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Liquidity or Capital?

The Impacts of Easing Credit Constraints in Rural Mexico

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Inter-American Development Bank
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Office of Strategic Planning and Development Effectiveness

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Contents

Abstract*

This paper evaluates the effectiveness of easing credit constraints for rural producers in Mexico through loans provided by a national public development finance institution (DFI). In contrast to most of the existing literature, the study focuses on the effect of medium-sized loans over a two- to four-year time horizon. This paper looks at the effects of such loans on production and investment decisions, input use, and yields. Using a multiple treatment methodology, it explores the differential impacts of providing liquidity for working capital versus providing credit for investments in fixed assets. It finds that loans increased the likelihood that producers grow and sell certain key annual crops, in particular among recipients of working capital loans. It also finds significant effects on production value and sales (per hectare), with similar impacts for recipients of both types of loans, with gains in yields driven by changes in labor quality and more intensive use of key inputs. There is no evidence of significant effects on the purchase of large machinery, but there are impacts on the acquisition of cattle. Overall, the results reported in this paper suggest that lack of liquidity is at least as important as lack of funding for new investment in capital for rural producers in Mexico. Producers benefit from easing their credit constraints, regardless of the type of loan used for that purpose.

JEL codes: G21, O13, O16, Q14

Keywords: agricultural finance, credit constraints, development finance institutions, investment capital, working capital

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1

Introduction

The characteristics of primary sector production, particularly in a developing country context, generate obstacles that limit the supply of financial services to producers. First, incomplete markets imply that there are insufficient instruments to manage the high risks associated with this sector, including weather, commercialization risks, and high price volatility.[1] Second, producers face limitations in terms of available collateral (Ghosh, Mookherjee, and Ray, 2000). Third, financial institutions face high operating costs due to geographic dispersion (Degryse and Ongena, 2005). Fourth, a large proportion of the producers operate on a small scale and with low profitability.

In the case of Mexico, these obstacles have led to a very low penetration of formal credit in the primary sector. In 2017, only 2.1 percent of total bank financing of the economy was channeled to agricultural producers,[2] just 9.9 percent of whom had accessed credit.[3] This insufficient access to finance is a critical obstacle to improving the conditions that drive growth and economic opportunities in the rural sector, such as overcoming low capitalization rates and investment (Escalante, Catalan, and Basurto, 2013; Love and Sanchez, 2009; Mora, Arellano, and Mendoza, 2011). Access to finance for productive purposes can facilitate the availability of working capital for the purchase of inputs and can allow new investment in equipment and infrastructure, crop conversion, and adoption of new technologies and productive capacities,[4] which can translate into higher profitability and productivity.[5]

[1] See, for example, Boucher, Carter, and Guirkinger (2008), Conning and Udry (2007), and Giné and Yang (2009) for more information.

[2] Banco de Mexico, data for 2017. For context, agriculture, forestry and fishing represent 3.4 percent of GDP and employed 13.1 percent of the population (World Bank, 2017 data).

[3] According to the survey Encuesta Nacional Agropecuaria (ENA) 2017, conducted by Mexico's national statistical agency, INEGI. As a comparison, according to an INEGI survey of firms in all sectors, 22 percent reported having a loan—more than twice as high a share as that for agricultural producers specifically (INEGI, Encuesta Nacional de Financiamiento de las Empresas, 2018).

[4] Uaiene, Arndt, and Masters (2009) analyze empirically the relationship between agricultural credit and technology and show that producers with access to credit are more likely to adopt technology. Foster and Rosenzwieg (2010) show that credit constraings play a preponderant role in delaying technology adoption.

[5] Guirkinger and Boucher (2008) show that in the case of Peru access to credit could increase agricultural productivity by 26 percent. Also, Sidhu, Vatta and Kaur (2008) show the positive correlation between credit, investment, and productivity in India.

In particular, access to credit is the key determinant of productive decisions and the amounts of investments realized.[6]

In this context, the role of public development finance institutions (DFIs) is particularly relevant in helping to relieve market failures and other factors that restrict credit. This study seeks to contribute to the literature on the impacts of credit programs provided by DFIs to the primary sector. Since this is a common type of intervention in the Latin American and Caribbean (LAC) region, the importance of generating knowledge about their effectiveness cannot be understated. Even though there is a vast empirical literature on the impacts of credit programs, some important knowledge gaps persist. Much of the literature focuses on microcredit and evidence of its effects over a relatively shorter term; in addition, most studies explicitly or implicitly focus on loans for investment in fixed capital[7] and do not differentiate between investment loans and those intended for the financing of working capital.[8]

This paper presents rigorous empirical evidence on the effectiveness of different credit programs offered by a public DFI in Mexico, the National Agricultural, Rural, Forest, and Fishing Development Finance Agency (Financiera Nacional de Desarrollo Agropecuario, Rural, Forestal y Pesquero, or FND). It measures the medium-term effects of productive credit from FND on the production and investment decisions of rural producers, their productive performance, and the potential mechanisms for these effects. In terms of investment, it studies the effects on the acquisition of different assets. Importantly, it differentiates between the impacts of different types of loans: working capital (WK) and investment in fixed assets (FA) loans. This distinction has received less attention in the existing literature. The target population studied in this paper includes not only individual producers but also producers registered as firms. The empirical analysis is based on a multiple treatments approach using inverse probability weights (IPW) based on a generalized propensity score.

The literature on the impacts of lifting credit constraints has focused primarily on limited types of interventions, particularly the provision of microcredit and to some extent public credit programs for small and medium-sized enterprises (SME), including by DFIs. The evidence on the effects of credit on microenterprises[9] may be less relevant in a context of productive credit programs where treated firms and the loans they acquire tend to be larger and the management skills and organizational structures of these firms tend to be different. Also, the profile and credit processes of the financial entities supplying the services are vastly different. For the credit program studied here, loan amounts are approximately $34,000, compared to less than $1,000 on average in studies on microcredit. In addition, the target population of the program includes established producers with at least seven years of experience, which contrasts with the usual target population of microcredit evaluations.

The available studies that focus on public credit programs aimed at SMEs include those of Echavarría, McAllister, and Villamizar-Villegas (2017), who study the impact of credit programs on coffee producers in Colombia[10]; Eslava, Maffioli, and Meléndez (2014), who study the effects

[6] Love and Sánchez (2009) find significant differences in the investment in physical assets between producers and agricultural enterprises subject to credit rationing compared with those with access to formal credit. Mora, Arellano and Mendoza (2011) demonstrate the importance of having additional monetary resources, particularly formal credit, as a determinant of productive investments and their magnitude.

[7] See, for instance, Karlan et al. (2014) in the case of farmers in Ghana, McKenzie and Woodruff (2008) for firms in Mexico, and De Mel et al. (2008) in Sri Lanka.

[8] An exception is the analysis of Banerjee and Duflo (2014), which looks at the effects of bank lending for working capital on Indian firms.

[9] For a review of the current literature on microcredit, see Banerjee (2013) and Banerjee et al. (2015).

[10] Furthermore, Echavarría et al. (2017) study the impacts of credit on producers using a national agricultural census.

of public lending through a second-tier DFI in Colombia; IDB (2014) and De Negri, et al. (2011), who look at the impacts of public lending for SMEs in Brazil; and Bueso-Merriam et al. (2016), who investigate the impact of a public-backed credit program in Argentina directed at firms of various sizes. Furthermore, Banerjee and Duflo (2014) estimate the impact of a credit expansion by a public bank for medium-sized enterprises in India; Zia (2007) investigates the impact of a reduction in subsidized credit on private firms; and Jiménez et al. (2017) estimate the effects of government lending on firms during an episode of credit crunch. Most of this literature does not focus on firms in the primary sector, and its lessons may not always be applicable to the rural context due to sector-specific issues, specifically, the high transaction costs resulting from remote locations and geographic dispersion, high seasonality, and the significant degree of correlation of production, market, and price risks. Consequently, there is a need to understand the effectiveness of larger loans in that specific context.

In addition, while those general studies on SME focused primarily on the effects on the living conditions of beneficiaries and/or sales and productivity of the enterprises, they do not delve specifically into evidence regarding whether loans provided by a DFI (and the type of loan they provide) help catalyze productive investment or affect other production decisions. Since DFIs tend to have lower credit history requirements than private banks, public credit may allow firms to establish a credit history and to become part of the credit information systems (i.e. credit bureaus).[11] In particular, some of the credit lines studied here are directed to enterprises without credit history, receiving formal credit for the first time.

Finally, while there is a robust literature regarding the effects of credit in the short term, fewer studies measure those effects over the medium or long term. Indeed, one of the reasons for the modest effects of credit on microenterprise performance cited by the microcredit literature is that most evaluations take place one to two years after the intervention (short to medium term) (Banerjee, 2013). Therefore, the lack of impacts may be due to the fact that expected effects may take longer to materialize and, hence, may be only observed in the medium to long term. This paper studies the effects of loans to producers and firms that have had between one to four years to mature,[12] that is, short- and medium-term effects.

The results show that FND loans increased the likelihood that producers grow and sell certain key crops. All of the significant effects in terms of crop decisions ocurred for annual crops, with no effect seen on perennials, and are driven primarily by working capital (WK) loans rather than fixed assed (FA) loans. Significant effects are also found for production value and sales (per hectare), both overall and for specific crops (primarily maize). These impacts are similar in size and significance for recipients of both types of

[11] The study by Eslava, Maffioli, and Meléndez (2014) is the only one that analyzes this effect, but it does not include rural SMEs. Otherwise, most of the evidence on access to credit and improvement of financial conditions comes from interventions that provide credit guarantees. For example, Jack et al. (2015) find that allowing for credit collateralization increases the probability of obtaining credit from 2 percent to 45 percent, approximately. D'Ignazio and Menon (2012) find that credit guarantees for SMEs lead to an increase in long-term loans and lower interest rates. Similarly, Lelarge, Sraer, and Thesmar (2010) find that credit guarantees cause firms to raise more external finance and pay lower interest rates, while Peña and Rios (2013) find that credit guarantees are associated with lower interest rates and higher loan amounts.

