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Increasing Access to Formal Agricultural Credit: The Role of Rural Producer Organizations

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Abstract

Access to agricultural credit contributes to rural development by allowing farmers to carry out profit-maximizing investments that increase productivity and income, underlining the importance of exploring ways to increase access to this resource. This paper analyzes the role of Rural Producer Organizations (RPOs) in easing access to formal agricultural credit. We build an original dataset comprising 15,000 municipality-year observations of RPO creation and credit allocation in Colombia to estimate a fixed effects model. We show that when the number of RPOs increases in a municipality, aggregate access to credit increases. This positive relation also holds at the individual level, with RPO membership increasing both the likelihood of a farmer requesting credit, and of receiving the requested credit. We discuss demand and supply-side mechanisms that plausibly explain these results, and we further show that the relation between RPOs and access to credit is heterogeneous according to the source of credit (public vs. private bank) and the type of farmer to whom it is allocated (low-wealth, mid-wealth or high-wealth farmers). Our results point to the potential of RPOs to improve access not only to input and output markets, but also to financial markets.

Key words: Agricultural credit, credit constraints, rural producer organizations, Colombia

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1. Introduction

Different studies document the relation between access to agricultural credit and improvements in variables such as productivity, output, income, and poverty (Bukari et al., 2021; Regasa et al., 2021; Ali, Deininger & Duponchel, 2014; Burgess & Pande 2005; Echavarría et al. 2017). Despite its relevance for rural development, over 1.7 billion people around the world continue to have limited or no access to financial services (Demirgüç-Kunt et al., 2018). Access to formal agricultural credit is even more restricted (Banerjee & Duflo; 2010), underlying the relevance of exploring ways to increase access to this source offering farmers better conditions than other sources (e.g. microfinance), including lower interest rates, longer terms, and larger credit amounts (Giné, 2011; Guirkinger & Boucher, 2008).

Different types of policy interventions have been designed to expand access to formal credit in rural areas. These include titling property rights so that land can be used as collateral, granting direct public credit, regulating and subsidizing interest rates, promoting bank branch expansion and offering public loan guarantees (Burgess & Pande, 2005; Besley, Burchardi & Ghatak, 2012; Conning & Udry, 2005). However, the persistence of large numbers of credit-constraint rural households shows that these alternatives have been insufficient and underlines the importance of exploring other alternatives to expand access to formal credit.

We explore the role of Rural Producer Organizations (RPOs) in easing access to formal agricultural credit (i.e. credit used for productive purposes). RPOs include agricultural cooperatives, rural associations, and other organizations in which farmers voluntarily invest time, effort, and resources to benefit from economies of scale in production (Desai & Joshi, 2014; Valentinov, 2007), the adoption of new technologies (Wossen et al. 2017), better inputs (Verhofstadt & Maertens, 2014; Hellin et al. 2009; Conley & Udry, 2010), easier access to information (Abebaw & Hail, 2013), and improved access to output markets (Markelova et al. 2009; Bebbington, 1997; Narrod et al., 2009). Overall, RPOs allow farmers to increase their

access to input and output markets. In this paper, we further show their potential to increase access to financial markets.

To analyze this relationship, we build a novel panel dataset of 15,000 municipality-year observations of RPOs and credit allocation in Colombia. To identify RPOs, we designed an algorithm combining names, type of social organization, and economic sector based on microdata from Colombia's chambers of commerce. This is the first dataset identifying RPOs by municipality and year in Colombia; it is publicly available.[3] We combine this information with secondary data on credit allocation and municipalities' sociodemographic characteristics. We estimate a fixed effects (FE) model of aggregate credit uptake, controlling for historical, institutional, and cultural factors that typically confound inferences made on small samples, as well as cross-country and cross-section data (Faguet 2012 & 2002, Khan et al. 2014). While the FE model controls for various sociodemographic time-varying characteristics, as well as for municipality, year, and department-year fixed effects, we cannot rule out the possibility of endogeneity caused by municipality and time-varying unobserved variables that can affect access to credit, or that can confound both access to credit and RPO formation. Because of this, and as there are no exogenous sources of variation that would allow us to conduct an experimental or quasi-experimental analysis, our analysis cannot be interpreted as causal.

Our results show a positive relation between increases in the number of RPOs in a municipality and increases in access to credit at both the extensive margin (total *number* of agricultural credit operations allocated) and intensive margin (total *value* of credit allocated). This aggregate relationship is heterogeneous according to the type of credit source (public credit vs. private commercial bank credit), and the type of recipient (low, mid, or high-wealth farmers). For credit allocated to low-wealth farmers we find a positive relationship via the increased allocation of public credit. For credit allocated to high-wealth farmers the relation is

[3]https://ukdataservice.ac.uk/find-data/

also positive, but this time via increased allocations of private credit. We find no evidence of greater access to credit for medium-wealth farmers.

We also estimate an individual-level logit model that explores the relation between RPO membership and access to credit at the individual (farmer) level. Using data on over 2.3 million Colombian farmers, we find that RPO membership is associated with farmers being 2.5 times more likely to demand credit, and 1.2 times more likely to receive the credit requested. We confirm the existence of heterogeneous effects according to credit source and type of farmer. While RPO membership is associated with an increased probability of credit demand for all farmer types (large-scale farmers, medium-scale farmers and smallholders), the effect is strongest for large-scale farmers. We also find that the coefficient of RPO membership on the probability of a farmer receiving the requested credit (i.e. the supply-side effect), is largest in the case of large-scale farmers, in particular by increasing their access to credit granted by private banks.

As we discuss, this heterogeneity is likely explained by pre-existing segmentation of the rural credit market across sources and types of farmers, what the role of RPOs appears to replicate, rather than countervail. The heterogeneity in our results points to the importance of analyzing distributional effects, an aspect that has received limited attention in the literature on rural credit (Banerjee et al. 2015). We show that distributional effects depend not only on farmer type, but also on credit source. While existing studies have focused on differences in access to formal vs. informal (i.e. microfinance) sources of credit (Giné, 2011; Boucher & Guirkinger, 2007; Guirkinger & Boucher, 2008), less attention has been given to analyzing differences between types of formal credit.

The existence of both individual-level and local-level relations between RPOs and access to agricultural credit implies that while RPO members have increased access to credit, this does not crowd out resources available for non-RPO members. If that were the case, we

would observe individual-level relations but not aggregate-level ones[4]. These results suggest that RPOs have the potential to increase local financial outreach, rather than expanding access to credit for members at the expense of non-members.

