $\hat{M}$ ).

Continuing with the analysis, among other indicators, the following table shows the bunching estimates, the behavioral response of FND customers to the introduction of the referred social program and the semi-elasticities for the selected sample and its subsamples.

|                     |                               | Excluded | Polynomial | Bunching | Behavioral | Excess | Mass   | Mass   | Mass       | Traditional | Reduced form    |
|---------------------|-------------------------------|----------|------------|----------|------------|--------|--------|--------|------------|-------------|-----------------|
|                     |                               | bins     | order      | estimate | response   | mass   | LHS of | RHS of | difference | semi-       | semi-elasticity |
|                     |                               |          |            |          |            |        | notch  | notch  |            | elasticity  |                 |
|                     |                               | (1)      | (2)        | (3)      | (4)        | (5)    | (6)    | (7)    | (8)        | (9)         | (10)            |
| Selected sample     |                               | [-2, 15] | 8          | 51,258   | 71.56%     | 2.45   | 40.57% | 40.50% | 0.07%      | -17.44      | -13.58          |
| Gender              | Male                          | [-2, 14] | 8          | 39,272   | 71.06%     | 2.43   | 39.21% | 39.17% | 0.04%      | -17.77      | -13.78          |
| Gender              | Female                        | [-2, 16] | 6          | 12,514   | 85.94%     | 2.94   | 45.81% | 46.20% | -0.39%     | -19.10      | -16.74          |
|                     | Priority                      | [-2, 19] | 6          | 28,867   | 92.21%     | 3.15   | 47.56% | 47.59% | -0.04%     | -22.47      | -20.85          |
| Zone                | Non-<br>priority              | [-2, 13] | 12         | 20,946   | 46.27%     | 1.58   | 34.87% | 34.19% | 0.68%      | -11.28      | -7.34           |
|                     | Fixed assets                  | [-2, 17] | 8          | 22,781   | 69.72%     | 2.39   | 64.52% | 64.55% | -0.03%     | -16.99      | -13.04          |
| Type of<br>loan     | Enabling                      | [-2, 16] | 6          | 25,447   | 55.15%     | 1.89   | 33.64% | 33.59% | 0.05%      | -13.44      | -9.28           |
|                     | Non-fixed<br>assets           | [-2, 13] | 9          | 26,344   | 56.96%     | 1.95   | 31.18% | 31.24% | -0.06%     | -13.88      | -9.70           |
|                     | Short term (0-1 years)        | [-2, 11] | 10         | 16,815   | 43.53%     | 1.49   | 26.21% | 26.52% | -0.31%     | -10.61      | -6.78           |
| Term                | Medium<br>term<br>(1-3 years) | [-1,18]  | 5          | 9,765    | 101.73%    | 5.22   | 54.69% | 54.54% | 0.15%      | -24.80      | -25.23          |
|                     | Long term<br>(>3 years)       | [-2, 19] | 6          | 23,743   | 96.66%     | 3.31   | 64.98% | 65.07% | -0.09%     | -23.56      | -22.80          |
|                     | 2014                          | [-3, 12] | 10         | 4,676    | 44.48%     | 1.52   | 36.53% | 36.38% | 0.15%      | -10.84      | -6.97           |
| Year of origination | 2015                          | [-2, 16] | 6          | 20,213   | 65.72%     | 2.25   | 37.35% | 37.36% | -0.01%     | -16.02      | -11.93          |
|                     | 2016                          | [-2, 17] | 6          | 27,458   | 93.82%     | 3.21   | 45.85% | 46.03% | -0.17%     | -22.87      | -21.54          |

Figure 14: Bunching approach estimates.

The table can be read as follows: column (1) shows how many bins were excluded for estimating the counterfactual loan distribution, being the first number in brackets the order of the excluded bins at and to the left side of the borrowing limit (including bin 0). For example, if the first number is equal to -2, then bin 0, -1 and -2 are excluded (3 bins). Meanwhile, the second number in brackets is the number of the excluded bins to the right side of the 45,000 UDIs threshold. Column (2) shows the degree of the polynomial used for obtaining the pre-notch (counterfactual) loan distribution. Then, column (3) shows the bunching estimate which is the number of loans in the three excluded bins at the left side of the cut-off for the empirical distribution minus the number of loans in the three excluded bins at the left side of the cut-off for the counterfactual one. Column (4) shows the behavioral response obtained by applying the formula given by expression (12). This figure shows how much on average (as a percentage, since the loan amounts were log transformed) the marginal buncher reduces its loan demand due to the notch introduction. Then, column (5) reflects the number of times more loans are observed as compared to a scenario without the notch's presence. Column (6) exhibits the percentage of the total mass of the loan size distribution in the three excluded bins at and to the left-hand side of the cut-off, while column (7) shows the accrued mass on those excluded bins at the right-hand side of the cut-off (also as a percentage of the total mass of the loan size distribution). Column (8) indicates the difference between columns (6) and (7). To retrieve a valid bunching estimate and therefore credible behavioral responses, this difference should be (approximately) equal to zero. Column (9) displays the semi-elasticity, which considers the regular interest rate spread ( $\Delta \hat{r}$ ), as shown by expression (16). Finally, the last column shows the reduced form semi-elasticity obtained by applying formula (19). Both semi-elasticity estimates should be interpreted as follows: an increase of one percentage point in the interest rate (i.e. from 7% to 8%) will lead to a decrease of X% in the loan demand. As mentioned earlier, the reduced form semi-elasticities are included in order to compare the results with those obtained by Best et al. (2015) and DeFusco and Paciorek (2017).

Before explaining the obtained results, it is important to highlight two important matters: first, to obtain the semi-elasticity of the main sample, the zone, type of credit and long-term subsamples, a "gender" weighted average interest rate was needed as these datasets contain loans granted to both men and women. The obtained rate is equal to 6.8971%. The spread  $\Delta \hat{r}$  in equations (16) to (18) is then obtained with the difference between the traditional loans interest rate (11%) and this figure (taking into account the implicit marginal interest rate as discussed in section IV). In the case of gender subsamples, the spread is calculated considering the established rates for men (7%) and women (6.5%) customers. Second, the obtained semi-elasticities represent an upper bound for this estimate since they do not only include the effect of interest rates on loan demand, but also the lower level of collateral required for the simple and current account loans granted under the *Pequeños Productores* program, as well as the laxer documentation requirements for this program.

Summarizing the table above, the polynomial orders that were used more often to construct the counterfactual distributions were 6 and 8, as 9 out of 14 "pre-notch" distributions were derived from these polynomial degrees. Bunching estimates are noticeable, reflecting the fact that

farmers responded favorably to the implementation of the program as observed in Figures 9 and 12. This led to behavioral responses ranging between 43.53% and 101.73%, and an excess mass of between 1.49 and 5.22 times more loans than in a counterfactual scenario (without the notch). Finally, the combination of the behavioral response in column (3) and the spreads in interest rates (as discussed in section IV) led to semi-elasticities of between -10.61 and -24.80 for the traditional definition of semi-elasticity as in equation (16), and of between -6.78 and -25.33 in the case of the reduced form.

The results from the main sample will be thoroughly examined below, and only the semielasticity results for the different subsamples (as the other estimations are interpreted in the same way) will be discussed. Such discussion will be done in the following order: loan term subsamples, type of loan, zone category, and gender category.

#### Bunching approach results for the main sample

In order to obtain the different estimations of the bunching approach, 3 bins at and to the left side of the cut-off were excluded. These three bins contained approximately 40.57% of all the loans in the empirical distribution, as observed in column (6). Meanwhile, 15 bins were excluded to the right of this threshold. This excluded region plus a counterfactual loan distribution that was constructed with an 8th degree polynomial generated a bunching estimate of 51,258 loans, meaning that there are 51,258 loans in excess below the 45,000 UDIs borrowing limit. Together with the estimated counterfactual number of loans in the 15 excluded bins at the right-hand side of the Pequeños Productores program threshold, this bunching estimate generated an average behavioral response from the marginal bunchers of 71.56%. This means that, on average, bunching farmers reduced their loan demand by 71.56% to obtain the benefits of the program. Considering this figure, it can be inferred that the FND faces a high opportunity cost as a result of the introduction of the program, as farmers would be willing to ask for higher loans, although, as shown later, the institution's income has increased after the program's implementation. Also regarding the pre-notch scenario, figure in column (5) shows that there are 2.45 times more credits in the left vicinity of the borrowing limit as compared with a scenario where the *Pequeños* Productores program was not implemented. Moving forward to column (7), the captured mass at the right-hand side of the cut-off is equal to 40.50% of the entire counterfactual loan size distribution, rendering a difference between excess bunching and missing mass in the empirical distribution of only 0.07% (see column (8)), thus ensuring that the bunching estimate is well specified. Finally, column (9) an (10) display the interest rate semi-elasticity under the traditional and the reduced-form definitions, respectively, as discussed in section IV. From this estimations, a 17.44% decrease in the demand of loans can be observed when the interest rate increases by one percentage point, in the case of traditional semi-elasticity, and 13.58% for the reduced-form elasticity. Two reasons that support the magnitude of the elasticities of the used sample will be provided. Thereafter, the semi-elasticity results of the different loan categories will be discussed.

First, the spread between the interest rate of the *Pequeños Productores* loans and traditional loans is considerably high, being in its minimum 4% (400 basis points), and being able to increase up to 5% (500 basis points,) when non-preferential customers (11.5% interest rate) and female

customers are considered (6.5% interest rate). As it will be shown later, this kind of spreads are not observed frequently in other works. This significant decrease in the interest rate was very attractive to the customers of the development bank, leading to very pronounced bunching as observed in the histograms. This result is confirmed also by the gradual increase in the yearly elasticities, as shown by the last figure's (year of origination) subsample.