[12] Approximately 50 percent of the FND loans studied here were granted in 2012 and 2013; the remaining 50 percent were granted in 2014. The follow-up survey, which took place at the end 2016 and in 2017, asked producers for information regarding the most recent agricultural year (Oct 2015-Sep 2016). More limited information was also gathered in the survey for the treatment (2012 to mid-2015) and pretreatment periods (2009 to 2012).

loans. The gains in yield appear to be achieved via labor quality, as producers hire more paid workers (replacing unpaid labor), as well as through a more intensive use of certain types of key inputs (in particular those that are part of a technological package that is sometimes required, as will be discussed later). At the same time, there is no evidence of significant effects on the purchase of large machinery (the type of purchase that could be expected as associated to an FA loan); there are, however, impacts on the acquisition of cattle, an intended use of FA loans.

Overall, the results in this paper suggest that lack of liquidity is at least as important a constraint for rural producers in Mexico as funding for new investment in capital, and that producers benefit from easing their credit constraint, regardless of the type of loan used for that purpose.

2

Institutional Characteristics and Criteria for Credit Approval

This paper studies an intervention in the Mexican credit market through FND.[13] FND operates both as a first-tier financial institution, granting credit directly to final beneficiaries, and as a second-tier institution, channeling credit though other regulated financial institutions. In this paper we focus on the former type of operations only.

After a period of slow growth following its creation in 2002, FND substantially increased its loan portfolio since 2013; it doubled in the period 2013–2017, reaching an equivalent of over $3.5 billion by the end of 2017. Longer-term loans for productive investments increased their share in the total portfolio from 22.4 percent to 29 percent in the same period. The latter reflects a policy aim of FND, supported by resources provided by the IDB, of increasing the supply of credit to rural producers for investment in productive assets and to adopt improved technologies.

In this respect, based on the intended use of the credit, loans provided by FND could be classified as follows: (i) loans for working capital (WK) and (ii) loans for investment in fixed assets (FA).[14] Applicants decide on the type of loan they apply for based on the intended use of the funds and loan characteristics (e.g., maturity). Working capital loans are characterized as short-term loans; they are generally intended for recurring activities, such as payroll and purchase of inputs (seeds, fertilizers, etc.). Investment loans are characterized by medium- to long-term repayment periods. They are generally intended for real estate, capital improvements and asset purchases, primarily machinery, equipment, and vehicles (45 percent of all fixed asset loans

[13] FND's mission is to channel resources for the development of agricultural, forestry, fishery, and other economic activities linked to the rural environment, with a view to boosting productivity and improving the population's living standards.

[14] FND refers to working capital loans as "capital de trabajo" or "avio", and it refers to investment loans as "activo fijo" or "refaccionario." FND also offers a different type of loan referred to as "simples"; however, these types of loans may themselves be classified as loans for working capital or investment.

in 2010–2018), as well as livestock (39 percent). FND records the credit type on each loan application and evaluates the loan applications, taking into account the type of loan and the client's credit history with FND, among other factors.[15]

Working capital loans are commonly accompanied by a technological package (TP) from FND. These TPs integrate standardized, verifiable, and repeatable components to parameterize a particular activity, with the objective of ensuring the feasibility of the loan by increasing the productive efficiency of a certain crop in a certain region. For example, TPs may provide guidance on the best-practice type of seeds to use, planting density, fertilizer use, required irrigation, and proper use of machinery and labor. In addition to the information regarding best practices, TPs include the necessary inputs to implement such practices and the support of an agricultural specialist to provide technical assistance. Nearly three quarters of borrowers with WK loans in the period analyzed were either encouraged or required[16] by FND at loan approval to adopt the TP.

[15] All loans under a pre-specified amount (700,000 UDIs; between 3.3 and 3.7 million pesos in the period of analysis) are evaluated based on a credit scoring methodology, and this paper focuses on those loans only; loans above the threshold are evaluated on a case-by-case basis. A credit scoring model with a threshold for approval in principle would present an opportunity to use regression discontinuity methods as an identification strategy. In this case, this was not possible because the credit approval rule based on the credit score was not always followed, and it ended up being a weak instrument for credit adoption.

[16] Applicants for WK loans whose application was initially rejected and who then appealed to the credit committee were required to adopt the technological package as a condition of loan approval.

3

Data

The data used in this paper comes from administrative data from FND and a survey of agricultural producers/enterprises who are either clients of FND or applied for a loan from FND between 2012 and 2014. The former provides information on clients' credit history with FND, while the latter gathered detailed data on their production and investment decisions, business practices, output, and sales.

3.1 ADMINISTRATIVE DATA

In 2012, FND introduced major changes to the methodology it uses to assess applications and approve loans. As a result, this paper focuses on applications starting in 2012 through the end of 2014. It was considered necessary to wait at least two years for the results of the loan to materialize, so this application period matches well with the survey data that was gathered starting in 2016. The FND database used in this paper contains information on all credit applications between 2012 and 2014 below the threshold of 700,000 UDIs[17], which is equivalent to between 3.3 and 3.7 million Mexican pesos (MXN) during the period in question. In other words, the loan portfolio that comprises the dataset used in this paper includes applicants for all small and medium-sized loans originated by FND in this period.

Each observation in the database corresponds to a single loan application. A significant number of producers apply for more than one FND loan, and they therefore appear more than once in the dataset. The database has a unique identifier for each application and a unique identifier at the client level (individual producer or company). The unique client indicator enables the credit history that each producer/company has with FND to be reconstructed, not just during the treatment period (2012–2014). Thus, we have data starting in 2003 and ending in mid-2018; this database for the regions of interest consists of nearly 21,000 applicants.

The data include the number of loans that were applied for and approved, their amount, the type of loan (fixed asset or working capital), its purpose (e.g. purchase of inputs, investment in machinery, etc.), interest rate, duration, and type of collateral (for a full list of the variables in the administrative database, see Appendix). The pre-treatment period data are used in the generalized

[17] UDI, or Unidad de Inversion, is an inflation-linked unit of account that was originally introduced in 1995, after the currency crisis in Mexico. Because the UDI adjusts for inflation, it maintains its purchasing power and reduces potential losses from currency devaluation, including the likelihood of defaulting on loans.

propensity score analysis to select comparable producers, while the treatment period data allow us to classify clients into one of three treatment groups, as explained in more detail below.

A key difference between the two types of loans (FA and WK) is their average maturity. The majority of WK loans in the sample have maturities in the 6 to 12 month range, while few were approved with a tenor longer than one year (see Table 1 and Appendix, Figure A1). FA loans, on the other hand, are most commonly (60 percent of all FA loans) approved with a tenor of 4 to 6 years. Interest rates on FA and WK loans are similar and tend to rise and fall together over time. This is likely due to the fact that, according to FND, interest rates were set administratively and did not necessarily depend on the type of loan.

Somewhat surprisingly, the average and median amounts are lower for fixed asset than for working capital loans throughout most of the period for which data is available. In the treatment period of 2012–14, for example, the median WK loan was 612,000 pesos, or almost twice as high as the same value for FA loans (343,000 pesos).[18] In addition to the fact that the median amount of WK loans is higher, borrowers took out more of them, as would be expected. As a result, the cumulative amount of WK loans they received was much higher. Typically, among those who received a loan, the total amount of WK loans was more than twice as high in the treatment period, and in the post-treatment period more than three times as high.

An important distinction between the two loan types are the collateral requirements. Approval of an FA loan is much more likely to require a guarantee in the form of collateral. Approximately 86 percent of all FA loans in the dataset have a guarantee, while this is the case for just under 50 percent of WK loans.[19]

3.2 SURVEY DATA

To obtain detailed data on production and investment decisions, a survey of producers that applied for loans from 2012 to 2014 was carried out starting in November 2016. The survey questionnaire was based on the agricultural census and surveys done by the Mexican National Statistics Institute (Instituto Nacional de Estadísticas y Geografía, or INEGI) and included questions to measure total production and productivity. It also included a comprehensive module on financial services and retrospective questions used to construct a baseline. The objective of the survey was to obtain a representative sample of applicants, both those that received and those that did not receive loans in the Northeast, North and Center-Occidental regions[20] of Mexico. We obtained complete surveys for 2,758 producers.

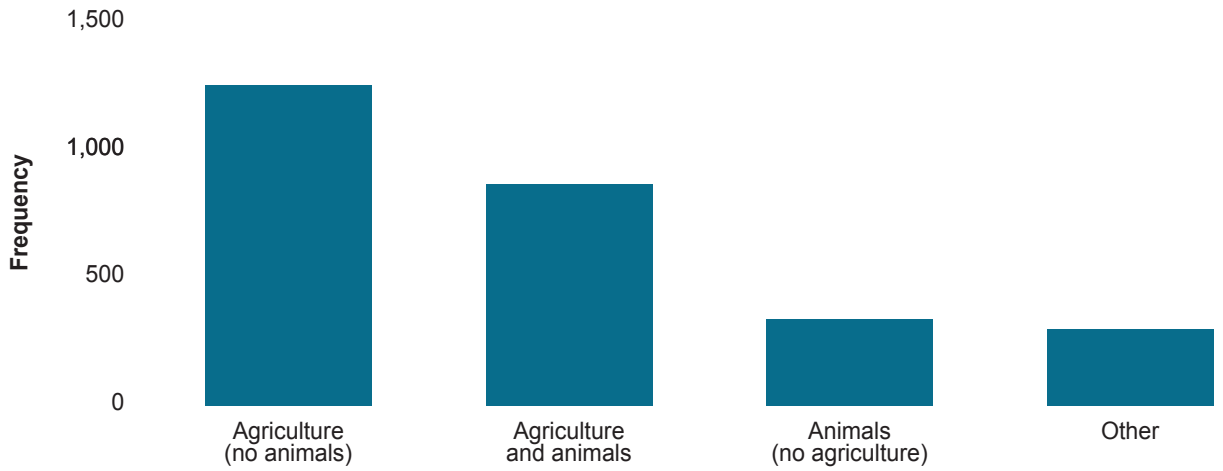
Originally, the intention was to interview 4,000 out of the universe of nearly 21,000 applicants. However, during the data collection process, significant problems were encountered in locating respondents, which substantially increased the cost and time per survey completed. As a result, the target for the sample was lowered to 3,000 respondents; ultimately, during field work, the final number of valid surveys obtained was 2,758. To reach that number, it was necessary to attempt to contact 12,839 loan applicants. There were five reasons for this response rate: (i) in 13 percent of cases, the address could not be found during the visit to the locality; (ii) in 31 percent of cases, the

[18] The average exchange rate during 2012–2014 was USD/MXN≈13.