The remainder of this paper is structured as follows: section 2 discusses the potential of RPOs to reduce demand and supply-side credit constraints. Section 3 presents the setting. Section 4 provides details on the data, and section 5 on the empirical strategy. Results are presented in section 6. Section 7 discusses the results, and section 8 concludes.

2. Rural Producer Organizations' potential to increase access to agricultural credit

In most developing countries, rural credit markets are inexistent or incomplete. This is partly explained by the existence of information and enforcement problems that lead to moral hazard and adverse selection (Conning & Udry, 2009; Boucher et al. 2008). Information is costly to access in rural areas as population and production units are dispersed and physical and technological infrastructure is precarious. Furthermore, access to information, for example on farmer's experience, does not provide financial institutions with certainty, as output and revenues are vulnerable to weather conditions and fluctuations in international commodity prices and exchange rates. This makes credit analysis and allocation both costly and risky, leading to supply-side credit constraints.

Other credit constraints stem from the demand side. Many relate to production characteristics that can limit demand – for example, when a farmer's productive project is too small, or insufficiently profitable, to support additional investment. Following the terminology of Guirkinger and Boucher (2008), demand-side credit constraints also include transaction-cost and risk constraints. The first derive from the monetary and time costs of traveling long distances to reach banks and carry out complex credit application paperwork. Risk credit

[4] The existence of aggregate effects also implies that the total amount of (real) resources allocated would increase, as we show was the case. See Figure 1.

constraints derive from farmers refraining from demanding credit not because of costs, but because of the risk of not being able to repay debts, potentially losing the asset employed as collateral. Loosening credit constraints requires increasing both the willingness of banks to approve credit requests, and of farmers to demand credit. We now describe the potential of RPOs to do both.[5]

First, RPOs can increase the supply of credit. This can happen through several channels: RPOs can grant in-house credit to their members; also, by joining RPOs, farmers become eligible to access formal associative credit lines (i.e. credit allocated by banks to organizations or organized farmers); and finally, RPO membership can increase the likelihood of banks supplying regular individual credit to a farmer – banks consider that farmers who market via RPOs have better commercial opportunities and bear less risk. In practice, as Benson (2019) shows for Colombia, and Markussen & Tarp (2014) for Vietnam, when requesting formal credit from banks, organized farmers can request their RPOs to certify their membership, or in some cases, request from these informal financial references of their participation in in-house input credit or group lending schemes. These signals help screen clients and reduce problems of imperfect information, making banks more willing to lend to organized farmers.

RPO membership can also make farmers more willing to demand agricultural credit. First, by increasing their access to new, larger, and more profitable productive projects that are more likely to require investment. For instance, RPOs can help increase project profitability by facilitating member access to lower-price inputs via bulk buying, and can act as low-cost commercial intermediaries, helping members capture a larger share of added value. RPOs can also help members access technical assistance and other types of public or third-sector technical

[5] Through qualitative research we conducted in parallel to writing this paper, we identified different demand and supply side mechanisms explaining the relation between RPOs and access to agricultural credit. The mechanisms and the qualitative methodology employed are discussed in detail in a working paper still not published. In the present paper, we summarize the mechanisms as part of the conceptual framework.

support often targeted to organized farmers, what can make productive projects become more profitable.

Furthermore, the demand for credit can increase due to a social imitation effect within RPOs. Studies analyzing the role of social relations on access to credit show, for instance, that when the number of people in a church who access credit doubles, the probability of an individual accessing credit increases by 14% (Wydick et al. 2011). The imitation effect generated by RPOs is plausibly larger, as it is a specialized production-oriented network providing more relevant information or role models than non-productive social networks like churches or neighbors.

RPOs can also help farmers reduce transaction-cost credit constraints. These organizations constitute hubs through which information flows, including that on credit opportunities and application processes. Previous studies show that social networks (measured as participation in community meetings) increase the probability of knowing about credit opportunities, of applying for credit, and of receiving credit (Okten and Osili, 2004). The flow of information among RPO members can be particularly relevant as members are engaged in similar investments and projects, making information especially pertinent.

Finally, RPOs can help reduce risk-related credit constraints. Guirkinger and Boucher (2008) show that family and friend networks can reduce risk credit rationing; RPOs have the potential of doing the same. Organization members can act as a safety network to back others in cases of emergencies or low liquidity[6]. This could reduce farmers' hesitancy to demand credit for fear of losing their collateral.

It is important to note that the potential mechanisms through which RPOs increase access to credit are not limited to RPO members. RPO benefits can spill over onto non-

[6] In related fieldwork, we found more than one case in which RPO members mentioned other members having lent them money after family emergencies and other shocks, demonstrating that RPO communities can act as safety nets for RPO members.

members and the community more generally. For example, information accessed through RPO networks can be shared with non-members. More generally, as RPOs generate local jobs, contribute to the provision of public goods like roads, and attract financial resources from public programs and private investors, they increase the flow of money and make the local economy more dynamic. This can increase both the demand and supply of credit.

All in all, RPOs can act as gateways to formal financial inclusion. This goes in line with what existing studies have documented analyzing related dynamics, including how access to credit increases through family networks (Bouquet et al. 2015), links to persons of higher social status (Dufhues et al., 2013), informal social networks measured as relatives in public offices (Markussen & Tarp, 2014), participation in production clusters (Reyes & Lensink, 2011), participation in community meetings (Okten & Osili, 2004), and quantity and quality of social connections (Heikkilä et al. 2009).

3. Setting

According to the agrarian census of 2013, about 11% of Colombian rural producers access credit in any given year. Most agricultural credit comes from two sources. The public bank (Banco Agrario) allocates over 65% of all credit in the country, mainly through small operations targeting low-wealth farmers, and averaging COP 8 million (US $2,956). A further 20% of credit operations are allocated by private banks, mainly through large operations targeting high-wealth producers, and averaging COP 526 million (US $194,357).[7] Less common sources of credit include financial and credit cooperatives and input suppliers. Their scale and geographic coverage are smaller, and there is no aggregate information on their credit operations.

[7] Commercial banks in Colombia are forced by law to invest a fixed share of their checking and savings accounts in TDAs (Agricultural Development Titles). These resources are managed by Finagro, a second-level bank, and are transferred to the public bank to finance its own credit allocations. Commercial banks have the alternative of granting agricultural credit directly, which substitute for the forced investment requirements.

