RESR Revista de Economia e Sociologia Rural
ISSN 1806-9479
ARTICLE

Access and impact of Pronaf in Brazil: evidence on typologies and regional concentration

Acesso e impacto do Pronaf no Brasil: evidências sobre as tipologias e a concentração regional

Bruno de Souza Machado[1], Mateus de Carvalho Reis Neves[1], Marcelo José Braga[1], Davi Rogério de Moura Costa[2]

[1]Departamento de Economia Rural, Programa de Pós-Graduação em Economia Aplicada, Universidade Federal de Viçosa (UFV), Viçosa (MG), Brasil. E-mails: bruno.machado@ufv.br; mateus.neves@ufv.br; mjbraga@ufv.br
[2]Faculdade de Administração, Economia e Contabilidade, Universidade de São Paulo (USP), Ribeirão Preto (SP), Brasil. E-mail: drmouracosta@usp.br

How to cite: Machado, B. S., Neves, M. C. R., Braga, M. J., & Costa, D. R. M. (2024). Access and impact of Pronaf in Brazil: evidence on typologies and regional concentration. Revista de Economia e Sociologia Rural, 62(3), e273994. https://doi.org/10.1590/1806-9479.2023.273994

Abstract: The objective of the study was to measure the impacts of Pronaf access on family farming (FF) performance measures with analysis for the FF and its typologies Pronaf B and Pronaf V of the 2017 Agricultural Census. Variables related to family farmers, their establishments and climate were used. The methodology was composed of Entropy Balancing for treatment analysis and Minimal Weighted Squares to measure the impacts. The use of different levels of intensity confirmed the presence of regional concentrations in access in all analyzes. The results of the impacts on FF showed to be related to the Pronaf V typology, confirming the need to analyze the disaggregated FF. The impacts on the Pronaf B typology were negative, suggesting that these farmers are potentially using the obtained credit inappropriately and/or inefficiently. This reaffirms the need to integrate Pronaf with other policies, such as technical assistance and rural extension.

Keywords: Family Farming, Pronaf, impacts, concentration.

Resumo: O objetivo do estudo foi mensurar os impactos do acesso ao Pronaf nas medidas de desempenho da agricultura familiar (AF) com análise para o AF e suas tipologias Pronaf B e Pronaf V do Censo Agropecuário 2017. Foram utilizadas variáveis relacionadas aos agricultores familiares, seus estabelecimentos e o clima. A metodologia foi composta por Balanceamento por Entropia para análise do tratamento e Mínimos Quadrados Ponderados para a mensuração dos impactos. O uso de diferentes níveis de intensidade confirmou a presença de concentrações regionais no acesso em todas as análises. Os resultados dos impactos sobre a AF mostraram-se relacionados à tipologia Pronaf V, confirmando a necessidade de analisar a AF desagregada. Os impactos na tipologia Pronaf B foram negativos, sugerindo que esses agricultores estão potencialmente utilizando o crédito obtido de forma inadequada e/ou ineficiente. Isso reafirma a necessidade de integrar o Pronaf a outras políticas, como assistência técnica e extensão rural.

Palavras-chave: Agricultura Familiar, Pronaf, impactos, concentração.

1. Introduction

The processes experienced in Brazil in the 1990s, such as trade liberalization, brought about significant changes in the Brazilian agriculture, adapting its way of producing and competing in the national and international agricultural market (Santos & Santana, 2020). In this scenario, the so-called family farmers required more attention from the State (Mattei, 2014).

The creation of the National Program for the Strengthening of Family Farming (Pronaf), in 1996 was a solution found by the State to legitimize the importance of family farming (FF), in addition to promoting institutional and economic support to it, through access to rural credit (Schneider, 2003). However, since its creation, one of the main challenges of Pronaf is still to find mechanisms that include and support the poorest segments of the FF (Nascimento, 2008).

The access to rural credit by Pronaf is still concentrated in Brazil (Mattei, 2014). The farmers most likely to access the Pronaf are the more capitalized ones, located in the South, while the more impoverished farmers, mainly located in the Northeast region, tend to face more difficulties in access (Pires, 2013). Thus, given the poverty that marks a considerable fraction of the Brazilian FF (Belik, 2015), there is a need to better understand the most impoverished part of farmers as well as the regions in which it is found in Brazil (Bianchini, 2005).

Research aimed at studying FF in Brazil intensified in the 1990s (Schneider, 2003). In relation to the Agricultural Censuses of the Brazilian Institute of Geography and Statistics (IBGE), the FF was investigated in a way more held for the first time in the 2006 Agricultural Census[1] (Instituto Brasileiro de Geografia e Estatística, 2006). This census contributed significantly to the process of legitimation of the family farming segment in the country (Pereira & Nascimento, 2014).