[19] There are also differences between the two loan types regarding the type of collateral. For FA loans, this typically involves various assets (including certificates of deposit) used as collateral (68 percent of cases), or somewhat less commonly mortgages (32 percent); in the case of WK loans, the collateral is most often (62 percent) the good or product that is the object of the financing (e.g., the harvest itself), a relatively weak form of collateral.

[20] The Northeast region includes the states of Baja California Norte, Baja California Sur, Sinaloa and Sonora; the North encompasses Chihuahua, Coahuila, Durango, Nuevo Leon, San Luis Potosí, Tamaulipas and Zacatecas; while the Center-Occidental region includes Aguascalientes, Colima, Guanajuato, Jalisco, Michoacan, Nayarit, and Queretaro.

FIGURE 1 DISTRIBUTION OF THE SURVEY SAMPLE BY MAIN ACTIVITY



house was found but did not correspond to the applicant (e.g. the applicant had moved); (iii) in 26 percent of cases, the correct house was found but the applicant was not present even after several visits; (iv) in 8 percent of the cases, the applicant refused to participate in the interview, or it was cut short; and (v) in 1 percent of the cases, the original loan applicant had died or was incapacitated, or for other reasons was unable to respond to questions. Obviously, this high nonresponse rate raises concerns of potential selection bias, and we discuss in detail how we deal with this issue in Section 5.1.

Throughout the 2009–16 period, 74 percent of respondents were engaged in agriculture, defined as reporting that they cultivated at least one crop during the period. Among agricultural producers by far the most common crop was white maize, grown by 56 percent of producers in the treatment period, followed by beans (21 percent), wheat (18 percent), sorghum (16 percent), and yellow maize (11 percent). These and other annual crops were much more commonly grown (91 percent of producers engaged in agriculture) than perennial crops (e.g., alfalfa or sugarcane), which were grown by fewer than a quarter of producers (23 percent). Most agricultural producers sell at least some of their crop. In the 2015–16 period, 85 percent report having done so; that is, they report a sales value. At the same time, a significantly smaller share of the sample (44 percent) was engaged in animal production at some point during 2009–16; most of them raised cattle (87 percent), while some raised pigs (16 percent), sheep (15 percent), poultry (8 percent), and goats (6 percent). See Figure 1 for the distribution of the survey sample by main activity.

3.3 TREATMENT DEFINITION

We define the treatment based on whether an applicant received a particular type of loan during the treatment period from January 2012 until December 2014[21]. Accordingly, there are three treatment groups: (i) Control (T=0), which did not receive FND loans, (ii) FA (T=1), which received FA loan(s) or FA and WK loans[22] from FND, and (iii) WK

[21] See section 3.1. regarding the definition of the treatment period.

[22] 304 applicants, or a third of this treatment group, have both a fixed asset and a working capital loan; the rest have only a fixed asset loan.

TABLE 1 KEY LOAN CHARACTERISTICS BY BORROWER, BY TREATMENT GROUP AND TIME PERIOD (UNIVERSE OF APPLICANTS)

	Pre-treatment (2003–2011)			Treatment (2012–2014)			Post-treatment (2015–2016)		
	Control	FA	WK	Control	FA	WK	Control	FA	WK
Share of applicants with: either type of loan	0.12	0.39	0.44	0	1	1	0.61	0.33	0.41
FA loan	0.03	0.15	0.07	0	1	0	0.37	0.16	0.09
WK loan	0.06	0.29	0.39	0	0.32	1	0.28	0.22	0.37
Mean loan amount, annual avg: all loans	30.8	197.0	222.7	0	563.2	522.8	204.3	327.8	350.4
FA loans	3.7	21.1	7.1	0	291.1	0	75.9	95.9	28.6
WK loans	24.9	165.5	208.5	0	272.1	522.8	128.5	231.9	321.8
Average maturity (months): all loans	21.3	19.6	13.6	—	40.9	9.3	34.0	24.0	14.7
FA loans	45.0	40.8	46.9	—	48.7	—	53.4	46.2	51.1
WK loans	9.2	9.3	8.9	—	8.9	9.3	8.2	9.2	8.8
Average interest rate on loans	13.5	13.8	14.0	—	12.1	11.4	9.3	10.7	10.1

Note: Loan amounts are in thousands of pesos and are adjusted for inflation (2018=100).

(T=2), which received only WK loan(s) from FND. The number of applicants in the survey sample is similar across groups: 917, 930, and 913, respectively. Table 1 summarizes some key characteristics of the loans by treatment group for the universe of applicants and for the three time periods[23]: before treatment (prior to 2012), during treatment (2012–14), and after treatment (2015–16).[24]

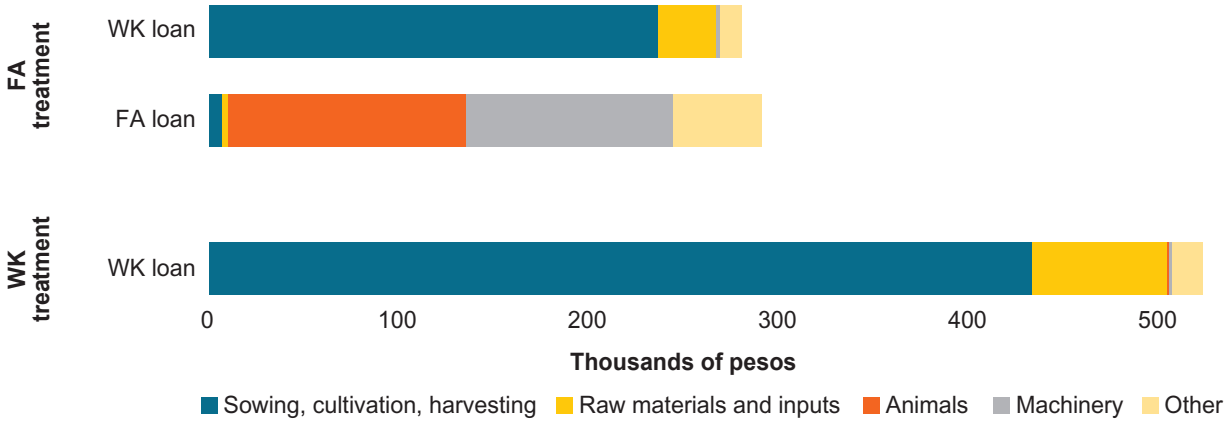
By construction, in the treatment period everyone in the WK treatment group has a WK loan, while everyone in the FA treatment group has an FA loan. But the likelihood of having a loan is not necessarily higher for each group and type of loan in the post-treatment period than it was before. For example, 85 percent of the FA group had never received a FA loan prior to the treatment period, and in the post-treatment period the likelihood of obtaining one is again low (16 percent). Differences do exist between loan amounts, which increased substantially in the treatment period and, though they decreased somewhat thereafter, remain higher than before 2012.

There is a significant difference in maturities between types of loans, but once we control for having the same type of loan, not between treatment groups. Maturities are also similar over time. That is, WK loans appear to have been approved with a nine-month tenor throughout

[23] The same table, but for the weighted survey sample (i.e. weighting by the inverse generalized propensity score) is shown in Table A3.

[24] Although administrative data is available until mid-2018, the table only includes the period until the end of 2016. This is to limit the post-treatment period to the same timespan as the one covered by the survey. That questionnaire collected information on the 2015–16 agricultural season.

FIGURE 2 INTENDED PURPOSE OF LOANS, BY TREATMENT GROUP AND TYPE OF LOAN, 2012–2014



the 2003–16 period. Interest rates, on the other hand, fall slightly over time for both loan types and are also similar between groups.

Another issue of note is the extent of Control group "contamination" in the post-treatment period: 61 percent of that group has a loan in 2015–2016, which is also higher than for the two treated groups. This suggests that the difference between treated and control groups is partially in the timing of obtaining a loan from FND, as opposed to only the probability of obtaining one at all.

The administrative data also records the intended use for each loan (Figure 2). In both treatment groups, WK loans are typically used to finance activities related to sowing or harvesting, which may include costs related to hiring workers, purchase of seeds, equipment rental, and others. On the other hand, borrowers took out FA loans to buy machinery (e.g., tractors) and animals.

4

Methodology

We study the effects of receiving a loan using a methodology based on inverse probability weighting (IPW), using a generalized propensity score (GPS) for multiple treatments (Hirano and Imbens, 2004; Imbens, 2000).[25] Specifically, we employ the methodology proposed by Flores and Mitnik (2013), which relies on a *selection on observables* or *unconfoundedness* assumption, and use a multiple-treatment non-experimental estimator to eliminate the differences in pre-treatment observable characteristics between observations (in this case, individual farmers). In the first step, the GPS is estimated using a multinomial logit model, and the observations satisfying simultaneous overlap across treatments are identified.[26] Simultaneous overlap is attained by defining the *overlap region* for each treatment: based on the probability of belonging to a particular treatment T=*t*, only those farmers with probability above a certain quantile *q* threshold are deemed to be part of the overlap region for that treatment. Simultaneous overlap is deemed to satisfy the overlap condition for all the farmers that are part of the overlap region simultaneously for all treatments.[27] Intuitively, it implies that farmers are comparable in terms of covariates in each of the treatment groups.