Both public and private credit are subject to government regulations on interest rates, guarantee schemes, and incentive schemes (i.e. special credit lines).[8] Some of these regulations lead to differential credit conditions for different types of farmers. For instance, interest rate ceilings favor low-wealth farmers with rates of 12%, compared to 13% for mid-wealth farmers and 14.6% for high-wealth farmers. The market interest rate for credit granted to low-wealth farmers is lower in the public bank than in private banks, while for credit granted to high-wealth farmers, private banks can offer more competitive interest rates.

Another difference between credit sources is approval times. While credit approvals by the public bank takes on average weeks or even months, approvals by commercial banks take only days. There are also differences regarding the paperwork and other administrative demands that each source makes to different types of farmers. For instance, credit allocated to low-wealth farmers requires little paperwork, while credit allocated to mid-wealth and high-wealth farmers require presenting certified financial documentation, structured productive projects, mortgages, among others.

Official data shows that during the study period (2002-2015), 84% of all credit operations (and 23% of total resources) where allocated to low-wealth farmers, which constitute most farmers in Colombia. Credit allocated to mid-wealth farmers represented 14% of all credit operations (34% of resources), and credit allocated to high-wealth farmers represented 2% of operations, but 43% of resources.

As the aforementioned figures on credit allocations show, private credit in Colombia tends to be biased towards large operations and public credit towards small ones. This fragmentation of the credit market across farmer type and sources is common in many countries (United Nations, 2006). The reasons behind this sorting of credit includes private banks' preference for larger credit operations, as fixed approval and disbursement costs constitute a

[8] Regulations require that agricultural credit be used for productive purposes, not consumption or debt repayment.

smaller proportion of total costs. Credit operations allocated to large high-wealth rural producers are also perceived as more creditworthy, as these producers tend to have more fixed capital that can be used as collateral, reducing credit risk. Meanwhile, public banks can favor the allocation of small credit operations to low-wealth farmers, following normative considerations (i.e. their mission to promote rural development) as well as regulations that favor these farmers (e.g. a cap on the size of credit operations they can allocate). All in all, this sorting of credit across sources and farmer type has development implications, as different sources of credit offer different conditions and benefits (e.g. interest rates, guarantee requirements, payment schemes).

Turning now to RPO dynamics in Colombia, the original database we built shows that over 27,000 RPOs were formally created between 2002 and 2015, throughout the whole country and with no obvious geographic clustering. [9] Our data shows that exit rates are much lower than entry rates (the average number of RPOs cancelled per year is equivalent to 5% of RPOs created).[10]

No registry or database reports RPO characteristics or details (e.g. number of members, products produced, services offered). However, case study analyses, including FNC (2019), Gómez et al. (2016), and Econometría & SEI Consultores (2015) characterize some organizations and show that in general, there is a large heterogeneity in their characteristics. The number of members can range from a dozen to over 100, and services provided vary greatly. While some RPOs carry out joint production or commercialization, sell inputs, and even offer training, others are limited to being vehicles for accessing sporadic financial and in-

[9] Formally created in the sense that their creation was registered with a Chamber of Commerce. It is impossible to estimate how many non-registered organizations there are, although this number is probably small, considering that organizations need to be registered to access public support, sign contracts with buyers, or access credit. Furthermore, the registry process is not costly, requiring only to fill out forms and establish their own statutes.
[10] There can be underreporting of cancellations. However, RPOs are legally required (by Decree 019 of 2012) to update their registry annually, and thus we have information on the last update date, allowing us to identify whether RPOs are active.

kind support that is provided by public or third-sector actors through RPOs, while not offering services as such. Case studies also show that RPOs tend to specialize in one product; common ones include cattle ranching, coffee, cocoa, fruit, and milk.

The agrarian census of 2013 shows that 10% of farmers participate in RPOs. Interestingly, participation rates across farmer types are similar: 10% for smallholders, 11% for medium-scale farmers, and 12% for large-scale farmers.[11] Relatively low participation rates might result from poor information about the benefits these organizations offer. More generally, farmers might consider participation (fees, meetings) and coordination costs high. As the literature on collective action notes, the latter include costs like negotiating divergent interests, making collective decisions, monitoring compliance with rules, and solving conflict (Ostrom, 1990).

4. Data

For the municipal-level analysis, we build an original panel dataset identifying RPOs per municipality-year for the period 2002-2015. We rely on microdata from the country's Chambers of Commerce.[12] From a universe of 260,000 registered social organizations, we identified RPOs through an algorithm that searched names containing a set of 250 key words (e.g. farmer, rural producer, coffee, tomatoes, banana) and merged the results with data points reporting organization type (e.g. association, cooperative) and economic sector (e.g. agriculture, manufacturing). We then manually validated each potential RPO observation and built a dataset of over 27,000 RPOs. This is the first RPO panel dataset built for Colombia.

We then merged this data with data on credit allocations reported by Finagro (the Agricultural Sector Finance Fund). This includes the total number and total value of agricultural credits granted per municipality per year. Credit data is reported classifying credit

[11] Census data does not allow classifying farmers based on the value of their assets.
[12] From the Unique Economic and Social Registry (RUES), in which social organizations are required to register and update their register annually. RPOs have incentives to do this, despite the cost, as public programs, clients, and banks require organizations to be registered.

allocated to low-wealth, mid-wealth, and high-wealth farmers. This classification, used in the country since the 1960s, is based on the value of farmer-owned assets reported to banks in credit applications.[13] As defined in Decree 2179 of 2015, low-wealth farmers are those whose total assets are worth less than COP 182 million, or approximately US $83,000. Medium-wealth farmers, as defined by Resolution 8 of 2010, are those with total assets worth less than COP 3,200 million or US $1.3 million. High-wealth farmers are those owning assets above this value. We further classify credit data by source, as credit data is reported differentiating between credit granted by the public bank and by private banks.

Data on municipal economic and social conditions was obtained from the Centre for Research in Economic Development (CEDE). Information on homicide rates comes from the Ministry of Defense. Data on intragovernmental transfers and local tax revenues comes from the National Planning Department (DNP). We also used weather data from the Institute of Environmental, Hydrological and Meteorological Studies (IDEAM) to build a weather shock variable. This variable contains municipality-month data on centimeters of rain. We compare each municipality-month data point to its historic average and sum the centimeters of rain below or above the average by one standard deviation. This constitutes our yearly measure of rain shocks.