A second explanation relies on basic microeconomic theory, which establishes that the existence of more (and better) substitutes of a certain good leads to more elastic demands. Here, an alternative loan provider for farmers is present. This additional source of funding is another agricultural development bank known as Fideicomisos Instituidos en Relación con la Agricultura (FIRA, for its acronym in Spanish). This institution also provides credit to farmers, but with the difference that its loans are granted through a second floor banking scheme, meaning that its resources are allocated through commercial banking in the following way: FIRA grants its resources to commercial banks at an interest rate of X%, and then the commercial bank lends the money to the final customer (farmer) at an interest rate of Z% = X% + Y%. Therefore, FIRA's interest income comes from the X% interest rate, meanwhile the commercial banks remain with the rate surcharge, which is given by Y%. On May 2014, FIRA modified its interest rate policy and, as a result, during the analyzed period, the interest rate that the final customer had to pay (Z%) was lower than that of FND's traditional loans, but higher than that of the Pequeños Productores program in most of the cases (i.e. rates within the interval (7%, 11%)). Hence, the introduction of the *Pequeños Productores* program plausibly detonated two situations that drove up elasticities. First, farmers preferred to use the Pequeños Productores program instead of the FND's traditional loans and FIRA's funding (substitute credit provider), leading to high elasticities. Last, farmers that had larger funding needs and probably were willing to pay for a traditional FND loan decided to cover one part of these requirements with the Pequeños Productores program (just below the 45,000 UDIs borrowing limit) and the other with FIRA's resources. This strategy could be also cheaper than to be fully funded by FIRA, leading to high behavioral responses as those shown in the histograms and bunching graphs.

### Type of loan semi-elasticities

Loans for acquiring fixed assets present a traditional semi-elasticity of -16.99, whereas non-fixed assets, of -13.88, being -13.04 and -9.70, respectively, for the reduced-form estimations. Finally, for the enabling type of loans, the reduced-form estimation is -9.28 and -13.34 for the traditional semi-elasticity. These results can be explained through two viewpoints. First, as stated on page 12, enabling loans are used to acquire commodities, materials and to cover operating expenses as well as capital needs; i.e. they are used for concepts that are fundamental to keep the business operating and, therefore, farmers cannot afford to stop covering such expenses (i.e. they are more inelastic), which are mostly covered in the short run. On the other hand, fixed-asset loans are elastic nature than those contemplated in enabling and non-fixed asset loans subsamples, such as acquiring a more modern irrigation system or more efficient harvesting machines or tractors. Although this kind of investments can be beneficial to the farmer's business, most of them are

not strictly necessary to keep business working as commodities or operating expenses. The second explanation has its basis on the close link between the type of credit and the loan term. As we observed in Figure 11, fixed assets have an average "life" of 1,711.4 days, while non-fixed asset and enabling loans only 279.4 days and 281.9 days, respectively. Therefore, as the investment horizon increases, customers are more prone to default when they borrow larger amounts at higher interest rates, like in the case of FND traditional loans. The same logic naturally follows: in order to mitigate to some extent the likelihood of default, customers prefer to reduce their loan amount (i.e. make use of the *Pequeños Productores* funding), which leads to more bunching around the borrowing limit and, therefore, to larger semi-elasticities in absolute terms. This reasoning is supported by the credit risk indicators of fixed-asset loans which present more deterioration than other types of loans, as shown in Figure 3.

Finally, despite the implementation of the *Pequeños Productores* program, the FND did not change the collateral requirements for fixed assets and enabling loans, being this always a "natural" guarantee during the analyzed period. Therefore, recalling that the laxer documentation applies only to simple and current account loans (included in the non-fixed assets subsample), the retrieved elasticity for fixed assets and enabling loans is a pure interest rate semi-elasticity. Now, the difference in absolute terms of the traditional elasticity of the non-fixed assets subsample in relation to the traditional enabling loans elasticity is 0.44 (0.42 for the reduced-form estimations). Nonetheless, given the relatively high elasticity of the fixed-asset loans subsample, this small difference is attributed to those fixed-asset loans classified as simple loans and not to the effect of the change in the collateral's scheme for simple and current account loans. This argument is supported by the following histogram, where simple and current account loans are not very demanded under the *Pequeños Productores* program during the analyzed period, since most of the mass is concentrated in the right-hand side of the 45,00 UDIs borrowing limit. It can therefore be argued that the effect of collaterals and laxer documentation in the retrieved elasticities is not so relevant.

Figure 15: Difference between (log)loan amount and (log) *Pequeños Productores* borrowing threshold (simple and current account loans).



Loan term semi-elasticities

The loan term category shows that when the interest rate is raised by 1%, the loan demand decreases 10.61% for short-term loans, 24.80% for medium-term loans and 23.56% long-term loans (6.78%, 25.23% and 22.80% for the reduced form semi-elasticity). The explanation of these findings relies on the positive relationship between time and risk.

Although the FND's Manual of Credit Policies and Norms states that fixed-asset loans are of medium- and long term, this is not necessarily true because there are some fixed-asset loans with loan terms of less than one year. However, we can rely on this as these short term fixed-asset loans represents only 0.67% of the fixed assets subsample. Additionally, only 17.38% of the enabling loans have a loan term of more than one year. Due to this, the explanations outlined in the type of loan category apply to the loan term category, as the referred link between type of credit and term is once more present.

Short-term loans are used to cover more inelastic concepts. Conversely, medium and long term loans are destined for more elastic ones (i.e. fixed assets). Also, credit risk indicators in Figure 4 show a greater deterioration in the case of medium- and long-term loans, confirming once more that riskier loans lead to higher elasticities. Nevertheless, based on the latter risk argument, it is counterintuitive that medium-term loan elasticity is higher than long-term loan elasticity. This is explained by an atypical behaviour in the medium-term loan distribution with respect to short and long-term ones (and hence, in the rest of the subsamples), presenting this type of loans a big hole at the right side of the 45,000 UDIs. In this sense, it is important to state that medium-

term loans drive up the semi-elasticities of the main sample, as well as the other categories subsamples, since all of them contain medium-term loans. If FND customers requiring medium-term funding had reacted more moderately when the *Pequeños Productores* program was implemented, the interest rate semi-elasticities would have been lower.

## Zone semi-elasticities

The traditional semi-elasticity of loans granted in the most disadvantaged regions (priority zones) shows that an increase of 1% in the interest rate drives the loan demand down 22.47% and 20.85% in its reduced form. On the other hand, when the interest rate increases the demand for loans in non-priority zones diminishes less as compared to priority zones, showing the credits originated in these regions a traditional semi-elasticity of -11.28 (-7.34 in the case of the reduced form semi-elasticity).

The results of these subsamples are challenging to explain since microeconomic theory is opposed to the results of empirical literature. Hence, the results can be counterintuitive, but coherent at the same time.

First, microeconomic theory predicts that when a larger proportion of income is spent in a certain good, its demand is more elastic. In a setting with two goods (i.e food and productive investment), with heterogeneity in the farmer's income, poor farmers who devote a larger part of their income to food consumption will show a more elastic food demand and a less elastic productive investment demand. On the other hand, non-poor households/individuals will show the opposite behavior. In the specific case of Mexico, the results of the 2016 National Survey of Household's Income and Spending (ENIGH, for its acronym in Spanish) buttresses microeconomic theory. The first three deciles of the income distribution devote 72.1% of their income to food, beverages and tobacco consumption, while the last three deciles only 17.2%, thus reflecting the fact that groups with higher income levels are more capable of spending their earnings in other goods when the price of a specific good increases. This survey also reports that the three states with the lowest income population are located in priority zones. These states are Chiapas, Guerrero, and Oaxaca, having and average quarterly income of 31,555 MXN, 31,593 MXN and 35,333 MXN, respectively, in contrast to a national average of 45,521 MXN<sup>22</sup> (INEGI, 2016).

In spite of this, the empirical literature has demonstrated that lower income groups present higher behavioral responses than higher-income ones. For example, in an attempt to find evidence of Giffen behaviour when the prices of food were exogenously changed in two provinces of China (Hunan and Gansu), Jensen and Miller (2008) found that the poorest households, such as those whose caloric intake comes essentially from one staple food, present higher demand elasticities than those whose diet is composed of more than one product (less poor households).<sup>23</sup> Son and Kakwani (2009) measured the effect of inflation on several poverty

<sup>&</sup>lt;sup>22</sup> To obtain the equivalent in euros consider an average exchange rate EUR/MXN of 20.6767 for the year 2016.

<sup>&</sup>lt;sup>23</sup> In this research, the authors find that "poor-but not too poor" households exhibit Giffen behavior, showing a positive elasticity in the case of the Hunan province of 0.45, whereas the poorest households exhibited a "standard"

measures, including an own-designed measure. They verified this empirically using data from Brazil for the period 1996-2006, finding that in most of the years of the selected time window inflation had a higher negative effect on poorest households since the price of necessities increased at a higher rate than luxuries, which are consumed by richer households. In Mexico, Székely Pardo and Ortega Díaz (2014) found out that poor households exhibited higher responses to the price increases of 10 (out of 22) products that compose the Mexican basic food basket<sup>24</sup>. Finally, in line with this paper's topic, and as discussed in the literature review, in their study of interest rate elasticity for microcredits in Bangladesh, Deheija, Montgomery and Morduch (2012) found that low-income customers exhibited interest rate elasticities of -0.86, in contrast with a response of -0.26 from those with higher income levels, which is opposed to the belief that poor people look for gaining access to credit markets, regardless of their price, given by the interest rate (Deheija, Montgomery and Morduch, 2012).