In a second step, we estimate inverse probability weighting (IPW) regressions of the form:

$$Y_i = \sum_t \beta_t D_t + \delta X_i + \varepsilon_i$$

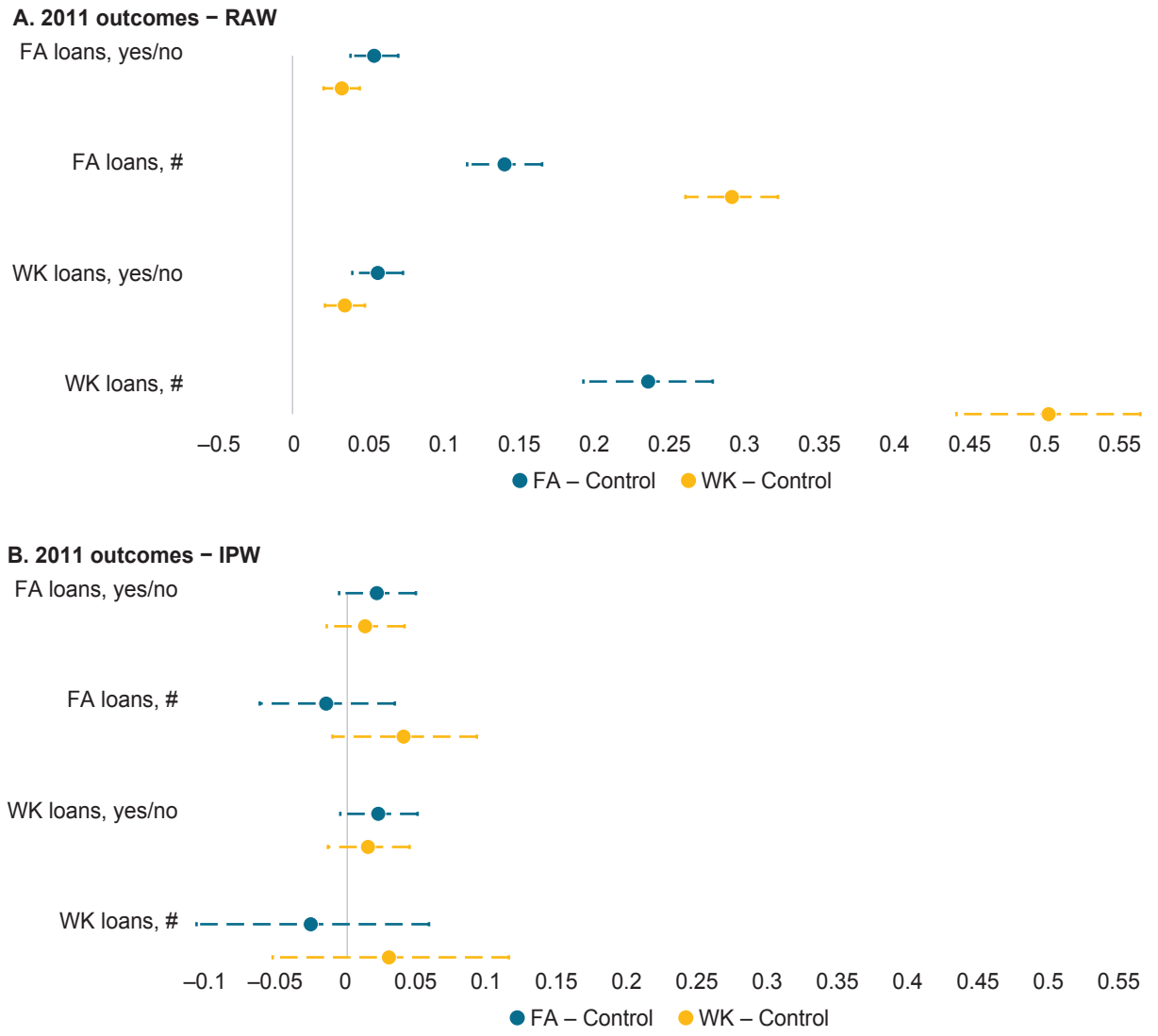
where Y_i is the outcome variable; D_t are dummies for treatments t=0 (Control),1 (FA), 2 (WK); X_i are a set of covariates for observation i; and ε_i is an error term. These regressions are estimated only for those observations satisfying the overlap condition and using weights that are equal to the inverse of the GPS of observation i. We report in the results section IPW treatment effects as the difference in the expected outcomes conditional on covariates for treatments FA and WK versus the Control treatment. We obtain treatment effects for both the administrative data sample that include all applicants and for the sample of surveyed producers, by estimating the GPS and the above equation for each of these samples separately.

[25] The GPS is the probability of a particular treatment conditional on covariates, $\Pr(T=t \mid X=x)$, where $t=0,1,2$ and X refers to pre-treatment covariates.

[26] Following Flores and Mitnik (2013), simultaneous overlap is defined as $0<\xi<\Pr(T=t \mid X=x)$ *for all* t and $x \in X$.

[27] To define the overlap region of each treatment, we impose q=0.25 as the threshold. The results are robust to alternative values of q, and are available from the authors upon request.

FIGURE 3 PLACEBO TREATMENT EFFECTS WITH PRE-TREATMENT ADMINISTRATIVE DATA



Note: Bars show 95 percent confidence intervals; the intervals are obtained with bootstrapped standard errors, using 500 replications.

In the first step, the estimation of the GPS, we rely on FND detailed administrative data for the pre-treatment period regarding applicants' credit history with FND, legal status (firm or private person), geographic location (state), and the number of years the firm/person has been engaged in the activity. In addition to the variables from the administrative dataset, we also include as a covariate the predicted probability of being surveyed, based on the same administrative data,[28] in levels as well as its square and cube (see Appendix B for the full list of covariates). We impose simultaneous overlap based on

[28] For more details see section 5.1 and the Appendix, as well as Figure 3.

the GPS distribution, dropping around 1 percent of observations.[29] In the second step, we include the same covariates in the regression estimation as in the GPS estimation. The treatment effects standard errors are obtained by bootstrapping both steps together. Throughout the paper we use 500 bootstrap replications.

Placebo treatment effects can be used as a check of the extent to which our methodology is successful in reducing pre-treatment differences between the treated and control groups. For this purpose, we use the same covariates as above, but restricted to the period 2003 until 2010, and obtain placebo treatment effects associated with the 2011 outcomes from the administrative data (e.g., the probability of having each type of loan and their number). If the methodology is successful, we should not observe significant treatment effects for 2011, given that these are pre-treatment outcomes. Figure 3 summarizes those results. The top panel (a) presents the raw average differences between the treatment groups (before imposing overlap), showing large differences between the FA and WK groups on the one hand, and the Control group on the other. All the estimates are significantly different from zero, with the differences being particularly large in the case of the number of WK loans. Panel (b) on the bottom shows the difference between the treated and the control groups after estimating the IPW treatment effects, which are statistically indistinguishable from zero for all outcomes. This suggests that our methodology is successful in removing pre-treatment differences and creating groups that are comparable at baseline.

[29] We drop 1.1 percent of the observations in the administrative data sample (20, 71, and 132 observations in the Control, FA, and WK treatments, respectively) due to the imposition of the overlap condition. In the survey sample we drop 0.7 percent of the observations (5, 7 and 7 observations in the Control, FA, and WK treatments, respectively) for the same reason. Other values of the threshold q were tested, and the results are robust to the choice of cutoff.

5

Analysis and Results

In this section, we first analyze and discuss potential selection bias issues resulting from the high non-response rate for the survey mentioned in section 3.2. Then, we present an analysis of the effects of the program on agricultural and animal production, as well as the potential mechanisms for those effects.

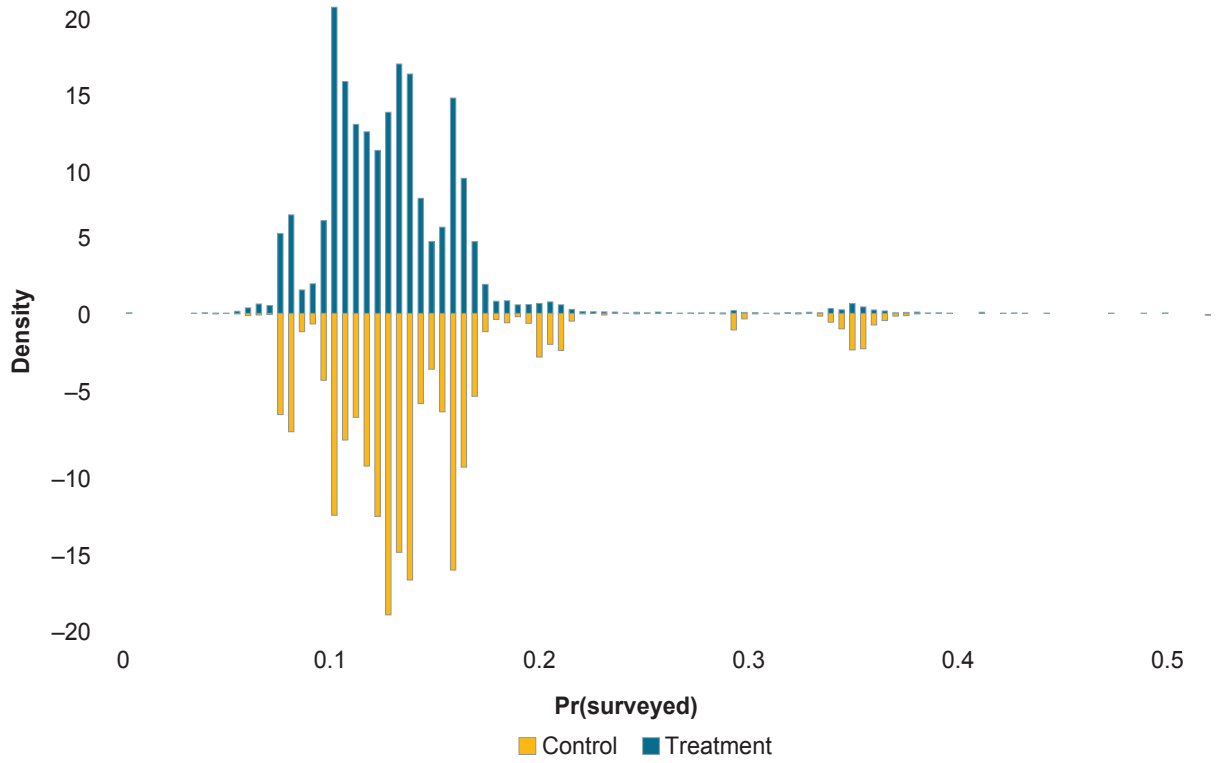
5.1 SURVEY SAMPLE SELECTION

As noted previously, the universe of applicants between 2012 and 2014 consisted of nearly 21,000 firms or individuals, and the survey was completed by 2,758 out of almost 13,000 applicants contacted. The high non-response rate, discussed in Section 3.2, creates the potential of sample selection bias. To investigate this issue, we performed an analysis comparing administrative data for the applicant population (the "universe") and the sampled population (the "survey sample") to see whether there are significant differences in characteristics between the two groups. We show that for some intermediate outcomes (i.e., post-treatment credit behavior), the two samples provide very similar results.