For the individual-level analysis, we use data on over 2.3 million rural producers from the national agrarian census of 2013.[14] Data includes farmers characteristics such as whether she participates in an RPO, has accessed credit or technical assistance, owns agricultural machinery, and sells produce in the market (a proxy for being a commercial rather than subsistence farmer). The data also includes variables indicating farmer sex, age, plot size,

[13] Note that the official terms used in Colombian laws are 'small, medium and large-scale farmers'.
[14] Census data refers to agricultural productive units – UPA, defined as the unit of organization for production managed under one producer. 96% of UPA are composed by one household and managed by one producer. Thus, for simplicity, we use the term producer or farmer instead of UPA.

education level, access to private health insurance (a proxy for high income), participation in community organizations, and being from an ethnic minority.[15]

We disaggregate individual-level data on credit by source and farmer type. The census data includes a variable reporting whether the credit accessed by farmers was given by the public bank or private commercial banks. To classify farmers by type, we are not able to employ categories based on values of wealth, as census data does not report this information. We use a related measure; we classify farmers as smallholders, medium-scale and large-scale farmers based on the size of their land plots. There is high correspondence of small, medium, and large-scale farms to low, medium and high levels of wealth.

Both datasets are publicly available[16] and constitute one contribution of this research. Summary statistics are presented in Annex Table A1.

5. Empirical Strategy

For the municipal level analysis, we estimate a fixed effects (FE) model for the universe of Colombian municipalities (1100+) between 2002-2015. We first estimate a model in which the dependent variable is $NC_{m,t}$, the *number* of agricultural credit operations allocated (per thousand rural inhabitants) in municipality m and year t (equation 1). This measures access to credit at the extensive margin. We then estimate a model (2) in which the dependent variable is $VC_{m,t}$, the total real *value* of agricultural credit allocated in municipality m and year t, (expressed in per capita terms), which explores access to credit at the intensive margin.

$$NC_{m,t} = \beta_0 + \beta_1 \boldsymbol{X}_{m,t-1} + \beta_2 \ RPO_{m,t} + \ \mu_m + \delta_t + \ \gamma_{d,t} + \epsilon_{mt} \quad (1)$$

$$VC_{m,t} = \beta_0 + \beta_1 \boldsymbol{X}_{m,t-1} + \beta_2 \ RPO_{m,t} + \ \mu_m + \delta_t + \ \gamma_{d,t} + \epsilon_{mt} \quad (2)$$

In addition to these two dependent variables, we also estimate the model with dependent variables that reflect the per capita number (and value) of credits allocated in a municipality-

[15] In Colombia, 'ethnic minority' includes afro-Colombians, indigenous populations, and Roma Gypsies
[16] https://reshare.ukdataservice.ac.uk/cgi/users/home?screen=EPrint::Summary&eprintid=855023

year by source (public vs. private banks) and recipient (to low-wealth, mid-wealth and high-wealth farmers)[17].

In all equations, the independent variable is RPO, the number of RPOs per thousand rural inhabitants[18]. We use this variable instead of the number of farmers participating in an RPO, as data on the latter does not exist at municipality-year level.

The equations include a vector ($\boldsymbol{X}$) of observable municipal characteristics that vary in time and can affect credit provision as well as RPO creation. These include transfers from central and departmental governments, and so control for public investments that likely affect credit dynamics as well as opportunities for creating and sustaining RPOs (e.g. investment in a new water district or road that might increase agricultural productivity or commercial opportunities). We also control for local tax revenues as a proxy for the dynamism of the local economy. This allows us to control for diverse economic effects, for example price shocks in particular products that might affect municipalities differently in terms of liquidity in the local economy, demand and supply of credit, or RPOs' production and commercialization opportunities. We also control for the number of homicides per capita as a measure of insecurity. Insecurity can affect the capability of banks operating in an area and can also influence their risk analysis. Insecurity can also drive farmers' investment decisions (De Roux & Martinez, 2020) and their decisions to join an RPO or not. We include rain shocks as an additional control, since changes in weather conditions affect repayment behavior and risk of default, and thence credit demand and supply more broadly (Adjognon et al. 2020).

Our specification includes a municipality fixed effect (μ_m), which controls for time invariant municipal characteristics that can drive the demand and supply of agricultural credit,

[17] We are able to estimate these additional dependent variables as we have the municipality-year numbers and value of credits allocated by source and recipient. We do not have municipality-year information on the total number of farmers by wealth levels, but we do have municipality-year information on municipalities' rural populations. This is why we use per capita measures.

[18] We express the variable in this way rather than per capita terms so that its scale is easier to understand. It does not have econometric implications vis a vis dividing by total population (RPO per capita).

for example distance to the capital city, a proxy for market integration. Other examples include local cultures of entrepreneurialism and debt repayment. This fixed effect also controls for variables that do not vary significantly over the period studied (e.g. land quality, strength of economic institutions, and the 'stock' of RPOs created before the study period).

We also include a time fixed effect (δ_t) that controls for aggregate variations affecting all municipalities over a given period, for example macroeconomic and political cycles. Finally, we include a department-year fixed effect ($\gamma_{r,t}$) to control for aggregate variations affecting all municipalities in a specific department during a given year. Examples include a natural disaster or an upsurge of violence. The last term is the standard error ϵ_{mt}, clustered at the municipal level.

We deal with endogeneity related to omitted variable bias by controlling for time-varying observables and including municipality, year, and department-year fixed effects. However, these controls do not account for potential endogeneity caused by municipality and time-varying unobserved variables. There could also be endogeneity due to reverse causality. For example, Phan et al. (2020) show that microcredit improves rural households' social network quantity and quality, and Fischer & Qaim (2012) find that access to credit has a positive effect on participation in farmer organizations. Considering these threats to identification, and the impossibility of exploiting exogenous sources of variations such as policy interventions or natural shocks[19] to carry out experimental or quasi-experimental analyses, our results cannot be interpreted as causal.