The 2017 Agricultural Census delimits the FF and classifies[2] family establishments in Pronaf V, Pronaf B and nonpronafiano. This last typology is composed of classified farmers with potential of not access to financing by Pronaf. Farmers classified as Pronaf V are significantly present in the South region, while those of Pronaf B are predominantly located in the Northeast region (Instituto Brasileiro de Geografia e Estatística, 2017). Therefore, through Pronaf there seems to be some action on several fronts, aiming to serve both a more capitalized FF and a more impoverished FF.

Therefore, there are different debates involving relevant characteristics of FF and access to Pronaf, such as its coverage, its targeting for producers with certain characteristics, among other factors. Even with these discussions, different authors have sought to measure the impact of access to Pronaf in several indicators (Kageyama, 2003; Magalhães et al., 2006; Freitas et al., 2020) to evaluate the effectiveness of Pronaf.

This article understands the relevance of continuously investigating the effectiveness of Pronaf as a public policy focused on FF. Thus, with more recent data, this study aimed to analyze the impacts of access to Pronaf on profitability, the Gross Value of Production (GVP) and the partial productivities of total labor, family labor and land of FF establishments in Brazil.

Three analyses were made: for FF as a whole and for Pronaf V and Pronaf B typologies. The first contribution of this research is the aggregated and disaggregated analysis of FF since the impacts tend to be different between these typologies. The answer to this difference is how the restriction to Pronaf acts in Brazil according to the results observed in the literature.

Another contribution is the use of different levels of intensity in the analysis of the impacts. The study aimed to verify both the behavior of the impacts and the possible patterns of concentration of access in Brazil. Thus, a different analysis of the studies carried out on Pronaf is performed, since it expands the simple dual analysis of access or not to the Program.

The 2017 Agricultural Census was the source of information on family farmers and Pronaf. The Terrestrial Hydrology Research Group (THRG) was the source of climatic variables, since climatic conditions can interfere with access to Pronaf. Entropy Balancing and Weighted Least Squares estimation were adopted as analytical strategies.

This article is structured as follows: besides this introduction, section 2 focuses on the relationship between Pronaf and FF; section 3 presents the methodology; section 4 presents the results and discussion of the research; and finally, the last section presents the conclusions.

[1] Some studies delimited the FF using previous censuses, such as the United Nations Food and Agriculture Organization (FAO) and the National Institute of Colonization and Agrarian Reform (INCRA).

[2] Farmers who fulfilled the conditions imposed by the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017) are understood as a potential audience of a particular group. For example, a farmer classified as Pronaf B has the potential to access rural credit via Pronaf B Group but does not indicate that he accessed the funding in practice.

2. Theoretical foundation: Family farming and Pronaf

Debates on family farming (FF) in Brazil intensified in the 1990s (Schneider, 2003), and the creation of the National Program for the Strengthening of Family Farming (Pronaf) in 1996 marked a significant milestone in providing rural credit to this sector. Pronaf aims to contribute to the development of family establishments and since its inception, the Program has been under scrutiny, subject to questions, and continuously improved to achieve its objectives.

Access to Pronaf depends on the possession of the Declaration of Aptitude to Pronaf (DAP), which qualifies the producer as a family farmer (Bianchini, 2015). One of the criteria adopted to determine access to Pronaf credit was family income, comprising the sum of agricultural and non-agricultural income within the family establishment, as well as non-agricultural income outside the establishment (Bianchini, 2015).

Initially, Pronaf consisted of four groups of farmers in 1999: A (settled or beneficiaries of the National Land Credit Program); B (below the poverty line); C (in transition, but with low capitalization); and D (more capitalized or in the process of capitalization). From the year 2000, the A/C group emerged. According to Schneider et al. (2004), these different groups allowed Pronaf's rules to become more suitable for the various profiles of FF.

In the Agricultural and Livestock Plan (PAP) of 2004/2005, Group E (extended reproduction level) was created. In the PAP of 2008/2009, groups C, D, and E were discontinued, and Group V was established (more capitalized farmers eligible for Pronaf and unable to access groups A, A/C, and B). The 2017 Agricultural Census covers groups B and V, as well as non-pronafians[3]. Groups B and V include a significant portion of family farmers, with Group B representing the less capitalized segment (Mattei, 2014).

In the first decade of the 21st century, Law 11.326/2006[4] established the guidelines for the formulation of the national policy on FF and rural family businesses (Brasil, 2006). According to the definitive results of the 2017 Agricultural Census, out of the 5,073,324 registered agricultural establishments, 3,897,408 were classified as FF (76.82% of the total).

This relevant portion contains significant economic and social heterogeneity, both among Brazilian regions and within the regions themselves (Belik, 2015). The Central-Southern region of Brazil, particularly the South, hosts the most capitalized and developed family farming (Mattei, 2014; Souza et al., 2019), while the North and Northeast regions have a higher concentration of less capitalized family farming, especially in the Northeast, where the majority falls into the category of the poorest farmers (Bianchini, 2015).