A comparison of key variables from the administrative data, regarding whether, how many, what type, and the total amount of loans that borrowers received in each year prior to the treatment period—suggests that overall, the surveyed and the non-surveyed applicants were equally likely to have a loan from FND (see Appendix, Table A1). The number of loans also does not differ in any of the years, while the total amounts appear to be somewhat higher in two out of the nine years for which data are available prior to the start of the treatment period (i.e., 2003–2011). Applicants are also similar in terms of whether they are registered as a firm (11.8 percent among non-surveyed vs, 11 percent for surveyed), as well as the length of time they have been engaged in agricultural activity (around 25 years in both cases).

In addition, we determine whether there is a difference in the likelihood of having participated in the survey between treatment and control groups, that is, those that received and did not receive loans during the treatment period. We predict the probability of participating in the survey with the available administrative data for the pre-treatment period and check the distribution by treatment group. This probability appears to be similarly distributed between those that received a loan in 2012–2014 (treated) and those that did not (control) (Figure 4).

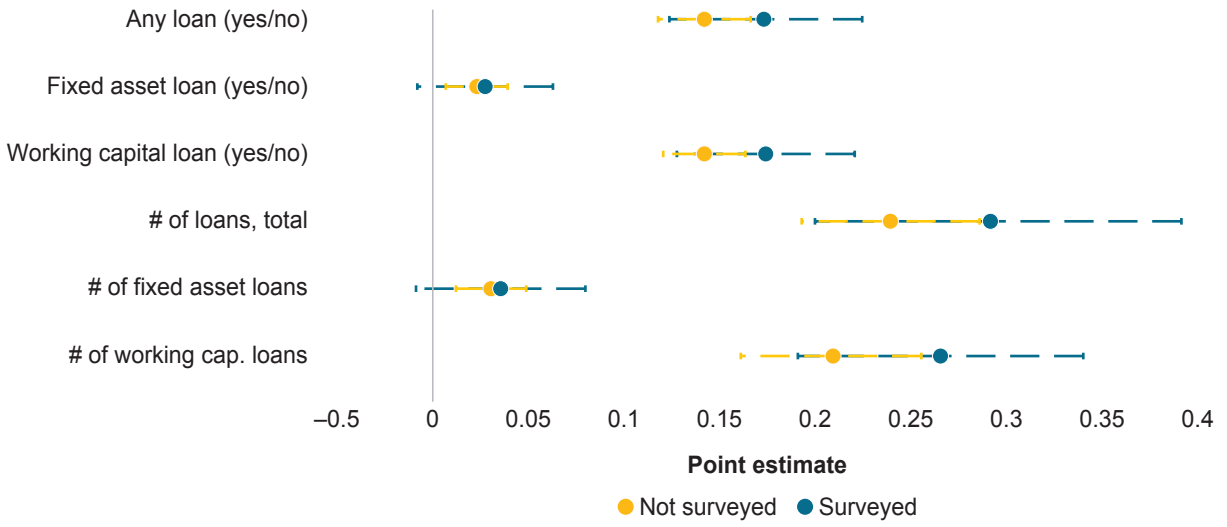
FIGURE 4 PREDICTED PROBABILITY OF SURVEY PARTICIPATION



Applying the IPW treatment effects methodology, we then look at changes in credit behavior in the post-treatment period as an intermediate outcome for the three treatment groups. We first use this data in an additional test of whether the surveyed and the non-surveyed groups are similar. Specifically, we estimate the treatment effect on the probability of receiving a loan (overall and by type) and the number of loans received for the post-treatment period 2016–2018. For purposes of this comparison, the two treated groups are pooled together so that we could compare a single point estimate for each outcome variable. As shows, treatment effect estimates of the probability of having a loan, as well as the number of loans received for the two groups, are statistically indistinguishable, indicating that in terms of the administrative data outcomes, the surveyed and non-surveyed farmers are in fact comparable. Taken together, the results presented in Figures 3 and 5 suggest the validity and robustness of our methodological approach, since it is able to provide comparable treatment and control groups at baseline, and shows evidence that those groups are representative of the universe of FND applicants in 2012–14.

After establishing that the survey sample is representative of the universe of borrowers, we analyze the treatment effects for administrative data in more detail (see Appendix, Table A4). These results suggest that treated groups are overall less likely to obtain another FA loan in the immediate post-treatment period (i.e,. starting in 2015), but that they continue to receive more WK loans (33 percentage points higher in the WK treatment group and 25 in FA+WK). Both of these results are largely to be expected. If a farmer received an FA loan

FIGURE 5 POST-TREATMENT 2016–2018 TREATMENT EFFECTS FOR SURVEYED VS. NON-SURVEYED GROUPS



Note: Error bars denote 95 percent confidence intervals; bootstrapped standard errors (500 replications).

between 2012 and 2014, which typically has a tenor of several years, they are unlikely to get another one in 2015. On the other hand, WK loans are typically used for recurring expenses and are thus often rolled over, which explains why those with more WK loans in one period would also have more of that type of loan in the next. If we wait another year, and instead focus on the results for the period after 2015, past recipients of FA loans are more likely to obtain another FA loan (6 and 16 percentage points in the FA and FA+WK groups, respectively).

5.2 RESULTS

Given the distribution of activities shown in Figure 1, the paper focuses on agricultural producers. This section presents results on the effects of the credit program on production decisions, input use, and production value for the agricultural year starting in October 2015 and ending in September 2016 (which includes two planting seasons). Since the treatment period during which loans were approved lasts from 2012 until the end of 2014, we observe outcomes between approximately 1 and 4.5 agricultural years from the time those in the treatment group obtained a loan.

5.2.1 Effects on Agricultural Production

Production Decisions

First, we explore the extent to which the treatments may have affected producers' decisions regarding the type and number of different crops to plant. The effects of treatment on agricultural producers appear stronger in the case of WK loans. The WK treatment group is significantly more likely (+9 p.p.) to cultivate crops. This is entirely due to an increase of the same magnitude in the likelihood of planting annuals, while perennials are unaffected (see Table 2). In addition, the WK group is 9 p.p. more likely to cultivate and 11 p.p. more likely to sell maize (either white or yellow varieties); the WK group is also 5 p.p. more likely to cultivate at least one of the top

TABLE 2 PRODUCTION DECISION TREATMENT EFFECTS – AGRICULTURE

	Control	Treatment effects: FA		WK		FA-WK
	mean	point est.	s.e.	point est.	s.e.	p<0.05
Cultivates any crops	0.70	0.01	(0.03)	0.09***	(0.03)	Yes
Cultivates perennials	0.02	0.00	(0.01)	0.01	(0.01)	
Cultivates annuals	0.71	0.01	(0.03)	0.09***	(0.03)	Yes
Top 5 annuals – cultivates	0.78	0.00	(0.03)	0.05**	(0.03)	Yes
Maize – cultivates	0.48	0.07*	(0.04)	0.09**	(0.04)	
Sells any crops	0.73	0.00	(0.10)	0.11	(0.08)	
Sells any annual crops	0.71	0.00	(0.11)	0.09	(0.11)	
Top 5 annuals – sells	0.60	0.00	(0.04)	0.08**	(0.04)	
Maize – sells	0.35	0.00	(0.05)	0.11**	(0.05)	Yes
Number of crops cultivated	1.91	0.00	(0.19)	0.02	(0.19)	
Total area planted (ha)	42.10	11.10*	(6.54)	–1.00	(4.42)	

Note: N=2755 for first three lines; N=2015 for the last; N=2117 for the rest. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; bootstrapped standard errors (500 replications). Outcomes refer to the period October 2015–September 2016.

TABLE 3 PRODUCTION AND SALES TREATMENT EFFECTS (CONDITIONAL ON PRODUCING A GIVEN CROP) – AGRICULTURE

	Control	Treatment effects: FA		WK		FA-WK	
	mean	point est.	s.e.	point est.	s.e.	p<0.05	N
Production value per ha (000 pesos):							
All annual crops	17.55	37.30**	(17.98)	42.31**	(21.12)		1839
Top 5 annual crops	19.08	28.13*	(16.80)	43.69**	(23.81)		1622
Maize	34.80	10.53*	(5.73)	1.31	(5.05)		1255
Sales per ha, top 5 annuals (000 pesos)	16.51	32.08*	(19.11)	36.19*	(19.22)		1622

Note: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; bootstrapped standard errors (500 replications). Outcomes refer to the period October 2015–September 2016.

five most commonly grown crops[30], and 8 p.p. more likely to sell them.

Fixed asset loans do not appear to have had similarly strong and broad effects on production decisions. Still, there is a significant impact on increased cultivation of maize (7 p.p.). On the other hand, FA loans had a significant positive effect on the total area planted with annual crops, with an increase of 26 percent over the Control group mean.

The loan program does not appear to have had an impact on crop diversification. The number of different annual crops grown is not statistically significantly different between the three groups, with most farmers growing only two types of crops.

[30] In addition to white and yellow maize, this group includes beans, wheat, and sorghum.

TABLE 4 MACHINERY AND INPUT USE TREATMENT EFFECTS – AGRICULTURE

	Control	Treatment effects: FA		WK		FA-WK
	mean	point est.	s.e.	point est.	s.e.	p<0.05
Machinery use:						
Dummy (yes/no)	0.98	0.00	(0.01)	0.00	(0.01)	
Index (0–12)	4.06	0.05	(0.15)	0.21	(0.14)	
Input use:						
Dummy (yes/no)	0.96	0.01	(0.01)	0.02*	(0.01)	
Index (0–11)	4.81	–0.01	(0.21)	0.43**	(0.21)	Yes
Tech. package use – dummy	0.94	0.01	(0.02)	0.03*	(0.02)	
Tech. package use – index (0–5)	3.35	0.22	(0.26)	0.58**	(0.26)	
Non-organic input use – dummy	0.80	0.05	(0.11)	0.11	(0.11)	
Non-organic input use – index (0–6)	2.64	0.20	(0.29)	0.55*	(0.29)	
Organic input use – dummy	0.88	0.00	(0.02)	0.00	(0.02)	
Organic input use – index (0–5)	1.79	–0.20	(0.16)	–0.19	(0.16)	
Improved cultivation practices:						
Dummy (yes/no)	0.63	0.02	(0.06)	0.08*	(0.04)	Yes
Index (0–10)	1.42	–0.10	(0.12)	0.06	(0.24)	Yes

Note: N=2121. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; bootstrapped standard errors (500 replications). Outcomes refer to the period October 2015–September 2016.