Note as well that while the FE analysis is carried out at the local level, some of the potential mechanisms we discuss by which RPOs might increase access to credit operate at the

[19] The only policy intervention that took place during the period was a law creating a new public agency and modifying requirements for creating and registering social organizations. But this was a national level change affecting all municipalities. As such, it did not generate exogenous variation across time and municipality groups that could be analysed, for instance, in a differences-in-differences approach.

individual level. Such results could be subject to ecological fallacy. To address this and push our exploration further, we carry out an individual-level analysis of the relation between RPO membership and individual farmers' access to credit. Focusing first on the demand side, we estimate a logit model where the dependent variable is a dummy indicating whether a farmer *requested* credit during the past year (equation 3). A second model (equation 4) focuses on the supply side, estimating a dummy of whether a farmer *received* the requested credit.

$$P\ (requested\ credit)_i = \beta_0 + \beta_1 \boldsymbol{X}_i + \beta_2 RPO_i + \ \epsilon_{it} \quad (3)$$

$$P\ (received\ credit)_i = \beta_0 + \beta_1 \boldsymbol{X}_i + \beta_2 RPO_i + \ \epsilon_{it} \quad (4)$$

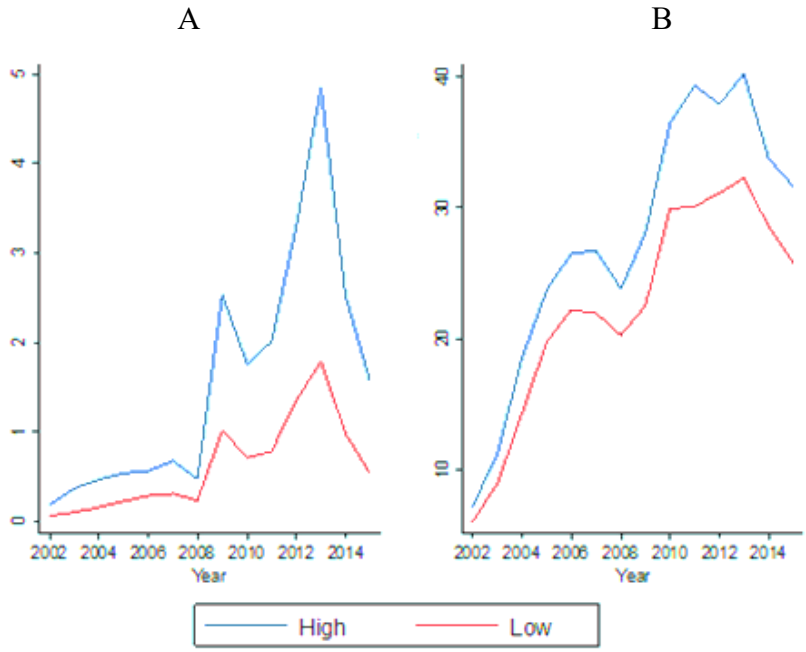
For the logit model, we also estimate heterogeneous effects by type of farmer. To this end, we split the sample of farmers by farmer type and estimate equations (3) and (4) for each subsample. The dependent variables in these regressions are also dummy variables, taking a value of 1 if a small-scale farmer requests a credit, and 0 otherwise.

In all equations, the key independent variable is *RPO,* a dummy indicating whether the farmer is a member of an RPO. Socioeconomic controls in vector $\boldsymbol{X}$ include age, gender, level of education, ownership of machinery, access to technical assistance, participation in community organizations, being from an ethnic minority and having private health insurance. Because of self-selection in joining an RPO and requesting credit, and because farmer characteristics affecting RPO membership can also affect access to credit, the logit analysis cannot be interpreted as causal.

6. Results

Figure 1 provides suggestive evidence of how municipalities with more RPOs per capita have higher access to credit, and how this difference becomes larger over time. We categorize municipalities as having high vs. low levels of RPOs depending on whether they are above or below the study period's national average number of RPOs per thousand rural

inhabitants. Figure 1 also shows that there is an increase in both the number and real value of credit allocated over time. It should be noted, however, that the magnitude of the observed increase in total number and value of credits allocated nationwide is partly due to measurement changes – i.e. what is classified as agricultural credit.[20] In any case, this does not undermine our identification, as our concern is to analyze the distribution of credit across municipalities, not overall levels of credit.



Source: Author's calculations based on data from Finagro and the National Economic and Social Registry RUES. Value of credit in real per capita terms. Number of credit operations reported per thousand rural inhabitants.

Figure 1. Real value (panel A) and number (panel B) of credit operations per municipality (RPOs per thousand rural inhabitants)

Let us now examine econometric results on RPOs and credit. Table 1 shows results from the municipal level FE model, in which columns 1 and 2 refer to the total number of credit operations allocated (extensive margin), and columns 3 and 4 refer to the value of credit operations allocated (intensive margin). For both outcomes, coefficients on RPOs are positive

[20] Over time, regulators broadened the legal definition of agricultural credit to include various rural activities, and even credit to supermarkets and restaurants, so inflating the credit count.

and statistically significant at the five and one percent levels and are robust to the inclusion of controls. In the specifications that include controls, coefficients show increases of 0.07 standard deviations in the number of credit operations allocated, and 0.22 standard deviations in the value of credit operations allocated.

Table 1. FE estimations: Aggregate access to credit

Dependent variable:	**Number of credit operations**		**Value of credit operations**	
VARIABLES	(1)	(2)	(3)	(4)
RPO (per thousand rural inhabitants)	1.204**	1.679**	0.600***	0.502***
	[0.563]	[0.687]	[0.189]	[0.165]
Rain shocks		0.001*		0.000
		[0.001]		[0.000]
Lag Local fiscal revenue (per capita)		-3.036***		0.921**
		[1.168]		[0.363]
Lag National transfers (per capita)		14.601***		-0.082
		[2.919]		[0.491]
Lag Homicides (per capita)		-1.130***		-0.019
		[0.271]		[0.028]
Constant	7.455***	-4.838*	0.670***	0.013
	[1.812]	[2.768]	[0.040]	[0.293]
Observations	15,615	11,980	15,615	11,980
R-squared	0.421	0.443	0.284	0.220
Number of Municipalities	1,117	1,077	1,117	1,077
Municipality FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Department-year FE	YES	YES	YES	YES

Robust standard errors in brackets clustered at municipal level. *** p<0.01, ** p<0.05, * p<0.1. Number of credit operations per thousand rural inhabitants. Value of credit operations expressed in per capita terms. All monetary variables in real terms. Homicides per capita in logs. Estimations exclude the five principal cities in the country. Specifications with only municipal fixed effects, with municipal and year fixed effects, and with region-year fixed effects generate consistent results. Results clustering errors at the department level are also robust.

To analyze heterogeneity in credit patterns, we analyze credit allocation at the municipality-year level, differentiating credit allocated by source and recipient. Results in Table 2 show a positive relation between RPO formation and increases in the number and value

of credit allocated to low-wealth farmers, but only for credit granted by the public bank. Coefficients are also positive for credit allocated to high-wealth farmers, but only from private banks. For mid-wealth farmers, RPO coefficients are insignificant for both public and private credit, by both number and value of credits.