Certainly, the results for the zone category are not aligned with microeconomic theory nor with statistical facts of income and expenditure in Mexico. Nevertheless, empirical literature in different settings and countries reveals serious findings about the higher responses to price increases from low-income people relative to high-income groups, making the results of the zone category not negligible. Principally, the consistency of the results obtained with the work of Deheija, Montgomery and Morduch (2012) alleviates to some extent the failure of fulfilling the predictions of microeconomic theory, as their paper is parallel to the present thesis.

### Gender semi-elasticities

The last category shows that women are more responsive to increases in interest rates than men, showing an elasticity of -20.95 (13.74 in the reduced-form estimation), in contrast to an estimation of -17.32 (13.78 in the fashion of Best et al. (2015) and DeFusco and Paciorek (2017)) for the male subsample. The difference between them is small when compared to that present in other categories. Considering the stylized fact that women are more risk averse than men (Armendariz de Aghion and Murdoch 2005, Heckman et al. 2009, and Charness and Gneezy 2012), the obtained results are not completely logical as the responses from female customers would have been expected to be smaller than those observed in the men's subsample. However, two arguments can be useful to explain how these results are oriented.

The first argument follows the logic of the zone category outlined above: lowest-income groups show a higher behavioral responses to price changes (in this case, the interest rate). It is a fact that women face a less advantageous situation than men in terms of job opportunities, income equality and human development. The statistics of the United Nations 2016 Human Development Report (UNDP, 2016) are overwhelming in this matter. First, throughout the world the female-to-male ratio of the total unemployment rate is 1.21, meaning that there are

negative elasticity of -0.61. Regardless of the elasticity sign, in absolute terms, the poorest households exhibited a greater behavioral response. In the case of the Gansu sample, the majority of the estimates were non-significant. Still, the trend is similar.

<sup>&</sup>lt;sup>24</sup> Only poor people exhibited smaller elasticities in absolute terms for one group of foods. For the remaining 11 food groups, elasticities of poor and non-poor households where practically the same.

more than 20% more unemployed women than men; second, the UNDP's Gender Development Index, which is given by the quotient of dividing the ratio between the male human development index by its female counterpart, shows a world average of 0.938, reflecting the fact that women are lagging behind men in terms of human development. Last, the OECD (2018) estimates that the average gender pay gap is 13.9% for its members. In other words, the median of men's wage is on average 13.9% higher than women's median wage. For Mexico these figures are 1.06, 0.951 and 16.5%, respectively. Moreover, using surveys from 89 different countries, Buitrago, et al. (2018), found that there are 654.9 million people living below the International Poverty Line (1.90 USD), being 50.3% of these women.

The second argument relies on the design of the *Pequeños Productores* program. It can be suspected that the additional benefit in interest rate for female customers (0.5% less in comparison with men) resulted very attractive for this group (to a larger extent than how the regular characteristics of the program resulted for men), boosting their demand for this program's loans, leading to more bunching and, consequently, to higher behavioral responses ( $\Delta \hat{l}$ ), being these 85.9% for women and 71.6% for men.

These two effects dominated the risk aversion component of the female loan demand.

Finally, the possibility of having a higher composition of medium-term loans (which upward biased the results) present in the female subsample was explored, a scenario that would also contribute to explain the higher semi-elasticities from female customers. However, this possibility was ruled out as the distribution is very similar between genders.<sup>25</sup>

### Year of origination

As for the year on which the loans were granted, an upward movement in the value of both kind of elasticities can be observed. First, for those loans granted between August 20, 2014 and December 31, 2014, the estimations are -10.84 and -6.97 for the traditional and reduced form semi-elasticities, respectively. Such values increase in absolute terms to -16.02 and -11.93 for the loans originated in 2015, ending in -22.87 and -21.54 for the last year considered in the analyzed window. Such increments reflect that there have been learning effects among the users of the *Pequeños Productores* program. In other words, as time passes by, more farmers get acquainted with the new program and its multiple benefits (promoted by FND officers or other farmers) and start to use it, cutting down their finance needs in order to have access to the program's benefits. These learning effects are supported by the fact that loans granted during 2015 and 2016 represent the same proportion of the total sample (44% each one), but the presented semi-elasticities are notably higher in 2016 (refer to Figure 14).

<sup>&</sup>lt;sup>25</sup> The composition of the contracted loans by loan-term is the following: i) Men: 60.2% short-term, 13.2% medium-term and 26.6% long-term. ii) Women: 60.6% short-term, 12.1% medium-term and 27.3% long-term.

### **Robustness checks**

This subsection is devoted to verify the robustness of the preferred estimates of both traditional and reduced form semi-elasticities by performing a sensitivity analysis of the excluded region (bins) at the left side of the cut-off (the order of L in the interval  $[l_L, l_U]$ ) as well as the order of the polynomial, as suggested by Kleven's review of the bunching approach (2016). The table columns contain both the order of the polynomial starting in 6 and finishing in 12 and the excluded bins, which range from -1 to -3. Meanwhile, the rows show the (sub)sample used. A "special case is presented" since the semi-elasticity of medium-term loans was specified using a polynomial order of 5 and an L=1. The range for the sensitivity analysis in the case of the excluded bins was decided taking into account the bins where bunching can still be present as shown in the histograms, whereas the order of the polynomial was decided considering that the preferred specifications ranged from 5 to 12. In the first sensitivity analysis (change in the polynomial order), the order of L was set to -2 (-3 for loans granted in 2014), while for the second check the degree of the polynomial is the same as that of the preferred specification (column 2 in Figure 14) for each (sub)sample. Finally, the preferred specifications are shown in bold letters. The results of each row can be interpreted as follows: a 1 percentage point increase in the interest rate can lead to a decrease in loan demand of between X% and Y% (lower and upper bounds of each sample). Finally, Figure 18 presents the results of the assessment of the preferred specification's robustness. The process to assess whether the sensitivity analysis results are robust is to construct two intervals around the preferred specifications specified in columns (9) and (10) of Figure 14 in the following way:

• First interval:

Lower bound:Upper bound:Preferred specification \* 0.9Preferred specification \* 1.1

Second interval

| Lower bound:                  | Upper bound:                  |      |  |  |  |
|-------------------------------|-------------------------------|------|--|--|--|
| Preferred specification * 0.8 | Preferred specification * 1.2 | (22) |  |  |  |

The second step is to verify if the results fulfill the following criteria for each subsample (which were discretionarily proposed considering the magnitude of the preferred specifications):

- a) The majority of the scenarios lie between a (first) interval of  $\pm 10\%$  of the preferred specification, and
- b) The majority of the scenarios lie between an interval of  $\pm 20\%$  of the preferred specification (lower degree of robustness).

Since the preferred specifications (in bold letters) are not considered as a scenario per se, eight different scenarios are proposed (six for the polynomial order and two for the order of L). If five of the eight scenarios fulfill at least one of the proposed criteria, the results will be considered

(21)

robust (in a lower degree if only criterion b) is fulfilled). This can also be analyzed by separating the robustness checks. In other words, if at least four scenarios for the polynomial check fulfill either criteria a) or b), the polynomial check will be considered robust (less if only b) is fulfilled). On the other hand, for the number of excluded bins at the left side of the borrowing limit, the results will be considered robust if both scenarios fulfill the above criteria.

Finally, Figure 18 can be interpreted as follows: the first column shows the (sub)sample, followed by the preferred specification of each (sub)sample. The next two columns show the lower and upper bound of the first interval, followed by the count of scenarios that fulfil criterion a). The last three columns are analogous to the first three columns, but considering the lower and upper bounds of the second interval in order to check compliance of criterion b). At the end of the section, remarks are given on some findings in Figures 16 and 17 and the robustness assessment is made.