Production and Sales

After finding that the loans affected producers' decisions regarding whether or not to plant certain crops, we also investigate the extent to which they may have impacted yields for those crops, conditional on planting. The value of production, measured in pesos per hectare, increased for maize in the FA treatment group by 0.05 standard deviations over the control.[31] The value of production per hectare of the top 5 annual crops was significantly higher in both treatment groups (by 0.3 standard deviations in FA and 0.5 in WK), as was the value of sales of those crops (by 0.4 standard deviations in FA and 0.5 in WK). The same is true of the yield overall for annual crops, which increased by 0.7 standard deviations in FA and +0.8 in WK.

5.2.2 Mechanisms

This section explores the possible channels by which an increase in credit from FND may have led to the increased cultivation of certain crops and value of production per hectare. These include the use of labor, technology adoption, and the use of inputs, as well as investment in capital.

Machinery and Input Use

One way that treatment may have contributed to higher production values per hectare is by facilitating access to higher-quality inputs. The survey questionnaire asked all respondents about their use of a variety of inputs before, during, and after the treatment period. Specifically, farmers were asked about their use of machinery (e.g., tractors, harvesters), improved and genetically modified

[31] Due to high variation in the data on production per hectare, the estimated coefficients are interpreted in terms of the standard deviations (for the Control group).

seeds, manure, natural, and chemical herbicides and insecticides, chemical fertilizer, fungicides, biofertilizer, and others.

Statistically significant effects on input use are seen mostly in the WK group. The binary indicator of overall input use (1 if any inputs on the above list are used and 0 otherwise) shows a statistically significant increase in the likelihood of using any inputs (2p.p.) and in their number (0.4, see Table 4). This appears to be primarily owing to an increase in the use of non-organic inputs: WK group farmers are 11p.p. more likely (though this is not statistically significant) than those in the control group to use one or more of these inputs (chemical fertilizer, herbicide, insecticide and fungicide, and GMO seeds), while the number of inputs used is higher by 0.6. At the same time, there is no effect on the use of most organic inputs (manure and biofertilizers, organic herbicides, etc.). In fact, point estimates are negative, though not statistically significant.

Regarding the use of inputs, it is important to look at the impact of requiring "technological packages." These packages are lists of recommendations to DFIs such as FND, prepared by the Ministry of Agriculture, universities, and other technical institutions, which outline the methods and inputs that should be used by agricultural producers to increase their yield for a given crop in a specific region. A package is prepared for each state and for each crop, including the type of seed to be used, when to plant and harvest, how to prepare the soil for planting, how and when to fertilize and irrigate, what to use for pest control, etc. In terms of inputs, for the main crops in the sample (white and yellow corn, beans, wheat, and sorghum), the recommendations include improved (non-GMO) seeds, as well as chemical fertilizer, pesticide, herbicide, and fungicide. Some FND loans were approved conditional on the borrowers adopting a technological package; in other cases, it was recommended though not required that they do so. FND administrative data include this information, which allowed us to check whether those that received loans in the treatment period tied to a technological package in fact adopted the recommended inputs, as well as whether they continued to use them after 2014.

Based on administrative data, a third of approved applicants received a loan that included a recommendation to adopt a technological package in the treatment period; for 5.7 percent of recipients, the adoption of the package was required as part of the loan. However, compliance with these requirements was not fully monitored; survey data suggests that a quarter of those who were supposed to adopt the technological package may not have done so[32] either during the treatment period or thereafter.

As the results in Table 4 show, the effect of treatment on whether farmers use any of the inputs in the technological package is either not statistically significant (FA group) or significant but small (3 percentage points in the WK group). That is not surprising, however, given that even in the control group more than 90 percent of farmers already use at least one of these inputs. The *number* of inputs used does increase, however, by 0.58 in the WK group (significant at 95 percent), which represents a meaningful increase given the control group mean of 3.4. Excluding those who were required to use the package does not change these results. At the same time, there is less statistically significant evidence of a change in practices (e.g., crop rotation, tillage for soil conservation, etc.).

[32] The survey does not ask specifically whether a respondent adopted a technological package for a particular crop, and if so which part. Instead, we construct an indicator of technological package adoption based on survey questions regarding the use of each particular type of input (e.g., improved seed varieties, chemical fertilizer, etc.) that is part of a typical tehcnological package for the key crops (maize, beans, wheat, sorghum). Technological packages differ across crops and states, but the input categories in the survey are broad enough to account for these differences.

TABLE 5 LABOR INPUT USE TREATMENT EFFECTS – AGRICULTURE

	Control	Treatment effects: FA		WK		FA-WK
	mean	point est.	s.e.	point est.	s.e.	p<0.05
Full-time equivalent work days:						
Total	222.2	76.01	(56.1)	–0.8	(54.0)	
Unpaid	88.2	–16.35	(27.1)	–9.6	(26.4)	
Paid	134.3	137.7***	(37.6)	51.8	(31.6)	Yes
Labor costs, 000 pesos per hectare	2.1	2.3**	(1.1)	0.9	(0.8)	

Note: N= 2096 for FTE results, N=2005 for labor costs. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Outcomes refer to the period October 2015–September 2016.

The loan program does not appear to have resulted in meaningful increases in the indicators of machinery use—the number of machines (e.g. tractors, harvesters, mechanized plows, etc.) used appears to increase in the WK treatment group (0.21 over a mean of 4.1 in the control group), mostly due to greater use of harvesters and tractor plows, but this increase is not statistically significant. At the same time, indicators of investment in capital, such as purchases (rather than use, which could reflect rental) of various types of machinery or equipment, do not appear to have been impacted by the treatment.[33]

Labor Use

Agricultural producers rely on both paid and unpaid labor; on average, they use about twice as much paid as unpaid labor (184 vs. 86 full-time equivalent, or FTE, days per year). FND loans appear to have affected hiring, as agricultural producers increased the amount of paid labor (in FTE) in the FA treatment group by an amount equal to the control group mean. This also led to an increase in overall labor, although it is not statistically significant. For the WK group, the point estimate for paid labor also suggested an increase, though a smaller one than in the case of the FA group. The point estimates for unpaid labor for both treatment groups are negative, but not statistically significant. Taken together, this suggests that producers are shifting to more paid labor after receiving FND loans, which could indicate labor hours of higher quality if paid labor is more specialized or experienced than unpaid labor (likely family members).

Additional evidence confirms these results, as labor costs per hectare of agricultural land double in the FA treatment group compared to the control group mean, while the impact on the WK group is not significant.

5.2.3 Effects on Animal Production

Next, we turn to livestock and other animal producers, which we define as those that report having any animals throughout the period covered by the survey (2009–16). The loan program appears to have had no effect on the productivity of this segment of rural producers, although it led to changes in the ownership of animals. However, the sample of animal producers is significantly smaller than that of agricultural producers, resulting in lower statistical power.

[33] For instance, we analyzed the possible treatment effects on purchases of tractors, combine harvesters, motocultivators, trucks, and plows, among others. Results are available from the authors upon request.

TABLE 6 CREDIT, INSURANCE AND BUSINESS PRACTICES TREATMENT EFFECTS

	Control	Treatment effects: FA		WK		FA-WK
	mean	point est.	s.e.	point est.	s.e.	p<0.05
Plans to get new loan in next 3y	0.88	0.01	(0.02)	0.06**	(0.02)	Yes
from private banks	0.06	0.00	(0.02)	–0.01	(0.02)	
from FND	0.86	0.02	(0.02)	0.08***	(0.02)	Yes
Improved business practices index (0–4)	1.87	0.39***	(0.15)	0.30**	(0.15)	
Purchases insurance	0.61	0.06*	(0.03)	0.14***	(0.03)	Yes
Issues tax receipts	0.69	0.04	(0.06)	0.05	(0.06)	
Employs an accountant	0.33	0.16**	(0.08)	0.06	(0.08)	Yes
Keeps accounting records	0.29	0.13***	(0.04)	0.05	(0.04)	Yes

Notes: N=2628 for first three lines; N=2610 for the fourth, N=2621 for the rest. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; boostrapped standard errors (500 replications). Outcomes refer to the period October 2015–September 2016.

Production Decisions, Input Use, and Sales: Overall, effects of the FND program are less apparent in the case of the production of animals than on crop production (see Appendix, Table A5). There is a small decrease in the likelihood of having any animals in the period after treatment—3 p.p. in the FA group—a minor change compared to the Control group mean of over 98 percent. The WK treatment group is 7 p.p. more likely to have pigs (binary indicator 0–1), and 12 p.p. more likely to have sheep. The FA treatment group is not more likely to have cattle, but the number of cows is significantly higher (by 32, over a mean of 79 in the Control group). This is in line with the intended use of FA loans, which could be used to purchase livestock. At the same time, there is no evidence that the loans were used to increase investment in productive assets such as feeding silos, mechanized equipment for milking, and others. The binary indicator of the use of such assets appears to decrease in the FA group, while the number of assets is unaffected. Unlike what was found for crop producers, there is no evidence of increased use of labor; in fact, amount of paid labor decreased in the WK group equal to 0.3 standard deviations.[34]

5.2.4 Credit, Insurance, and Business Practices

In addition to agricultural decisions and practices, we also explore the potential effects of the loans on the ways these rural producers manage their businesses; that is, the business practices they employ, interest in obtaining new loans, or buying insurance, among others. For example, the WK group is 6 p.p. more likely (see Table 6) to say that they plan to take out another loan in the next three years; moreover, they are 8 p.p. more likely to say they would like to get another FND loan, while there is no effect on wanting a loan from a private bank. There is no effect on the FA treatment group. This difference could be due to the fact that many WK loans, which on average have a term of less than a year, are rolled over, while that is not the case with FA loans.

[34] The amount of labor, both paid and unpaid, is measured by the full-time equivalent, as in the case of crop producers. Results are available upon request.