Table 2. FE estimations: Aggregate access to credit by type of producer and credit source

	Number of credit operations						Value of credit operations					
	Public credit			Private credit			Public credit			Private credit		
VARIABLES	To high-wealth farmers (1)	To mid-wealth farmers (2)	To low-wealth farmers (3)	To high-wealth farmers (4)	To mid-wealth farmers (5)	To low-wealth farmers (6)	To high-wealth farmers (7)	To mid-wealth farmers (8)	To low-wealth farmers (9)	To high-wealth farmers (10)	To mid-wealth farmers (11)	To low-wealth farmers (12)
RPO (per thousand rural inhabitants)	0.011	0.015	1.503**	0.085*	0.012	0.047	-0.004	0.009	0.021**	0.493**	-0.015	-0.003
	[0.017]	[0.046]	[0.640]	[0.045]	[0.047]	[0.061]	[0.003]	[0.007]	[0.001]	[0.171]	[0.014]	[0.002]
Rain shocks	-0.000	0.000	0.001*	0.000	0.000	-0.000	-0.000	0.000	0.000	0.000	-0.000	-0.000
	[0.000]	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Lag Local fiscal revenue (per capita)	-0.0259	-0.007	-3.182***	0.401***	0.006	-0.199**	-0.002	0.0000	-0.066***	-0.878*	0.095***	-0.005**
	[0.038]	[0.0814]	[1.077]	[0.154]	[0.058]	[0.082]	[0.012]	[0.000]	[0.019]	[0.374]	[0.212]	[0.002]
Lag National transfers (per capita)	0.188***	0.267	14.641***	-0.215*	0.005	-0.177	0.003	0.002	0.310***	-0.240	-0.124 **	-0.006
	[0.068]	[0.290]	[2.767]	[0.119]	[0.168]	[0.186]	[0.013]	[0.015]	[0.062]	[0.481]	[0.044]	[0.005]
Lag Homicides (per capita)	-0.001	-0.011	-1.020***	0.004	-0.019	-0.099***	0.002	0.000	-0.011***	-0.005	-0.006	-0.000
	[0.009]	[0.003]	[0.253]	[0.010]	[0.020]	[0.035]	[0.002]	[0.004]	[0.004]	[0.026]	[0.005]	[0.001]
Constant	1.007***	0.861***	-7.045***	0.238*	0.377*	-0.454**	0.043***	0.032***	-0.057***	-0.006	-0.004	0.003
	[0.180]	[0.244]	[2.659]	[0.133]	[0.201]	[0.294]	[0.015]	[0.003]	[0.033]	[0.278]	[0.049]	[0.009]
Observations	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980	11,980
R-squared	0.178	0.103	0.140	0.046	0.007	0.261	0.046	0.405	0.589	0.117	0.282	0.473
No. Municipalities	1,077	1,077	1,077	1,077	1,077	1,077	1,077	1,077	1,077	1,077	1,077	1,077
Municipality FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Department-year FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES

Robust standard errors in brackets clustered at municipal level. *** p<0.01, ** p<0.05, * p<0.1. Number of credit operations per thousand rural inhabitants. Value of credit operations expressed in per capita terms. All monetary variables in real terms. Homicides per capita in logs. Estimations exclude the five principal cities in the country. Specifications with only municipal fixed effects, with municipal and year fixed effects, and with region-year fixed effects generate consistent results. Results clustering errors at the department level are also robust. All panel estimations are carried out at the municipality-year level, using different dependent variables reflecting the per capita number of credits allocated by source and recipient.

As a robustness check of municipal-level results, we use 2013 census data to conduct a sensitivity analysis. Our results (see Table 1 in the supplementary materials) are robust to the inclusion of 23 additional control variables that might affect the allocation of credit or RPO dynamics in a municipality, but that could not be included in the FE model due to a lack of data.[21] As an additional robustness check, we re-estimate results using an alternative measure of RPO presence in a municipality: the number of RPO members over total rural population, a measure of associational density. This estimation also uses 2013 cross-sectional census data. Our results are once again robust.

Let us turn now to individual-level logit results. Table 3 shows that RPO membership is associated with a 2.5-fold increase in the probability of a farmer requesting credit[22] – the demand-side effect. This result is robust to the inclusion of controls (column 2). Column 3 shows that RPO membership is also associated with a 1.2-fold increase in the likelihood of a farmer receiving the requested credit – the supply-side effect -. Column 4 shows that these results are also robust to the inclusion of controls. The table further shows that the magnitude of the RPO coefficient as a predictor of access to credit, is larger than that of other farmer characteristics, including gender, age, being from an ethnic minority, level of education, owning agricultural machinery, participating in other social organizations, or accessing private health insurance (a proxy for high income). This result is consistent with the data showing that the share of farmers who request credit in a given year is significantly higher for organized farmers (32.3%) that for non-organized ones (8.4%).

[21] The psacalc command running Oster´s (2019) test of unobservable selection and coefficient stability indicates that selection on unobservables would have to be too high to drive the RPO coefficient to zero. When we estimate the regression with no controls, the RPO coefficient is 7.365. With the full set of 23 controls, the coefficient is 8.152, while the R-squared increases from 0.011 to 0.490. This shows that the coefficient´s significance survives the barrage of controls.

[22] Value estimated using as exponent the coefficient on RPO membership (0.933) in specification (1), which has a significantly larger N.