| Category                  |                            |                  |        | Poly   | nomial o | Bins excluded at LHS of threshold ([0, L]) |        |              |                   |               |        |
|---------------------------|----------------------------|------------------|--------|--------|----------|--|--------|--------------|-------------------|---------------|--------|
|                           |                            | 6                | 7      | 8      | 9        | 10   | 11     | 12           | [0,-1]            | [0,-2]        | [0,-3] |
| Sele                      | ected sample               | -20.03           | -18.18 | -17.44 | -17.32   | -15.66                                     | -16.10 | -13.82       | -14.38            | -17.44        | -18.00 |
| <u> </u>                  | Male                       | -19.11           | -18.34 | -17.77 | -17.14   | -16.31                                     | -14.64 | -13.62       | -14.30            | -17.77        | -17.28 |
| Gender                    | Female                     | -19.10           | -17.68 | -15.63 | -15.68   | -12.27                                     | -13.01 | -10.16       | -15.67            | -19.10        | -20.43 |
| 7                         | Priority                   | -20.85           | -17.24 | -16.72 | -13.33   | -12.48                                     | -10.21 | -16.01       | -12.62            | -20.85        | -19.82 |
| Zone                      | Non-priority               | -12.46           | -10.60 | -10.39 | -10.39   | -8.98                                      | -9.72  | -7.34        | -5.95             | -7.34         | -7.87  |
| Type of loan              | Fixed assets               | -23.00           | -21.41 | -16.99 | -15.43   | -14.10                                     | -13.66 | -13.31       | -11.12            | -16.99        | -15.47 |
|                           | Enabling                   | -13.44           | -13.90 | -13.52 | -13.49   | -12.19                                     | -11.17 | -10.83       | -12.25            | -13.44        | -14.08 |
|                           | Non-fixed assets           | -14.17           | -12.86 | -13.61 | -13.88   | -13.42                                     | -13.01 | -11.00       | -13.02            | -13.88        | -13.97 |
| Term                      | Short-term<br>(0-1 years)  | -10.60           | -10.13 | -10.97 | -11.21   | -10.61                                     | -10.40 | -8.28        | -8.27             | -10.61        | -12.81 |
|                           | Long-term (>3 years)       | -23.56           | -20.45 | -17.69 | -15.53   | -15.12                                     | -13.75 | -14.69       | -15.53            | -23.56        | -24.19 |
|                           | 2014                       | -13.54           | -13.46 | -14.47 | -13.98   | -10.84                                     | -10.79 | -7.96        | -16.96            | -14.83        | -10.84 |
| Year                      | 2015                       | -16.02           | -15.14 | -14.82 | -14.28   | -13.90                                     | -11.86 | -12.23       | -13.14            | -16.02        | -16.53 |
|                           | 2016                       | -22.87           | -20.44 | -19.69 | -18.55   | -16.90                                     | -15.19 | -12.92       | -17.66            | -22.87        | -22.62 |
| Special case: medium-term |                            |                  |        |        |          |  |        |              |                   |               |        |
|                           |                            | Polynomial order |        |        |          |  |        | Bins exclude | d at LHS of thres | hold ([0, L]) |        |
|                           |                            | 4                | 5      | 6      | 7        | 8  | 9      | 10           | [0,-1]            | [0,-2]        | [0,-3] |
| Term                      | Medium-term<br>(1-3 years) | -24.63           | -24.80 | -22.57 | -26.04   | -25.15                                     | -28.36 | -29.91       | -24.80            | -23.52        | -19.79 |

Figure 16: Robustness check for "traditional" semi-elasticity results.

| Category                  |                            |                  |        | Poly   | nomial o | rder   | Bins excluded at LHS of threshold ([0, L]) |        |              |                   |               |
|---------------------------|----------------------------|------------------|--------|--------|----------|--------|--|--------|--------------|-------------------|---------------|
|                           |                            | 6                | 7      | 8      | 9        | 10     | 11   | 12     | [0,-1]       | [0,-2]            | [0,-3]        |
| Sele                      | ected sample               | -17.00           | -14.49 | -13.58 | -13.43   | -11.54 | -12.02                                     | -9.64  | -10.20       | -13.58            | -14.27        |
| Condor                    | Male                       | -15.46           | -14.48 | -13.78 | -13.04   | -12.10 | -10.35                                     | -9.36  | -13.61       | -13.78            | -13.20        |
| Gender                    | Female                     | -16.74           | -14.67 | -12.05 | -12.11   | -8.47  | -9.20                                      | -6.59  | -12.10       | -16.74            | -18.90        |
| 7                         | Priority                   | -20.85           | -17.24 | -16.72 | -13.33   | -12.48 | -10.21                                     | -16.01 | -12.62       | -20.85            | -19.82        |
| Zone                      | Non-priority               | -12.46           | -10.60 | -10.39 | -10.39   | -8.98  | -9.72                                      | -7.34  | -5.95        | -7.34             | -7.87         |
| Type of loan              | Fixed assets               | -21.77           | -19.08 | -13.04 | -11.29   | -9.92  | -9.49                                      | -9.16  | -7.20        | -13.04            | -11.33        |
|                           | Enabling                   | -9.28            | -9.72  | -9.44  | -9.33    | -8.12  | -7.24                                      | -6.97  | -8.18        | -9.28             | -9.90         |
|                           | Non-fixed assets           | -9.99            | -8.73  | -9.44  | -9.70    | -9.26  | -8.88                                      | -7.10  | -8.88        | -9.70             | -9.79         |
| Term                      | Short-term<br>(0-1 years)  | -6.78            | -6.39  | -7.08  | -7.28    | -6.78  | -6.61                                      | -4.99  | -4.98        | -6.78             | -8.69         |
|                           | Long-term (>3 years)       | -22.80           | -17.61 | -13.88 | -11.39   | -10.96 | -9.57                                      | -10.52 | -11.40       | -22.80            | -24.00        |
|                           | 2014                       | -9.37            | -9.30  | -10.29 | -9.80    | -6.97  | -6.93                                      | -4.76  | -13.00       | -10.66            | -6.97         |
| Year                      | 2015                       | -11.93           | -10.98 | -10.65 | -10.10   | -9.72  | -7.84                                      | -8.17  | -8.99        | -11.93            | -12.51        |
|                           | 2016                       | -21.54           | -17.60 | -16.52 | -14.98   | -12.94 | -11.03                                     | -8.79  | -13.85       | -21.54            | -21.11        |
| Special case: medium-term |                            |                  |        |        |          |        |  |        |              |                   |               |
|                           |                            | Polynomial order |        |        |          |        |  |        | Bins exclude | d at LHS of thres | hold ([0, L]) |
|                           |                            | 4                | 5      | 6      | 7        | 8      | 9  | 10     | [0,-1]       | [0,-2]            | [0,-3]        |
| Term                      | Medium-term<br>(1-3 years) | -30.19           | -25.23 | -21.02 | -27.94   | -25.98 | -33.90                                     | -38.71 | -25.23       | -22.73            | -16.65        |

Figure 17: Robustness check for the reduced form semi-elasticity results.

| Traditional semi-elasticities |  |                           |                           |                           |   |                          |                           |   |
|-------------------------------|--|---------------------------|---------------------------|---------------------------|---|--------------------------|---------------------------|---|
| (Sub)s                        | sample   | Preferred specification   | Lower<br>bound<br>-10%    | Upper<br>bound<br>+10%    | Scenarios<br>within<br>±10%<br>interval | Lower<br>bound<br>-20%   | Upper<br>bound<br>+20%    | Scenarios<br>within<br>±10%<br>interval |
| Selected                      | l sample   | -17.44                    | -15.70                    | -19.19                    | 4                                       | -13.95                   | -20.93                    | 7                                       |
| Gender                        | Male<br>Female   | -17.77<br>-19.10          | -15.99<br>-17.19          | -19.48<br>-21.01          | 5<br>2                                  | -14.21<br>-15.28         | -21.19<br>-22.92          | 7<br>5                                  |
| Zone                          | Priority   | -20.85                    | -18.76                    | -22.93                    | 1                                       | -16.68                   | -25.02                    | 3                                       |
|                               | E' 1   | -7.54                     | 15.00                     | -0.07                     | 1                                       | -3.07                    | -0.00                     | 4                                       |
| Type of loan                  | Enabling   | -13.44                    | -13.29                    | -18.34<br>-14.79          | 6                                       | -13.39                   | -20.08                    | 4 8                                     |
| Type of loan                  | Non-fixed assets                                       | -13.88                    | -12.49                    | -15.27                    | 7                                       | -11.11                   | -16.66                    | 7                                       |
|                               | Short term<br>(0-1 years)<br>Medium-                   | -10.61                    | -9.55                     | -11.67                    | 5                                       | -8.49                    | -13.21                    | 6                                       |
| Term                          | term   | -24.80                    | -22.32                    | -27.27                    | 5                                       | -19.84                   | -29.75                    | 6                                       |
|                               | Long term<br>(>3 years)                                | -23.56                    | -21.20                    | -25.92                    | 1                                       | -18.85                   | -28.27                    | 2                                       |
|                               | 2014   | -10.84                    | -9.76                     | -11.92                    | 1                                       | -8.67                    | -13.01                    | 1                                       |
| Year                          | 2015   | -16.02                    | -14.42                    | -17.62                    | 3                                       | -12.81                   | -19.22                    | 6                                       |
|                               | 2016   | -22.87                    | -20.58                    | -25.15                    | 1                                       | -18.29                   | -27.44                    | 4                                       |
|                               |  | Reduce                    | ed form s                 | emi-elast                 | icities                                 |                          |                           |   |
| (Sub)sample                   |  | Preferred specification   | Lower<br>bound<br>-10%    | Upper<br>bound<br>+10%    | Scenarios<br>within<br>±10%             | Lower<br>bound<br>-20%   | Upper<br>bound<br>+20%    | Scenarios<br>within<br>±10%             |
| Sologtor                      | lampla   | 13 58                     | 12.22                     | 14.04                     | 3                                       | 10.86                    | 16.20                     | 5                                       |
| Selected                      | Mala   | -13.30                    | 12.22                     | 15.09                     | 3                                       | -10.80                   | -10.29                    | 5                                       |
| Gender                        | Famala   | -13.76                    | -12.40                    | -13.00                    | 4                                       | -11.02                   | -10.39<br>20.00           | 0                                       |
|                               | Drionity   | 20.85                     | -13.07                    | -10.42                    | 1                                       | -13.39                   | 25.02                     | 2                                       |
| Zone                          | Non priority   | -20.85                    | -10.70                    | -22.95                    | 1                                       | -10.08                   | -23.02                    | 2                                       |
|                               | Fixed assots   | 13.04                     | 11 74                     | 1/ 17                     | 0                                       | -5.67                    | 15 30                     | 2                                       |
| Т (1                          | Enabling   | -9.28                     | -8.35                     | -10.21                    | 4                                       | -7.42                    | -11.14                    | 6                                       |
| Type of loan                  | Non-fixed<br>assets                                    | -9.70                     | -8.73                     | -10.68                    | 6                                       | -7.76                    | -11.65                    | 7                                       |
|                               | Short term<br>(0-1 years)                              | -6.78                     | -22.71                    | -27.75                    | 5                                       | -5.43                    | -8.54                     | 5                                       |
| Term                          | Medium-<br>term<br>(1-3 years)                         | -25.23                    | -6.10                     | -7.46                     | 2                                       | -20.19                   | -30.28                    | 5                                       |
|                               |  |                           |                           |                           |   |                          |                           |   |
|                               | Long term<br>(>3 years)                                | -22.80                    | -20.52                    | -25.08                    | 1                                       | -18.24                   | -27.36                    | 1                                       |
|                               | Long term<br>(>3 years)<br>2014                        | -22.80<br>-6.97           | -20.52                    | -25.08                    | 1                                       | -18.24                   | -27.36<br>-8.36           | 1                                       |
| Year                          | (1 5 years)<br>Long term<br>(>3 years)<br>2014<br>2015 | -22.80<br>-6.97<br>-11.93 | -20.52<br>-6.27<br>-10.74 | -25.08<br>-7.67<br>-13.12 | 1<br>1<br>2                             | -18.24<br>-5.58<br>-9.54 | -27.36<br>-8.36<br>-14.32 | 1<br>1<br>5                             |