Both treatment groups are more likely than the control group to have insurance, though the effect is stronger in the WK group (14 p.p.). At the same time, the FA group is more likely than the control group to engage in formal bookkeeping, both by employing someone for this task (16 p.p.) and by keeping formal acconting records (13 p.p.).[35]

We also explore possible heterogeneous effects of treatment on these outcome variables. Specifically, we check for differential effects of size (measured by the cultivated land area), age (number of years the firm/person has been engaged in the activity, i.e. agriculture), and pre-treatment credit history with the FND (i.e., whether the person/firm had received any type of loan from FND prior to 2012). Overall, we do not find any consistent and statistically significant differences in treatment effects based on those characteristics.[36]

[35] There is some indication that these effects on business practices may be somewhat stronger for those producers that are formally registered as firms. However, since just over 10 percent of the sample is in that category, these differences in impacts are not statistically significant. Results disaggregated by type of producer (firm or not) are available from the authors upon request.

[36] We also attempted an analysis based on the legal status of the farmer (i.e., individual farmer vs. registered firm). However, the share of respondents registered as firms is around 10 percent, meaning that the subsample is too small to perform the matching analysis. The results for the subsample of individuals are very similar to those for the full sample.

6

Conclusions

This study takes advantage of a rich administrative dataset from FND and survey data collected specifically for this paper to study the effects of productive credit on the performance of agricultural producers in rural Mexico. Based on a sample of producers who applied for FND loans between 2012 and 2014, it uses a multiple-treatment non-experimental methodology based on inverse probability weighting by the generalized propensity score to identify the impacts of the loan program and differential impacts by loan types: working capital (WK) and investment in fixed assets (FA) loans. In contrast to most of the existing literature, which focuses primarily on short-term effects of smaller-sized credit on smallholder farmers, this paper focuses on short- and medium-term effects of medium and larger-sized loans given to small and medium-sized producers.

The results show that FND loans increased the likelihood that producers grow and sell certain key crops. All of the significant effects in terms of crop decisions are identified on annual crops, with no effect seen on perennials, and are driven primarily by WK loans. This is possibly due to the significantly higher average and median amounts of WK loans for borrowers in the sample.

There are also significant effects on production value and sales (per hectare), both overall and for specific crops (primarily maize). These impacts are similar in size and significance for recipients of both types of loans. This suggests that lack of liquidity is at least as important a constraint for rural producers as funding for new investment in capital.

It also appears that these gains in yields are achieved via labor quality, as producers hire more paid workers (replacing unpaid labor), as well as through a more intensive use of certain types of inputs, especially those that are part of the technological package. Adoption of these inputs was encouraged and, in a smaller number of cases, even required with the approval of WK loans, although compliance with the requirements may not have been universal.

The study does not find evidence of significant effects on the purchase of large machinery, such as would be supported by an FA loan; there are, however, impacts on the acquisition of cattle, one of the intended uses of FA loans. DFI programs often focus on funding capital (fixed-asset) investment, but the results in this paper suggest that working capital may be at least as important a constraint on agricultural productivity. This finding could have important implications for the design of policies and lending programs by DFIs. This paper suggests that producers benefit from easing their credit constraint, regardless of the

type of loan used. There is also some evidence that having a loan improves producers' business practices, with increased use of insurance and more formal bookkeeping.

A key point in the interpretation of the results is the distinction between WK and FA loans. While interest rates are similar for both types of loans, WK loans have shorter repayment periods and their approval is less likely to be contingent on the ability to provide collateral. Furthermore, more than a third of all working capital loans in the sample are credit lines, which are rolled over repeatedly, resulting in a longer effective repayment period in those cases. Since the FA group receives both WK and FA funds, as shown in Figure 2, and many WK loans are rolled over, the differences between the two treatment groups are less stark than the nature of the funding would suggest. On the other hand, WK loans are inherently riskier for borrowers, since the ability to roll them over would not be guaranteed during an economic downturn or under any other situation affecting the profitability of rural producers. That is, in this particular application, WK and FA loans may have been relatively comparable sources of funding for borrowers, but this would not necessarily be true in any situation, given the different risk profiles of the two types of lending.

In terms of other policy recommendations for similar DFI programs, increasing the monitoring of loan use should be encouraged. These programs should try to obtain accurate data on purchases of fixed assets to better understand and measure expected benefits. The same is true for WK loans. Some borrowers were required to adopt inputs that are part of the technological package, but survey data suggests many did not in fact do so, and better monitoring systems could provide timely information on this to the lender.

Overall, this paper shows that DFI loan programs can be successful in easing credit constraints faced by agricultural producers through different types of loan instruments beyond FA loans. Producers need financing; whether it takes the form of a long-term loan, or the form of (easily rolled over) short-term loans is less relevant than the actual provision of productive financing. For future research, it would be interesting to compare the client profile and impacts of lending between DFI provided-lending (i.e., institutions like FND) with lending provided by private financial institutions, especially because one of the explicit missions of DFIs is to address the financial needs of producers underserved by the private sector.

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Appendix A – Additional Tables and Figures

FIGURE A1 REPAYMENT PERIODS FOR FIXED ASSET AND WORKING CAPITAL LOANS

Note: The figure shows repayment periods at approval for all fixed asset and working capital loans approved between 2012 and 2014 (based on FND administrative data).

TABLE A1 COMPARISON OF PRE-TREATMENT OUTCOMES FOR SURVEYED AND NON-SURVEYED APPLICANTS

	Not surveyed mean	Surveyed mean	Not surveyed – Surveyed
received a loan (y/n), 2003	0.066	0.064	0.002
received a loan (y/n), 2004	0.138	0.139	–0.001
received a loan (y/n), 2005	0.144	0.147	–0.003
received a loan (y/n), 2006	0.147	0.146	0.001
received a loan (y/n), 2007	0.129	0.13	–0.001
received a loan (y/n), 2008	0.152	0.153	0
received a loan (y/n), 2009	0.146	0.144	0.002
received a loan (y/n), 2010	0.137	0.137	0
received a loan (y/n), 2011	0.181	0.183	–0.002
# of loans received, 2003	0.067	0.065	0.003
# of loans received, 2004	0.211	0.199	0.012
# of loans received, 2005	0.187	0.189	–0.002
# of loans received, 2006	0.178	0.181	–0.003
# of loans received, 2007	0.169	0.175	–0.006
# of loans received, 2008	0.182	0.19	–0.008
# of loans received, 2009	0.176	0.17	0.007
# of loans received, 2010	0.161	0.155	0.006
# of loans received, 2011	0.275	0.301	–0.026
total loan amount (pesos), 2003	6092.9	6140	–47.2
total loan amount (pesos), 2004	40862.6	43267.5	–2404.9
total loan amount (pesos), 2005	46821.6	58066.9	–11245.3**
total loan amount (pesos), 2006	71102.6	74898.3	–3795.7
total loan amount (pesos), 2007	49881.5	53497.5	–3616
total loan amount (pesos), 2008	102020.1	101381.6	638.5
total loan amount (pesos), 2009	100333.6	102881.1	–2547.5
total loan amount (pesos), 2010	89141.4	87646	1495.4
total loan amount (pesos), 2011	152461.1	177294.6	–24833.5*
registered as a firm (y/n)	0.118	0.11	0.008
# years engaged in ag. activity	24.97	25.32	–0.36
N	18063	2758	20821

Note: This table shows outcome variables in the pre-treatment period, in order to compare applicants that participated in the survey versus those that did not (based on FND administrative data for all loan applicants between 2012 and 2014). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, for the difference between not surveyed and surveyed applicants.

TABLE A2 BALANCE ON OBSERVABLES BEFORE (RAW) AND AFTER WEIGHTING (IPW)

	Treatment group means						RMSD		p-value	
	RAW			IPW						
	Control	FA	WK	Control	FA	WK	Raw	IPW	Raw	IPW
received a loan 2003–2006 (y/n)	0.08	0.25	0.29	0.29	0.21	0.21	0.44	0.17	0.000	0.583
# of FA loans received, 2007	0.00	0.02	0.01	0.02	0.01	0.01	0.61	0.37	0.012	0.809
# of FA loans received, 2008	0.00	0.02	0.01	0.01	0.01	0.02	0.50	0.40	0.011	0.539
# of FA loans received, 2009	0.01	0.02	0.01	0.00	0.01	0.01	0.26	0.39	0.323	0.084
# of FA loans received, 2010	0.01	0.03	0.01	0.02	0.02	0.01	0.66	0.07	0.000	0.885
# of FA loans received, 2011	0.01	0.06	0.04	0.04	0.04	0.04	0.61	0.03	0.000	0.962
# of WK loans received, 2007	0.03	0.15	0.19	0.21	0.13	0.12	0.57	0.26	0.000	0.645
# of WK loans received, 2008	0.02	0.17	0.25	0.15	0.14	0.15	0.66	0.03	0.000	0.978
# of WK loans received, 2009	0.01	0.15	0.25	0.10	0.14	0.15	0.71	0.16	0.000	0.675
# of WK loans received, 2010	0.01	0.14	0.23	0.20	0.13	0.13	0.72	0.20	0.000	0.771
# of WK loans received, 2011	0.02	0.26	0.52	0.37	0.27	0.27	0.77	0.16	0.000	0.725
total loan amount (log pesos), 2007	0.43	2.14	2.34	3.21	1.70	1.80	0.52	0.31	0.000	0.473
total loan amount (log pesos), 2008	0.35	2.41	3.19	2.30	1.95	2.12	0.61	0.07	0.000	0.749
total loan amount (log pesos), 2009	0.27	2.16	3.21	1.55	1.90	2.00	0.65	0.11	0.000	0.783
total loan amount (log pesos), 2010	0.20	2.23	2.93	3.30	1.85	1.84	0.65	0.29	0.000	0.542
total loan amount (log pesos), 2011	0.24	2.75	4.43	4.05	2.51	2.56	0.70	0.24	0.000	0.481
total FA loan amount (log pesos), 2008	0.06	0.24	0.14	0.10	0.13	0.24	0.52	0.40	0.010	0.531
total FA loan amount (log pesos), 2009	0.11	0.20	0.15	0.05	0.13	0.14	0.24	0.38	0.421	0.110

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TABLE A2 BALANCE ON OBSERVABLES BEFORE (RAW) AND AFTER WEIGHTING (IPW) *(continued)*