Table 3. Logit model: Individual access to credit

	Probability of credit demand		Probability of credit supply, conditional on demand	
VARIABLES	(1)	(2)	(3)	(4)
RPO member	0.933***	0.836***	0.210***	0.195***
	[0.028]	[0.027]	[0.032]	[0.031]
Received Technical Assistance	0.877***	0.769***	0.319***	0.295***
	[0.029]	[0.026]	[0.029]	[0.030]
Sells produce in the market	1.491***	1.031***	0.609***	0.485***
	[0.032]	[0.031]	[0.033]	[0.047]
Owns agricultural machinery	0.571***	0.448***	0.092***	0.087***
	[0.025]	[0.025]	[0.030]	[0.031]
Participates in community organization	0.051	0.089	-0.175***	-0.165***
	[0.051]	[0.054]	[0.052]	[0.057]
Male		0.285***		0.056**
		[0.017]		[0.026]
Above average age in municipality		-0.091***		-0.207***
		[0.012]		[0.021]
Finished primary		0.003		-0.231***
		[0.016]		[0.023]
Has private health insurance		-0.261***		-0.027
		[0.024]		[0.030]
Ethnic minority		-0.433***		-0.010
		[0.115]		[0.118]
Constant	-3.873***	-3.342***	1.270***	1.503***
	[0.044]	[0.044]	[0.044]	[0.054]
Observations	2,259,298	1,068,983	250,230	155,910

Robust standard errors in brackets clustered at the municipal level. *** p<0.01, ** p<0.05, * p<0.1. Results are based on self-reports of credit request and access during 2013. The number of observations for the likelihood of credit supply conditional on demand is estimated only for farmers who requested credit. Columns 2 and 4 have fewer observations as additional controls are not reported for all farmers.

Turning to heterogeneity in the individual-level results, Table 4 shows that RPO membership increases the likelihood of a farmer demanding credit for all three types of farmers. While the coefficients have similar magnitude, the size of the effect is largest for large-scale farmers, representing a 2.8-fold increase in the probability, relative to the 2.3-fold increase observed for smallholders. The supply-side effects presented in columns 4-6 show that RPO membership is also associated with an increase in the probability of a farmer receiving the requested credit. Again, the largest effect is observed for the case of large-scale farmers, with

a 1.5-fold increase compared to a 1.2-fold increase for both medium-scale farmers and smallholders. The results presented in the annex further show that the largest RPO coefficient is observed for the case of large-scale farmers' access to private credit.

Table 4. Logit model: Individual access to credit by farmer type

	Probability of credit demand			Probability of credit supply conditional on demand		
VARIABLES	Large-scale farmer (1)	Medium-scale farmer (2)	Smallholder (3)	Large-scale farmer (4)	Medium-scale farmer (5)	Smallholder (6)
RPO member	1.036***	0.842***	0.828***	0.377**	0.212***	0.183***
	[0.081]	[0.033]	[0.0293]	[0.186]	[0.061]	[0.032]
Received Technical Assistance	0.784***	0.684**	0.758***	0.395**	-0.365***	0.244***
	[0.099]	[0.038]	[0.027]	[0.205]	[0.060]	[0.030]
Sells produce in the market	1.067***	0.954***	1.051***	1.262**	0.323*	0.530***
	[0.285]	[0.077]	[0.032]	[0.623]	[0.172]	[0.047]
Owns agricultural machinery	0.320***	0.443***	0.491***	0.110	0.258***	0.122***
	[0.068]	[0.033]	[0.026]	[0.165]	[0.052]	[0.032]
Participates in community organization	0.591***	0.191***	0.069	-0.268	0.007	-0.169***
	[0.113]	[0.063]	[0.059]	[0.242]	[0.098]	[0.061]
Male	0.138	0.125***	0.315***	-0.367	-0.041	0.098***
	[0.090]	[0.034]	[0.018]	[0.266]	[0.100]	[0.025]
Above average age in municipality	0.273***	0.134***	-0.140***	-0.009***	-0.162***	-0.224***
	[0.060]	[0.023]	[0.012]	[0.166]	[0.058]	[0.020]
Finished primary	0.241***	0.057***	-0.0009	0.119	-0.208***	-0.238***
	[0.061]	[0.025]	[0.017]	[0.168]	[0.051]	[0.026]
Has private health insurance	-0.054***	-1.161***	-0.259***	0.524***	0.276***	-0.088***
	[0.070]	[0.110]	[0.026]	[0.169]	[0.072]	[0.030]
Ethnic minority	-0.225***	-0.597***	-0.433***	-0.275	-0.224*	-0.008
	[0.124]	[0.110]	[0.122]	[0.262]	[0.134]	[0.125]
Constant	-4.108***	-3.363***	-3.333***	0.243	1.189***	1.522***
	[0.294]	[0.056]	[0.046]	[0.648]	[0.207]	[0.054]
Observations	16,342	133,043	919,598	1,768	19,225	194,914

Robust standard errors in brackets clustered at municipal level. *** p<0.01, ** p<0.05, * p<0.1.

7. Discussion

Two key results stem from our analysis. First, there is a positive relation between RPOs and access to credit at both the individual and aggregate (municipality) levels. Increased credit for RPO members is not associated with decreased credit for non-members (i.e. there is no crowding-out[23]). While previous studies show that social networks can have negative consequences on access to credit when they end up excluding some members of the community from it (Okten and Osili, 2004), this does not appear to be the case with RPOs.

Secondly, the relation between RPOs and access to credit is heterogeneous for different types of farmer and sources of credit; that is, there are distributional effects. Specifically, increased access to credit for high-wealth farmers acts via private banks, whereas increased aggregate access to credit for low-wealth farmers acts via the public sector. We find no evidence that RPO dynamics in a municipality influence aggregate credit access for medium-wealth farmers.

What explains this heterogeneity? The difference does not appear to stem from heterogeneity in RPO participation rates, as these are homogeneous across all three farmer types. However, we do find differences in credit demand-side and supply-side effects associated with RPO participation across types of farmers. Our individual-level analysis shows that while RPO membership increases the likelihood of any farmer demanding credit, the largest effect is observed for large-scale farmers. A likely explanation for this is that large-scale, high-wealth farmers join RPOs with the aim of expanding their already large productive projects, for instance to jointly invest in a fruit processing unit, or similar large-scale projects. Investments of this scale are unlikely to be financed through individual capital, thus generating a strong demand for credit, and in particular for private credit, considering that public banks have ceilings for their credit allocations. This type of credit demand is likely attractive for

[23] This can be the case when the supply of credit is not fixed, and thus the total amount of resources allocated can increase, as occurred in this case.

banks, in particular private ones, as large operations of this sort have lower relative allocation costs, and because participation in large collective projects through RPOs can signal higher expected returns, making banks more willing to allocate the demanded credit. Indeed, our results show that the RPO effect on the probability of a farmer receiving the requested credit (i.e. a supply side effect) is strongest for large-scale farmers, and for large-scale farmers' access to private credit. While RPO membership increases a large-scale farmer´s access to private credit 3.6-fold, in the case of smallholders the increase is only 1.8-fold.