Figure 18: Applying robustness check criteria.

After carrying out the robustness checks for the polynomial order in Figures 16 and 17, the results obtained with 11th and 12th degree polynomial orders present a higher deviation with respect to the preferred specifications (especially, 12<sup>th</sup> order polynomials). This can be attributed to the fact that, in these cases, the difference  $\hat{B} - \hat{M}$  was not similar to zero. If these polynomials are disregarded and only the results from polynomial orders 6-10 are taken into account, in several subsamples the estimated semi-elasticities appear to show an adequate behavior (given the magnitude of the obtained semi-elasticities), based on the moderate variation with respect to the preferred specifications. Good examples of the subsamples that show small variation are enabling loans, short-term loans, loans granted in 2015, and to a less degree, male subsample and non-fixed assets. Moving to the second sensitivity check, when order of L is set to  $-3^{26}$ , both figures (16 and 17) reveal that there are relatively small deviations with respect to the preferred specifications in the majority of the subsamples. Nevertheless, robustness is less obvious when L=-1 as there is a higher variation in the case of these estimated values. Only the deviations with respect to the preferred specifications of enabling, non-fixed assets and medium-term loan subsamples when one bin is excluded at the left side of the 45,000 UDIs cut-off are relatively reasonable. This is explained because the result of applying expression (14) renders much more similar results than those of the preferred specifications when L=-3 as compared to scenarios when L=-1.

From the results of the first two tables of the present section it can be noted that, in general terms, variation is lower when the preferred specification of the semi-elasticity is smaller, thus explaining the lower variation observed in the case of reduced-form elasticities, as these are smaller than the traditional ones (refer to Figure 14).

Regarding the proposed assessment of robustness of sensitivity checks, in the case of traditional semi-elasticities it was found that five out of the fourteen (sub)samples fulfil both criteria (male subsample, enabling loans and non-fixed asset subsamples, short-term loans and medium-term loans subsamples). Additionally, three other (sub)samples fulfil criteria b): the selected sample, the female subsample, and the subsample containing those credits granted in 2015. For the reduced form semi-elasticities, only the non-fixed asset subsample and the short-term loans are robust under both criteria, whereas other five (sub)samples comply only with criterion b) (selected sample, male subsample, enabling loans subsample, medium-term loans subsamples, as well as loans originated in 2015).

When such analysis is performed separately (polynomial order vis à vis the order of L; for more detail, see appendix), for the polynomial check of the reduced-form semi-elasticities, only non-fixed assets and enabling loans subsamples exceed the 50% established threshold at the  $\pm 10\%$  criterion. When the robustness criterion is relaxed ( $\pm 20$  of the preferred specification) other five subsamples show robustness at a lower degree. As for the polynomial robustness check for the traditional semi-elasticities, four subsamples (male, enabling loans, non-fixed asset loans, short-

<sup>&</sup>lt;sup>26</sup> The semi-elasticity of loans originated in 2014 (August 20 onwards) was determined using an L order equal to -3. This order is equal to -1 for the medium-term loans subsample. L=-2 is therefore considered a sensitivity check for these subsamples.

term and medium-term loans) comply with both robustness criteria. Additionally, the full sample fulfills only criterion b). Moving forward to the separated analysis of the order of L, for the reduced form semi-elasticities only the male customer subsample and the enabling loans comply with both criteria. Meanwhile, criterion b) is fulfilled by an extra subsample: the non-priority zones. In the case of traditional semi-elasticities, more subsamples fulfill both criteria: two comply with a) and b) (enabling and non-fixed asset loans) while five additional subsamples comply only with b).

Summarizing, the obtained semi-elasticities of several subsamples exhibited some indications of robustness according to the proposed checks in their traditional and reduced form and/or low variation<sup>27</sup> with respect to the preferred specifications. These (sub)samples are: i) selected sample (robustness in traditional and reduced form semi-elasticities); ii) male customers (robustness and low variation for both kind of elasticities); iii) female customers (robustness in traditional semielasticity); iv) enabling loans (robustness and low variation for both kind of elasticities); v) nonfixed asset loans (robustness and low variation for both kind of semi-elasticities); vi) short-term loans (robustness and low variation for both kind of semi-elasticities); vii) medium-term loans (robustness in both kind of semi-elasticities and low variation in the case of traditional semielasticities); viii) loans granted in 2014 (low variation for traditional semi-elasticities); and ix) 2015 (robustness and low variation for both kind of semi-elasticities). Nevertheless, the results of the rest of the subsamples were not robust for the proposed test (the above criteria) and presented higher variation with respect to their preferred specifications. On the other hand, in general terms, the polynomial robustness check responded better to the proposed criteria than the check for the number of excluded bins at the left side of the cut-off (check last row of Figure A.4).

There are two main reasons as to why the robustness of the preferred specification's results were affected. First, polynomials of lower orders generated flatter counterfactual distributions, which resulted in higher elasticities. This outstands especially for those subsamples where the order of the polynomial is equal to 6. As noted, these cases exhibited a higher difference with respect to other polynomial orders. Second, higher order polynomials (specifically 11 and 12) generated differences of  $\hat{B} - \hat{M}$  that were not very close to zero. In the case of the excluded bins at the left of the 45,000 UDIs threshold, it was detected that when L was set equal to -1, the behavioral response from marginal bunchers ( $\hat{B}$ ) was smaller as compared to the preferred specification, rendering smaller elasticities.

Nonetheless, two important remarks must be provided in order to lessen the weakness of some specific estimations or subsamples. First, even though it was stated that the impact of collaterals may be relatively small, it can still prevail, making the obtained semi-elasticities an upper bound of the true interest rate semi-elasticity. As observed in Figures 16 and 17, when the preferred estimation of the interest rate semi-elasticity is smaller, the variation of both robustness checks with respect to the preferred specification is also smaller. Thus, if the effect of credit guarantees

<sup>&</sup>lt;sup>27</sup> When polynomials of order 11 and 12 are discarded.

and less strict documentation could be eliminated, the degree of robustness would be better than that observed, as interest rate semi-elasticities would be smaller. Second, at category level, the results of the different specifications are consistent in most cases with the main results in Figure 14. In other words, and taking as an example the zone category, the different estimates of the priority areas are greater than their counterparts of the non-priority areas subsample. This pattern is observed in all categories except in the gender one.

To conclude this section, the magnitude and plausibility of the retrieved semi-elasticities is supported by the following reasons:

- 1) The spread between the *Pequeños Productores* program interest rate and that of traditional loans is considerably large (equal or larger than 4%). This results in a very attractive program for farmers, leading to a pronounced bunching, especially in the case of female customers, who presented a higher response than men due to the additional interest rate benefit. Also, the existence of an alternative development bank upward biases the obtained elasticities.
- 2) As observed in all the analysis related to medium-term loans (histograms and sensitivity analysis), this subsample presents an atypical behavior that is driving up the estimations obtained under the main sample and the subsamples of the categories different than the loan term since all of them contain medium-term loans.
- 3) Theoretically, the required identifying assumptions were fulfilled during the process.
- 4) Within categories, the results have economic sense. In other words, responses for longer term loans are higher than shorter term loans, and given the link between the loan term and the type of loan, the elasticities for fixed-asset credits are higher than for enabling and non-fixed asset subsamples. Also, lower income areas present higher responses to a change in the interest rate than more prosperous regions, which is in line with the results from empirical literature. Finally, in the case of gender category, women show higher elasticities than men, which is counterintuitive considering that women are more risk averse than men. Nevertheless, the extra benefit in the interest rate and the poverty argument outlined above dominated the opposing effect of the more conservative investment profiles observed in women.

# VII. External validity and policy implications

The literature review outlined above shows that there are few studies regarding the interest rate elasticity of the demand for loans. Nevertheless, such studies are helpful to assess the external validity of the obtained results. However, this becomes a challenging task because, as observed in Figure 1, the elasticities obtained in the reviewed works differ largely from the elicited (semi)elasticities in the present work, making it difficult to make a valid comparison between them.