	Treatment group means						RMSD		p-value	
	RAW			IPW						
	Control	FA	WK	Control	FA	WK	Raw	IPW	Raw	IPW
total FA loan amount (log pesos), 2010	0.06	0.41	0.16	0.21	0.21	0.17	0.68	0.08	0.000	0.878
total FA loan amount (log pesos), 2011	0.09	0.78	0.53	0.45	0.46	0.49	0.62	0.04	0.000	0.967
total WK loan amount (log pesos), 2008	0.20	1.87	2.95	2.11	1.65	1.69	0.68	0.11	0.000	0.923
total WK loan amount (log pesos), 2009	0.13	1.83	2.90	1.28	1.65	1.74	0.70	0.13	0.000	0.757
total WK loan amount (log pesos), 2010	0.12	1.71	2.74	2.82	1.58	1.61	0.71	0.29	0.000	0.660
total WK loan amount (log pesos), 2011	0.15	2.14	4.07	3.61	2.16	2.18	0.75	0.26	0.000	0.548
State binary indicators:										
Aguascalientes	0.01	0.05	0.02	0.03	0.03	0.03	0.66	0.09	0.000	0.881
Chihuaha	0.06	0.02	0.01	0.03	0.03	0.03	0.76	0.08	0.000	0.870
Coahuila	0.04	0.03	0.01	0.02	0.03	0.02	0.51	0.14	0.000	0.615
Durango	0.03	0.04	0.01	0.02	0.03	0.03	0.58	0.19	0.000	0.490
Guanajuato	0.05	0.03	0.09	0.05	0.06	0.06	0.42	0.09	0.000	0.738
Michoacan	0.11	0.21	0.16	0.25	0.16	0.16	0.25	0.23	0.000	0.473
Nayarit	0.03	0.06	0.04	0.05	0.04	0.04	0.28	0.03	0.013	0.972
Sinaloa	0.18	0.21	0.32	0.25	0.24	0.24	0.25	0.03	0.000	0.957
Sonora	0.10	0.08	0.07	0.05	0.08	0.09	0.17	0.19	0.042	0.035
Zacatecas	0.03	0.05	0.06	0.03	0.05	0.05	0.24	0.13	0.019	0.469
Baja California Norte/Sure	0.04	0.02	0.04	0.03	0.04	0.04	0.22	0.15	0.062	0.411
Colima/Jalisca	0.15	0.12	0.14	0.11	0.13	0.14	0.10	0.10	0.102	0.329
Nuevo Leon/ Tamaulipas	0.05	0.03	0.02	0.03	0.03	0.03	0.35	0.08	0.014	0.783
Queretaro/San Luis Potosí	0.12	0.05	0.02	0.05	0.07	0.06	0.61	0.09	0.000	0.622
registered as a firm (y/n)	0.03	0.10	0.18	0.09	0.10	0.11	0.58	0.07	0.000	0.914
# years engaged in activity	25.41	25.64	25.29	23.50	25.12	25.63	0.01	0.04	0.910	0.375

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TABLE A2 BALANCE ON OBSERVABLES BEFORE (RAW) AND AFTER WEIGHTING (IPW) *(continued)*

	Treatment group means						RMSD		p-value	
	RAW			IPW						
	Control	FA	WK	Control	FA	WK	Raw	IPW	Raw	IPW
probability of being surveyed	0.16	0.15	0.14	0.14	0.15	0.15	0.07	0.01	0.000	0.717
probability of being surveyed^2	0.03	0.03	0.02	0.02	0.03	0.02	0.18	0.03	0.000	0.619
probability of being surveyed^3	0.01	0.01	0.00	0.00	0.01	0.01	0.30	0.05	0.000	0.515
							Average RMSD		Number of variables where p-value < 5%	
							0.49	0.16	38	1

Note: FND administrative data is used to calculate the generalized propensity score (GPS) based on the methodology detailed in Section 4. Raw refers to the observed variable before overlap, while IPW refers to the weighted (after imposing overlap) variable using the inverse of the GPS as the weight. RMSD refers to root mean square distance, an overall measure of distance among the estimated means (see Flores and Mitnik, 2013). The p-value is for the test of the joint hypothesis that the three means (Control, FA, WK) are equal.

TABLE A3 KEY CHARACTERISTICS BY TREATMENT GROUP AND TIME PERIOD, INVERSE PROBABILITY WEIGHTED SURVEY SAMPLE

	Pre-treatment (2003–2011)			Treatment (2012–2014)			Post-treatment (2015–2016)		
	Control	FA	WK	Control	FA	WK	Control	FA	WK
Share of applicants with: either type of loan	0.41	0.33	0.36	0	1	1	0.62	0.38	0.54
FA loan	0.08	0.11	0.10	0	1	0	0.37	0.18	0.14
WK loan	0.33	0.26	0.29	0	0.32	1	0.29	0.26	0.45
Mean loan amount, annual avg: all loans	418.7	184.8	154.4	0	503.9	474.0	272.1	359.0	377.0
FA loans	13.2	12.8	8.4	0	241.1	0	111.7	101.5	42.7
WK loans	401.1	163.8	138.8	0	262.8	474.0	160.4	257.5	334.3
Average maturity (months): all loans	15.6	17.1	16.0	—	43.0	9.9	33.8	23.7	16.9
FA loans	44.5	41.1	48.7	—	50.5	—	53.3	47.0	50.0
WK loans	9.4	9.4	8.7	—	9.5	9.9	8.6	9.5	8.8
Average interest rate on loans	13.8	13.7	13.9	—	11.7	11.2	9.4	10.7	10.1

Note: FND administrative data is used to calculate the generalized propensity score (GPS) based on the methodology detailed in Section 4; the GPS is then used to obtain the inverse-probability weighted sample. Loan amounts are in thousands of pesos, and are adjusted for inflation (2018=100). Means are IPW weighted.

TABLE A4 EFFECTS OF TREATMENT ON FND CREDIT

	Control	Treatment effects:					
		FA		WK		FA+WK	
	mean	point est.	s.e.	point est.	s.e.	point est.	s.e.
Received FND loan after 2014	0.63	–0.33***	(0.06)	0.05	(0.05)	0.02	(0.06)
Received FA loan after 2014	0.35	–0.19***	(0.06)	–0.25***	(0.06)	–0.08	(0.07)
Received WK loan after 2014	0.35	–0.15*	(0.08)	0.33***	(0.07)	0.25***	(0.07)
# FND loans received after 2014	1.26	–0.74***	(0.22)	0.18	(0.16)	0.38**	(0.19)
# FA loans received after 2014	0.45	–0.22***	(0.06)	–0.32***	(0.06)	–0.04	(0.08)
# WK loans received after 2014	0.81	–0.51***	(0.23)	0.50***	(0.18)	0.42***	(0.19)
Received FND loan after 2015	0.37	–0.09	(0.07)	0.27***	(0.06)	0.23***	(0.07)
Received FA loan after 2015	0.10	0.05*	(0.03)	–0.01	(0.03)	0.12***	(0.04)
Received WK loan after 2015	0.29	–0.13*	(0.07)	0.31***	(0.06)	0.25***	(0.07)
# FND loans received after 2015	0.53	–0.16	(0.13)	0.50***	(0.08)	0.62***	(0.12)
# FA loans received after 2015	0.12	0.06*	(0.04)	–0.02	(0.03)	0.16***	(0.06)
# WK loans received after 2015	0.41	–0.22*	(0.12)	0.52***	(0.09)	0.46***	(0.11)

Note: IPW matching estimates of the effect of treatment on the binary indicators of having any, an FA or a WK loan, and on their number for i) the period after 2014, and ii) the period after 2015. Matched groups are calculated using the methodology described In Section 4 and variables from the FND administrative data listed in Appendix B. N=2755. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; bootstrapped standard errors (500 replications).

TABLE A5 TREATMENT EFFECTS ON ANIMAL PRODUCTION

		Treatment effects:				
	Control	FA		WK		FA-WK
	mean	point est.	s.e.	point est.	s.e.	p<0.05
Owns animals	0.99	–0.03*	(0.02)	–0.04	(0.02)	
Owns cattle	0.91	–0.02	(0.03)	–0.06	(0.04)	
Owns pigs	0.08	0.03	(0.02)	0.07*	(0.04)	
Owns poultry	0.04	0.01	(0.02)	0.01	(0.03)	
Owns sheep	0.07	0.03	(0.03)	0.12***	(0.05)	Yes
Owned goats	0.04	–0.01	(0.02)	–0.01	(0.02)	
# of animals owned	483.6	–200.2	(498.8)	–552.2	(432.4)	
# of cattle owned	79.1	31.7***	(10.0)	–6.0	(13.9)	Yes
# of pigs owned	6.2	3.8	(3.6)	6.6	(7.0)	
# of poultry owned	387.4	–232.8	(508.6)	–551.4	(447.5)	
# of sheep owned	8.6	–2.1	(5.5	0.1	(5.8)	
# of goats owned	2.7	–1.3	(1.7)	–2.0	(1.5)	
Use of machinery for animal production	0.18	–0.06**	(0.03)	0.01	(0.05)	
# of machines used in animal production	0.12	–0.08	(0.06)	0.07	(0.09)	

Note: IPW matching estimates of the effect of treatment on animal production decisions. Matched groups are calculated using the methodology described In Section 4 and variables from the FND administrative data listed in Appendix B. Outcomes refer to the period October 2015–September 2016. N=1204. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; bootstrapped standard errors (500 replications).

Appendix B

VARIABLES USED IN GPS ESTIMATION AND AS IPW COVARIATES

- Dummy indicating whether applicants received any kind of loan from FND in any year between 2003 and 2006
- Number of FA loans received from FND in each year between 2007 and 2011 (5 variables)
- Number of WK loans received from FND in each year between 2007 and 2011 (5 variables)
- Total amount in pesos of all loans received from FND in each year between 2007 and 2011, log (5 variables)
- Total amount in pesos of all FA loans received from FND in each year between 2007 and 2011, log (5 variables)
- Total amount in pesos of all WK loans received from FND in each year between 2007 and 2011, log (5 variables)
- Dummy indicating whether producer is a firm
- Number of years the firm/individual has been involved in the activity
- State
- Predicted probability of being surveyed (level, square, and cube). This probability is obtained estimating a logit model using the administrative data for all applicants, using as covariates the above variables.