As such, the RPO effect appears to replicate, rather than counteract, the pre-existing segmentation of the credit market, in which private banks have a bias for allocating larger credits to larger and wealthier farmers. While smaller-scale, low-wealth Colombian farmers have the opportunity to access other sources of credit, in particular public credit (as the municipality-level results show), we posit that in development terms, identifying alternatives to increase access to private credit for less-wealthy farmers remains relevant. Doing so is likely to increase the credit alternatives from which they can choose, including opportunities to benefit from the advantages that private credit offers. For instance, private credit typically offers speedier approval times (less than a week, compared to a month or more for public credit), an aspect that is relevant for farmer´s financing plans, as agricultural investments have set times based on production and weather cycles. Indeed, rapid disbursement is amongst the main reasons farmers turn to high-cost financial alternatives, such as microfinance and money lenders.

Another advantage offered by private credit, at least in the Colombian setting, is lower transaction costs. Private banks have mobile advisors that reach rural customers directly by traveling to remote rural areas, where less wealthy and smaller farmers concentrate. The public bank does not offer this service, making it costlier for clients to request public credit, especially in a context in which travel costs to bank branches are seven times higher for rural vs. urban

clients (USAID, 2021). All in all, private credit has the potential of meeting a demand for speedier credit and lower transaction cost credit relative not only to public credit, but also to sources like microfinance.

8. Conclusion

Using an original dataset on farmers and municipalities in Colombia, we show a positive relationship between RPOs and access to agricultural credit at both the individual and local levels. This suggests that RPOs have the potential to ease access not only to input and output markets, as previous studies have found (Desai and Joshi 2014, Verhofstadt & Maertens 2014, Vandeplas et al. 2013), but also to financial markets. We also show that this relation operates differently for different types of farmers, an effect that appears to derive from pre-existing contextual conditions, in particular the structural segmentation of the agricultural credit market across farmer type and credit sources.

Further research is required to causally test the specific demand and supply-side mechanisms explaining this relation and its heterogeneity, and to identify whether RPO participation is associated to improved access to credit in lower-income contexts (e.g. Africa, South Asia) where formal agricultural markets are less developed, credit constraints more stringent and the supply of credit less flexible.

A more thorough understanding of the mechanisms behind the observed relations could help identify concrete ways to exploit RPOs' potential to increase financial outreach in rural areas, including through lower-cost alternatives. Some preliminary policy ideas include RPOs working jointly with banks' rural inclusion programs to reach potential clients in blocks, lowering search and allocation costs that make one-on-one credit allocations especially costly in remote areas, and more so for small credit operations. Through lower search and allocation costs, the structural bias of commercial banks against small loans might be at least partly counteracted.

Regulatory changes could also be introduced to recognize informal financial references provided by RPOs to their members as valid evidence of farmers' financial history. Because credit history is among the main criteria banks evaluate when analyzing creditworthiness, this could help lessen supply-side credit constraints that limit first-time financial inclusion. Any such policy alternatives should be analyzed by credit authorities, banks, RPO confederations, and policy experts, seeking to identify how best to leverage rural associativity to increase access to agricultural credit, and though this to contribute to rural development.

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Annex

Table A1. Data summary

Variable	Obs.	Mean	Std. Dev.	Min	Max
MUNICIPALITY LEVEL DATA					
A. Independent variables					
RPO per thousand rural inhabitants	15,615	0.206	0.475	0.000	27.972
B. Dependent variables					
Value of credit operations per capita – COP					
Total	15,726	0.789	2.326	0.000	132.845
Public					
For high-wealth farmers	15,728	0.015	0.213	0.000	14.786
For mid-wealth farmers	15,728	0.147	0.319	0.000	7.863
For low-wealth farmers	15,728	0.231	0.381	0.000	5.177
Private					
For high-wealth farmers	15,728	0.228	2.0015	0.000	130.248
For mid-wealth farmers	15,728	0.155	0.420	0.000	9.003
For low-wealth farmers	15,728	0.0110	0.117	0.000	13.383
Number of credit operations granted per thousand rural inhabitants					
Total	15,726	22.644	25.235	0.000	221.805
Public					
For high-wealth farmers	15,728	0.142	0.724	0.000	17.508
For mid-wealth farmers	15,728	2.196	3.500	0.000	42.058
For low-wealth farmers	15,728	18.438	22.839	0.000	206.076
Private					
For high-wealth farmers	15,728	0.179	0.811	0.000	24.379
For mid-wealth farmers	15,728	1.012	2.020	0.000	40.261
For low-wealth farmers	15,728	0.613	2.426	0.000	72.440
C. Control variables					
Rain shocks	14,450	637.615	337.045	0.000	4368.8

Local fiscal revenue per capita -COP	13,114	0.180	0.373	0.000	14.198
National transfers per capita - COP	13,112	0.151	0.296	0.000	13.331
Homicides (log)	10,238	-8.070	0.914	-11.998	-4.405
INDIVIDUAL LEVEL DATA					
D. Independent variables					
RPO member	2,366,192	0.098	0.297	0	1
E. Dependent variables					
Requested credit	2,366,192	0.107	0.309	0	1
Large-scale farmer	2,366,192	0.001	0.033	0	1
Medium-scale farmer	2,366,192	0.012	0.108	0	1
Smallholder	2,366,192	0.094	0.292	0	1
Received the requested credit	253,791	0.884	0.320	0	1
Large-scale farmer	253,791	0.009	0.094	0	1
Medium-scale farmer	253,791	0.094	0.291	0	1
Smallholder	253,791	0.782	0.413	0	1
F. Individual level control variables					
Received Technical Assistance	2,366,192	0.166	0.372	0	1
Sells produce in the market	2,366,192	0.731	0.443	0	1
Owns agricultural machinery	2,299,590	0.164	0.371	0	1
Participates in community organization	2,263,394	0.054	0.226	0	1
Male	1,383,503	0.748	0.434	0	1
Above average age in municipality	1,383,503	0.474	0.499	0	1
Finished primary	1,347,753	0.250	0.433	0	1
Has private health insurance	1,356,197	0.186	0.389	0	1
Ethnic minority	2,364,023	0.136	0.342	0	1

Notes: Per capita variables are calculated dividing by the number of rural inhabitants. Due to issues of scale, in the case of variables RPOs and total number of credit operations, the division is made using thousands of rural inhabitants (i.e. RPOs per thousand rural inhabitants), so that the units are easier to analyze. Monetary values are reported in millions of 2002 real COP. All individual level variables are dummy variables, indicating, for instance, whether a farmer requested credit or not, whether the farmer is male or not, etc.