A comparison of such dissimilar results will be presented in the following paragraphs in an effort to provide reasons as to why the obtained results in this work can be not only internally valid, but also externally. The elements to compare will be the nature of the obtained semi-elasticities (elastic or inelastic) and primarily the size of the spread between small and large interest rates as in Best et al. (2015) and DeFusco and Paciorek (2017) or the change in interest rate due to modifications in the financial intermediary's policies as in Deheija, Montgomery and Morduch (2012) or as a result of a random experiment as in Karlan and Zinman (2014).

First, considering studies that used macroeconomic data for analyzing the interest rate semielasticity of loan demand, Fase (1995) in the Netherlands and Kuovi (2009) in China found around-1.10 and -1.70, respectively, which largely differ even with the smallest reduced form semi-elasticity (short-term loans where  $\in = -6.78$ ). Nevertheless, their results are similar to the present work due to the elastic nature of the obtained results. The same occurs when the obtained semi-elasticities are compared with the work of Gross and Souleles (2002), who retrieved a long-run elasticity for credit card users of -1.3 in the United States.

The rest of the reviewed literature provides either a change in the interest rate due to a financial intermediary's policy, a random experiment or the spread between large and small interest rates when a notch is introduced. We can rely on this information to dimension the obtained elasticities in the present work and, therefore, make them meaningful. Nevertheless, it must be highlighted that the difference between the *Pequeños Productores* program interest rate and the traditional loans interest rate is considerably large (between 400 and 500 basis points), which explains the high behavioral responses. Furthermore, two other factors (which are intertwined) help to explain the elevated semi-elasticities of loan demand to interest rates of FND's customers. First, the effect of funding institutions such as FIRA, acting as a substitute of the FND, and then the possibility, given the size of the estimated behavioral responses, that not only small (and potentially poor) farmers have made use of the *Pequeños Productores* program, but also those that have access to credit or other funding sources (which is not common among microloan users who normally do not have access to credit markets). These issues are not addressed in the reviewed literature.

Reviewing these papers, Deheija, Montgomery and Morduch (2012) analyzed through a random experiment the change in interest rate in two out of three branches of the microlender SafeSave in Bangladesh. In these two branches, the monthly interest rate changed from 2% to 3% (remaining at 2% in one branch), which, in yearly terms, represents a difference of 120 basis points<sup>28</sup>, which is smaller than the 400/500 basis points difference in the *Pequeños Productores* scheme. These authors obtained primarily inelastic responses ranging from -0.26 to -0.88. Nonetheless, when they use an instrument for the customer's borrowing capacity an elastic response to the increase in the interest rate is found, being equal to -1.04, which is in line with the elastic nature of the elasticities found in the present work. However, this estimation is very small compared with the results presented herein. It is important to recall that this paper also suggests that poor people have larger responses to an increase in the interest rate, finding that it is consistent with the retrieved elasticities in the zone category. Continuing in the line of microfinance works, Karlan and Zinman (2014), along with the Mexican microlender

<sup>&</sup>lt;sup>28</sup> Considering annual interest rates of 24% in the branch where the monthly rate remained at 2%, vis à vis a 36% annual interest rate in those where the monthly rate changed to 3%.

*Compartamos Banco*, implemented a random experiment where cuts to the institution's annual percentage rate of 10 percentage points (1,000 basis points) and 20 percentage points (2,000 basis points) were implemented in different regions in Mexico. As the pre-treatment annual percentage rate of this institution was nearly 100%, it led to a small annual interest rate of approximately 80% and a large annual interest rate close to 90%. The difference between these rates was around 10 percentage points (1,000 basis points), which is higher than the *Pequeños Productores*-traditional loans' interest rate spread. Nevertheless, these reductions are proportionally smaller than in the FND's scheme, leading to smaller semi-elasticities (1.15, -1.99 and -2.91 for 1, 2- and 3-years horizons, respectively). Additionally, as microlending users often accept interest rates regardless of their level (Deheija, Montgomery and Morduch, 2012), their demand for loans is less elastic than that of other people who have more access to other credit markets (i.e. FND's customers). Moreover, discarding the medium-term elasticity because of its atypical behaviour, they also find that an increase in the time horizon leads to higher elasticities in absolute terms. These explanations give relevance to the results of the present work.

The papers that applied the bunching approach to elicit reduced form semi-elasticities present very small spreads between small and large interest rates. First, Best et al. who estimated elasticities between -1.37 to -0.07, distinguished six interest rate spreads at the different notches analyzed in their study, which ranged from 10.6 and 40.9 basis points (33 basis points in average). DeFusco and Paciorek (2017) distinguish an average spread between the conforming loans interest rate and the jumbo loans of approximately 22 basis points. Both spreads are considerably small, leading to smaller behavioral responses as compared to those shown in Figure 14. Nevertheless, the highest estimation from DeFusco and Paciorek (2017) (-5.20) is relatively close to the reduced form of short-term loans as shown in Figure 14 (-6.78).

Summing up, except for most of the Deheija, Montgomery and Morduch's (2012) results, estimates of the reviewed literature are elastic in nature, a feature that is also observed in the present study. There are common findings among papers; for example, higher semi-elasticities for low-income people as well as increasing semi-elasticities when the loan term increases.

As stated before, comparing the results of the reviewed literature with the obtained semielasticities was not straightforward given the difference in their magnitude. Thus, the above paragraphs are intended to convince the reader to not disregard such results. Although such reasons are not conclusive as to externally validate the results of this work, it would be irresponsible to automatically discard them.

Now, as more information about the response to an increase in the interest rates of borrowers in the country is available it is possible to derive some policy implications. The following lines will explain how different agents can make best use of the estimations, especially in Mexico.

First, the obtained behavioral responses are informative for the authorities that conduct fiscal and monetary policies. Specifically, Banco de México (and other central banks in the world) now has information about how productive investment diminishes when the interest rate increases, making it possible to assess its consequences on both inflation and economic growth (if the central bank has a dual mandate). The retrieved elasticities are also informative to conduct monetary policy given the positive and sizable response of people to a change in interest rates. According to McLeay, Radia, and Thomas (2014), nowadays money is created by commercial banks by granting loans and central banks by setting the price of these loans (interest rate), thus affecting the amount of deposits in the banks' customer accounts. As a result, when the level of deposits increases due to an expansion of credit (when interest rates are low), commercial banks need to demand more reserves from the central bank in order to be able to respond to regulatory requirements, interbank payments and money withdrawal from customers (McLeay, Radia, and Thomas, 2014).

Elicited elasticities are relevant given that people show a considerable response in loan demand when the interest rate increases, and therefore money creation is also affected as commercial banks make less deposits on the borrower's accounts. This channel enables the central bank to conduct monetary policy by adjusting the supply of reserves through the interest rate, having an impact in commercial banks' lending levels and, thus, on economic activity. In other words, monetary policy is conducted by controlling the amount of credit granted by banks.

Then, governments can provide subsidies to small and medium enterprises (SMEs) or agricultural firms or farmers, or by implementing investment tax credits in an attempt to develop some specific sectors or agents in the economy. These kind of instruments, however, would be superfluous if people do not modify their demand for loans after a change in the interest rate. Nonetheless, as it was observed in the studied setting, people change their behaviour when the interest rate increases. Hence, this kind of policies can indeed be implemented. In the specific case of Mexico, the Ministry of Finance and Public Credit and the Mexican tax authority can use the results of the present work to implement or modify investment tax credit (deductions), as well as to subsidize productive investments (especially for SMEs and agricultural firms), since these incentives are not very extended in Mexico; and, finally, to examine the consequences of these policies in tax revenue and in reducing the distortions in labor markets caused by labor income taxes.

For commercial and development banking in the country, the results are quite useful because with the information casted by the study, such institutions can adjust adequately their interest rates and guarantee schemes according to loan terms and types of credit, and even by gender. However, the use of this information for adjusting interest rates at a regional level is not desirable as it opens a door for arbitrage opportunities, since people can displace to other regions just to contract a loan at a lower interest rate, having implications on the institution's operations and management. Simultaneously, both type of banks can obtain more revenues by lowering their interest rates given that the retrieved elasticities are of an elastic nature. The next figure shows that in the period when the *Pequeños Productores* program was implemented and interest rates decreased, the FND exhibited an improvement in their sales, given by the interest income and by the return on equity (ROE).<sup>29</sup>

<sup>&</sup>lt;sup>29</sup> The change observed in 2015 in the ROE is explained by the fact that in that year the CNBV ordered the banks to modify the way of measuring the amount of preventive reserves for credit risks, depending now on the size of

| Year<br>(1)  | Interest income (MXN)<br>(2) | ROE<br>(3) |  |  |  |  |
|--|------------------------------|------------|--|--|--|--|
| 2013   | 2,482                        | 3.4        |  |  |  |  |
| 2014   | 2,939                        | 3.5        |  |  |  |  |
| 2015   | 3,407                        | 8.1        |  |  |  |  |
| 2016   | 4,139                        | 4.2        |  |  |  |  |
| 20171/   | 5,060                        | 4.4        |  |  |  |  |
| <sup>1</sup> /As of June 2017. Both indicators are annualized. |                              |            |  |  |  |  |
| Source: FND.   |                              |            |  |  |  |  |

Figure 19: Interest income and Return on Equity (ROE) of FND (2013-2017).

In the study of Karlan and Zinman (2015), the authors found that the randomized reduction of the interest rate of *Compartamos Banco* led also to an increase of the microlender interest income. In an official report (Compartamos Banco, 2013), this institution confirmed the Karlan and Zinman (2015) findings arguing that the reduction of the interest rate was sustainable for the institution and could lead not only to higher sales (income), but also to higher profits in the long run. Nevertheless, this can only be achieved if banks minimize the occurrence of adverse selection by implementing sound credit scoring models and mitigating credit risk through monitoring investment and strengthening debt collection processes.

The results from the present study contribute to the findings of the reviewed literature on interest rate elasticities, which also estimated elastic behavior responses (elasticities higher than 1 in absolute terms). Thus, as the results are consistent (in this aspect) across countries, regardless of the used methodologies, the estimations above can also be informative for economic agents in other countries, especially for those with similar economic conditions, financial inclusion levels and where development banking is highly extended (Latin America, for example). In this regard, the FND can share the results to other development banks in the region who may be planning to implement programs of this nature in their countries. This can be done through entities like the Latin American Association of Financial Institutions for Development (ALIDE, for its acronym in Spanish)<sup>30</sup>, of which the FND is a member institution.

### VIII. Further research

The present research led to results with significant policy implications. However, how does the change in the interest rate contribute to the behavioral response of small farmers? To what extent does the preference of a small farmers' borrowing scheme depend on the level of credit guarantees it has to provide? The first research line of the present work would be to obtain pure

the expected loss of credit portfolio of each institution. Since the FND had more reserves than the required by the new methodology, the institution registered the excess reserves as profits in its2015 income statement, making the ROE increase exogenously.

<sup>&</sup>lt;sup>30</sup> The ALIDE's mission is to "stimulate the exchange of information on products, services and expertise of its members, through technical forums, training and technical assistance, in order to foster collaboration, business and financial cooperation among these institutions, as well as to encourage their contribution to the economic and social development of the region" (ALIDE, 2018). It is formed by 63 active members from 22 American countries.

interest rate elasticities by trying to discount the small effect that simple and current account loans could have in those (sub)samples where these types of loans are present. This could be performed by conducting a random experiment (where the source of randomization will be a lottery) where the FND defines a treatment group composed of customers with funding needs over the *Pequeños Productores* program, keeping the traditional loan's interest rate for preferential customers (11%), but with the same collaterals and documentation requirements as those asked for the *Pequeños Productores* program. On the other hand, the control group would be composed of those customers subject to the current conditions of the traditional loans (higher interest rate, different collaterals for simple and current account loans and more strict documentation requirements, as in the present work). By applying the bunching approach, this setup would allow to obtain a pure interest rate elasticity of the FND's loan demand as well as the contribution of the different collaterals and documentation requirements). This exercise will confirm the suspicion that the effect of collateral in the estimated semi-elasticities is not relevant.

The second future research line is conducting a Regression Discontinuity Design (RDD) to determine if the implementation of the Pequeños Productores program had an effect on several characteristics of farmers. These characteristics can be, for instance, their income or their level of sales. This would be done by using the "FND's R04" report from the CNBV. Every commercial and development bank in Mexico is obligated by the CNBV to fill down a report known as R04, which contains the details of every loan granted by these institutions, including information regarding their borrowers and their gross income and net sales, among other chracteristics. Hence, by using these indicators and other features contained in the FND's R04 report, and setting again the *Pequeños Productores* program borrowing limit of 45,000 UDIs as a cut-off and defining a vicinity around this threshold (with the optimal band-width method), it can be observed if there is a positive and statistically significant difference in the income and/or sales of those farmers to the left side of the borrowing limit (*Pequeños Productores* program users) with respect to those to the right of this limit (traditional loans users). It can therefore be inferred that the program has been successful in improving farmer's financial situation. Nevertheless, as the size of the obtained semi-elasticities suggests that there are some farmers that are able to contract loans well above the Pequeños Productores borrowing limit, but prefer to locate just beneath this threshold (i.e. marginal bunchers), probably the results from the RDD can be overestimated as this marginal bunchers presumably have larger incomes or sales. Because of this, the RDD study can be complemented with a difference-in-difference (DID) analysis, which will be helpful to confirm if those farmers located in the optimal band around the 45,000 UDIs threshold and which have borrowed money from the FND under the Pequeños Productores program are better-off with respect to those taking traditional loans and with respect to themselves prior to the program's implementation. To perform this analysis, in the FND's R04 report, individuals that were considered in the RDD and which contracted a loan prior to and after the Pequeños Productores program was implemented would take part in the sample for conducting the DID analysis (via a regression). To implement this method, two dummy variables would need to be created, one for the treatment (i = 1 if the farmer took a Pequeños Productores loan and i = 0 if it took a traditional loan) and another one for the period before/after the program's implementation (i = 1 if the loan was granted after the program implementation and i = 0 otherwise). If the result of the DID coefficient (given by an interaction term of the two abovementioned dummy variables) is positive and statistically significant, it would be confirmed that in the selected dependent variables (i.e. income or sales) the *Pequeños Productores* program has been beneficial for farmers. This analysis could be extended to other potential dependent variables like crop yields or financial inclusion indicators if the pertinent information is available.

## IX. Conclusions

The recent bunching approach was used to obtain the behavioral responses of the customers of one Mexican development bank (FND) to the implementation of a social program which presents very attractive characteristics for them. These characteristics incentivize the institution's target population to diminish its loan demands, leading them to bunch at the borrowing limit set by this program (45,000 UDIs). After observing this behavioral response it was possible to obtain an upper limit for the interest rate elasticities of this institution's customers.

In order to obtain the abovementioned elasticities, administrative data from FND loans were used and filtered to finish with a sample of 177,950 loan observations. To furtherenrich the analysis, thirteen subsamples were obtained, divided in the following five categories: gender, type of loan, loan term, zones and year of origination. First, to find evidence of bunching, histograms of the main sample and the thirteen subsamples were plotted, finding excess bunching in the left vicinity of the 45,000 UDIs threshold in all datasets. Then, by applying the bunching approach as presented by DeFusco and Paciorek (2017), the interest rate semi-elasticities to loan demand of FND customers were obtained (in addition to other interesting indicators). For the main sample, a semi-elasticity of -17.44 (-13.58 in the reduced-form) was found, meaning that an increase of 1% in the interest rate should reduce the demand for loans by 17.44% (13.58%). In the loan term category, medium-term loans posted the highest elasticity (-24.80 in the traditional semi-elasticity and -25.23 in the reduced-form) since in this subsample an atypical behaviour was observed, because bunching was very high as compared to other subsamples. The long-term loans subsample presented an elasticity of -23.56 (-22.80 in the reduced form), while the elasticity of short-term loans was the smallest across the different datasets (-10.61 for the traditional semielasticity and -6.78 in its reduced form). This is because short-term loans are devoted to cover less inelastic concepts such as commodities and operating expenses, whereas long-term loans cover more elastic aspects. A second explanation of these results is that farmers are more exposed to default when interest rates and loan amounts are higher. Hence, when they are offered with a funding option that entails less risk such as the Pequeños Productores program, they change their behaviour in order to reduce such risk. Then, in the type of loan category, fixedasset loans registered a higher elasticity (-16.99 and -13.04 for the traditional and the reduced form semi-elasticities, respectively) than non-fixed asset loans (-13.88 for the traditional semielasticity and -9.70 for the reduced-form) and enabling loans (-13.44 and -9.28 for the traditional and reduced form semi-elasticities, respectively). This is due to the close link between the type of loan and the loan term, making it possible to explain these results in an analogous way to the loan term case, given that fixed-asset loans have a longer "life" than non-fixed asset loans. Moving to the zone category, it was found that less prosperous regions (priority zones) have a traditional semi-elasticity of -22.47 (-20.85 in its reduced-form), which is higher that the elasticity observed in regions with a higher human development (traditional semi-elasticity of -11.28 and -7.34 for the reduced-form), confirming the findings of other authors, as lower income people present higher behavioral responses to changes in prices than people with higher income levels. Moving forward to the gender subsamples, women presented a higher semi-elasticity (-20.95 for the traditional semi-elasticity and -16.74 for the reduced-form) with respect to men's (-17.32 and -13.78 for the traditional and reduced form semi-elasticities, respectively). This is explained by the additional benefit in interest rate for women, due to the design of the *Pequeños Productores* program, and also to income and job inequality factors, which have led women to earn less income than men. Finally, it was observed that program users showed learning effects as the semi-elasticities increased in a yearly way during the analyzed period.

Overall, the existence of alternative credit sources (FIRA) and the size of the spread contributed to obtain sizable interest rate semi-elasticities.

Robustness checks for the preferred specifications were performed, by changing first the order of the polynomial of the counterfactual loan size distribution and then the number of excluded bins at the left-hand side of the Pequeños Productores borrowing limit. Nine out of 14 (sub)samples registered indications of robustness to the proposed assessment criteria and/or low variation. Additionally, after performing the sensitivity analysis, the polynomial robustness check responded in a better way to the proposed assessment criteria.

The results are internally valid since the identifying assumptions of the bunching approach were fulfilled and the results have economic sense. However, it was not possible to confirm external validity due to the size of the estimated elasticities, which largely differ from the reviewed literature. Nonetheless, several reasons where provided to guide the reader in order to not discard the results of this work. The main reason for this is the large spread between the *Pequeños Productores* program's interest rate and that of the FND's traditional loans, which is of a greater magnitude than the spreads observed in other literature. Furthermore, an elastic loan demand is observed in most papers, in line with the elicited estimations. The obtained results are thus informative for several agents of the Mexican economy. These agents are taxation and monetary authorities, as well as financial intermediation institutions. The results can also be useful for several institutions with similar characteristics than those of the FND, especially in Latin America.

Finally, the analysis can be enriched by i) trying to uncover the (potentially small) effect that simpler documentation requirements and, specially, lower credit guarantees for the *Pequeños Productores* program have in the FND's loan demand, making it possible to obtain the contribution of the change in interest rate to the size of the behavioral responses of the marginal bunchers. This can be performed by a random experiment as the one mentioned in section VIII, and then by ii) conducting a RDD and a DID analysis to see whether the institution's target population is better off due to the implementation of this program in indicators like farmers income/sales, agricultural yields or financial inclusion indicators.

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# XI. <u>Appendix</u>

This section includes the following: a brief description of the institutions that compose development banking in Mexico, a brief review of the FND's background, the histograms of the used subsamples as well as the graphs for the bunching plots for the preferred specifications shown in Figure 14.

The development banking sector is composed of the following institutions:

# Nacional Financiera (NAFIN)

As stated in its organic law, this institution purpose is "to promote savings and investment, as well as to channel financial and technical support for industrial development" (Cámara de Diputados del H. Congreso de la Unión, 2014a). Its target population is composed of micro-, small- and medium-size firms and entrepreneurs. It also aims at facilitating the access to priority investment projects and financing (Nacional Financiera 2018a).

It has some programs to attend specific sectors of the population like *Crédito Jóven* which grants loans at preferential interest rates to young entrepreneurs between 18 and 35 years old (Instituto Nacional del Emprendedor, 2018) and *Apoyo a Mujeres Empresarias,* which grants credit to firms exclusively composed of women (Nacional Financiera 2018b).

# Banco Nacional de Comercio Exterior (BANCOMEXT)

The mission of this institution is to foster foreign trade through credit lending and currency generation in Mexico (Bancomext, 2018a). In addition to financing Mexican exports and importer firms, the bank also supports the internationalization of Mexican firms, foreign investment, the integration of value chains and financing of currency-generator activities like tourism and energy (Bancomext, 2018b).

# Banco Nacional de Obras y Servicios Públicos (BANOBRAS)

Being its mission "to foster investment in infrastructure and public services and to promote the financial strengthening of states and municipalities" this bank focuses on increasing both direct financing and the participation of commercial banking in financing infrastructure projects, and attracting institutional investors' resources to infrastructure projects and incorporating them to financial system's municipalities that are not subject to traditional banking (Banco Nacional de Obras y Servicios Públicos, 2018).

# Banco del Ahorro Nacional y Servicios Financieros (BANSEFI)

The purpose of this institution is "to promote savings, financial education and inclusion in those groups that have limited access to financial services). The strategy of BANSEFI is to reach the most remote villages in the country and those most impoverished, and also provide different social programs to accomplish its mandate (Banco del Ahorro Nacional y Servicios Financieros, 2018).

# Sociedad Hipotecaria Federal (SHF)

Through credit guarantees and other financial instruments related with dwelling construction or improvement, this institution promotes the development of first- and second-house markets. The institution presents operations in both rural and urban areas through instruments such as mortgage credits, giving priority to low-income groups (Sociedad Hipotecaria Federal, 2018a and 2018b).

# Banco Nacional del Ejército, Fuerza Aérea y Armada (BANJÉRCITO)

BANJÉRCITO provides financial services to the members of the Mexican armed forces and also civilians (Banco Nacional del Ejército, Fuerza Aérea y Armada, 2018).

Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero (FND)<sup>31</sup>

Size of development banking in Mexico

To end with this section as well as to make the reader aware of the size of development banking in Mexico, the following table shows the *performing loans portfolio* from each institution's balance sheet. This account can be used as a measure for this indicator.

| Institution           | MXN        | EUR <sup>1/</sup><br>(millions) |  |  |
|-----------------------|------------|---------------------------------|--|--|
| Institution           | (millions) |                                 |  |  |
| FND                   | 47,141.00  | 2,165.00                        |  |  |
| NAFIN                 | 212,135.29 | 9,742.55                        |  |  |
| BANCOMEXT             | 190,554.00 | 8,751.41                        |  |  |
| BANOBRAS              | 369,321.00 | 16,961.48                       |  |  |
| BANSEFI <sup>2/</sup> | 1,977.00   | 90.80                           |  |  |
| SHF                   | 62,341.00  | 2,863.08                        |  |  |
| BANJÉRCITO            | 35,858.00  | 1,646.82                        |  |  |

Figure A.1: Performing loans portfolio (as of December 31, 2016).

<sup>1</sup>/For BANSEFI the last available figure is from the end of the first semester of 2016.

<sup>2</sup>/The EUR/MXN exchange rate on 31/12/2016 was 21.7741.

Sources: FND, NAFIN, BANCOMEXT, BANOBRAS, BANSEFI, SHF, BANJÉRCITO and Banco de México.

Compared to other institutions, the FND is smaller in size, ranking in 5<sup>th</sup> place among them. This makes sense considering that primary activities averaged 3.14% of Mexico's GDP during the 2014-2016 period (BIE INEGI, 2018).

# FND's historical background

In January 1986, after the merge of the National Rural Credit Bank and 12 regional banks, the *Banrural System* was created with the purpose of funding the primary sector of the economy with a special focus on low-income famers. However, as a result of the high operating costs and the mismanagement that led to a severe financial imbalance on December 2002, after the Financiera

<sup>&</sup>lt;sup>31</sup> The FND is categorized by the CNBV as a development entity, not a development bank. However, for the purposes of this study it will be considered in this way.

Rural Organic Law enactment, the Federal Government ordered the dissolution and liquidation of Banrural (ASF, 2010).

Given the need to continue fostering the rural sector after Banrural's operations closure, the Federal Government created Financiera Rural as a decentralized body of the Federal Public Administration, under the wing of the Ministry of Finance and Public Credit and having its own legal personality and capital (Congreso de los Estados Unidos Mexicanos, 2002), but now excluding the National Credit Society figure. Formally, this entity began operations on July 2003. Since its creation and until its change in denomination as the current FND, the institution has followed a steady increase in the placement of resources to the target population.

Figure A.2: Histograms

• Gender subsamples



• Zones subsamples



b) Non-priority zones

a) Priority zones

• Type of credit subsamples



b) Non-fixed assets



c) Enabling


• Loan term subsamples



c) Long-term



• Year of origination



-3.946 -1.997 0 1.900 log(loan amount)-log(45,000 UDIs threshold)

3.849







Figure A.3: Bunching plots (preferred specifications).

• Gender subsamples



• Zones subsamples



a) Priority zones

#### b) Non-priority zones

• Type of credit subsamples

# a) Fixed assets



### c) Enabling



# b) Non-fixed assets

• Loan term subsamples

## a) Short-term



## b) Medium-term



### c) Long-term



• Year of origination

## a) 2014 (August 20, 2014 onwards)





c) 2016



|                 | Tradi                     | itional elasti | cities     |               |               |  |
|-----------------|---------------------------|----------------|------------|---------------|---------------|--|
| Category -      |                           | Polynomial     |            | Excluded bins |               |  |
|                 |                           | ±10%           | ±20%       | ±10%          | ±20%          |  |
| Selected sample |                           | 2              | 4          | 1             | 1             |  |
| Gender          | Male                      | 2              | 4          | 2             | 2             |  |
|                 | Female                    | 0              | 1          | 0             | 1             |  |
| Zono            | Priority                  | 0              | 2          | 1             | 1             |  |
|                 | Non-priority              | 0              | 0          | 1             | 2             |  |
|                 | Fixed assets              | 0              | 1          | 0             | 1             |  |
| Type of loan    | Enabling                  | 3              | 4          | 1             | 2             |  |
|                 | Non-fixed assets          | 4              | 5          | 2             | 2             |  |
|                 | Short-term<br>(0-1 years) | 5              | 5          | 0             | 0             |  |
| Term            | Medium-term               | 1              | 4          | 1             | 1             |  |
|                 | Long-term (>3<br>years)   | 0              | 0          | 1             | 1             |  |
|                 | 2014                      | 1              | 1          | 0             | 0             |  |
| Year            | 2015                      | 1              | 4          | 1             | 1             |  |
|                 | 2016                      | 0              | 1          | 1             | 1             |  |
|                 | Reduce                    | ed-form elas   | sticities  |               |               |  |
| Ca              | Catagory                  |                | Polynomial |               | Excluded bins |  |
| Ca              | legoly                    | 10%            | 20%        | 20%           | 20%           |  |
| Selecto         | Selected sample           |                | 5          |               | 2             |  |
| Gender          | Male                      | 4              | 5          |               | 2             |  |
| Gender          | Female                    | 1              | 3          |               | 2             |  |
| Zone            | Priority                  | 0              | 2          |               | 1             |  |
| Zone            | Non-priority              | 0              | 0          |               | 2             |  |
|                 | Fixed assets              | 1              | 3          |               | 1             |  |
| Type of loan    | Enabling                  | 4              | 6          |               | 2             |  |
| )T              | Non-fixed assets          | 5              | 5          |               | 2             |  |
|                 | Short-term<br>(0-1 years) | 5              | 5          |               | 1             |  |
| Term            | Medium-term               | 4              | 5          |               | 1             |  |
|                 | Long-term (>3<br>years)   | 0              | 1          |               | 1             |  |
|                 | 2014                      | 1              | 1          |               | 0             |  |
| Year            | 2015                      | 2              | 4          |               | 2             |  |
|                 | 2016                      | 0              | 3          |               | 1             |  |

Figure A.4: Applying robustness checks criteria (separated by type of robustness check).

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