There is evidence that economic and productive inequality in the rural areas of Brazil is persistent (Schneider et al., 2004; Pires, 2013; Mattei, 2014). Bianchini (2015) also emphasizes that family farming comprises a significant portion of farmers living below the poverty line. To mitigate this situation, Pronaf introduced a credit line focused on these farmers, called Pronaf B. Conversely, there is also Pronaf V (Variable Group), also known as Pronaf Family Farmers (Pires, 2013).

Aquino & Schneider (2015) consider the government's procedures to be a setback, indicating that marginalized farmers (Pronaf B, Pronaf A, and Pronaf A/C) have even lost the right to be categorized as family farmers. They also emphasize that transparency in the allocation of Pronaf's public resources has decreased. Thus, providing support to the poorest family farmers remains a Pronaf challenge.

[3] It was not possible to create the typologies for groups A and A/C due to methodological reasons (Del Grossi, 2019). Further analysis on the "A" and "A/C" groups can be found in Mattei (2014).

[4] This law defines that the family farmer is one who practices activities in the rural environment, whose area of establishment, under family management, has at most four fiscal modules, uses family labor and family income comes predominantly from activities related to the establishment.

3. Methodology

3.1. Levels of intensity and the evidence of regional concentration of access to Pronaf

The use of different intensity levels is adopted to measure the different impacts of Pronaf access on performance measures. The strategy is used so that it can contribute to the analysis of both the behavior of impacts and the investigation of possible patterns of concentration of access to Pronaf in Brazil.

Similar strategy of different intensity levels was employed by Ciaian et al. (2012). The authors analyzed how the use of inputs and agricultural production are related to access to rural credit in Eastern and Central Europe in some countries in transition. They estimated the impact of eight levels of credit restriction, since one of the objectives was to investigate the effect of credit use treatment. The justification for the adoption of the different levels of intensity was the research of Briggeman et al. (2009), which emphasizes that the impact of rural credit restriction may be non-linear.

The use of data at the agricultural establishment level was not possible. The lowest level of disaggregation of the available information of the 2017 Agricultural Census of free access is at the municipality level. So, the research adopted the idea that a municipality behaves as a representative family establishment[5], a concept that will be more detailed in subsection 5.2.

Then, by intensity is conceptualized the percentage of accesses to Pronaf in each municipality m, in which the proportion of establishments (P_m) classified as FF is analyzed and that reported having accessed the rural credit by Pronaf. Thus, a threshold is used to classify the representative family establishment into intensive or non-intensive in access to the Pronaf. The study considered both P_m, from the municipality , and P_M, which is the proportion of establishments that accessed Pronaf in Brazil, as well as its standard deviation (P_M^{dp}). Intensity levels arise in the change of the multiplier value of P_M^{dp}, given by x.

When P_m is greater than $(P_M + xP_M^{dp})$, x with the values 0.25, 0.5, 0.75, or 1, the family is classified as access intensive, and otherwise as non-access intensive. Since there are four possible values for x, four levels of intensity are used to investigate both the behavior of the measured impacts on the performance measures and the existence of possible patterns of concentration in access to Pronaf by varying the value of x. Intensity 1 represents the lowest level $(x = 0.25)$ and intensity 4 the highest level $(x = 1)$.

Figures 1, 2 and 3 elucidate this strategy. In them, the family establishments refer to the municipalities present in the "Financial movement" section of the 2017 Agricultural Census, in which the producers who declared to have obtained funding, which in this study was the Pronaf. Thus, a total of 5,516 municipalities are classified as intensive and non-intensive.

When observing Figure 1, the concentration of intensive family farms becomes more restricted as the intensity levels increase and highlights the municipalities that concentrate the accesses to Pronaf. The South region has the highest concentration of access both at the lowest and the highest intensity. The concentration in this region is in line with other studies that also alert to this situation in Brazil (Pires, 2013; Belik, 2015; Souza et al., 2019).

In intensity 1 there are several points in which intensive family establishments are found. This indicates the presence of Pronaf in all regions of Brazil. Aquino et al. (2014) highlight the presence of Pronaf in all these regions, in almost all municipalities, reflects the normative changes that the Program has undergone over the years.

[5] From that moment on, when citing only "family establishment" this article refers to the "representative family establishment", except for the circumstances in which the use of all expression is necessary.

Given the above, the present study notes that there is the presence of controversial opinions that consider the universe of family farming (FF) as uniform. On the contrary, Brazilian FF is marked by significant heterogeneity (Pires, 2013; Belik, 2015; Souza et al., 2019). Aquino et al. (2018) point out that the family farmer versus employer dichotomy has hidden the significant heterogeneity and (productive) inequality of this universe.

To clarify these points, we need to analyze the intensity differences between Pronaf V, the more developed farmers, and Pronaf B, the poorer ones (Aquino & Schneider, 2015). The intensities observed in family establishments classified as FF often align with the characteristics of more developed FF, like those in Pronaf V.

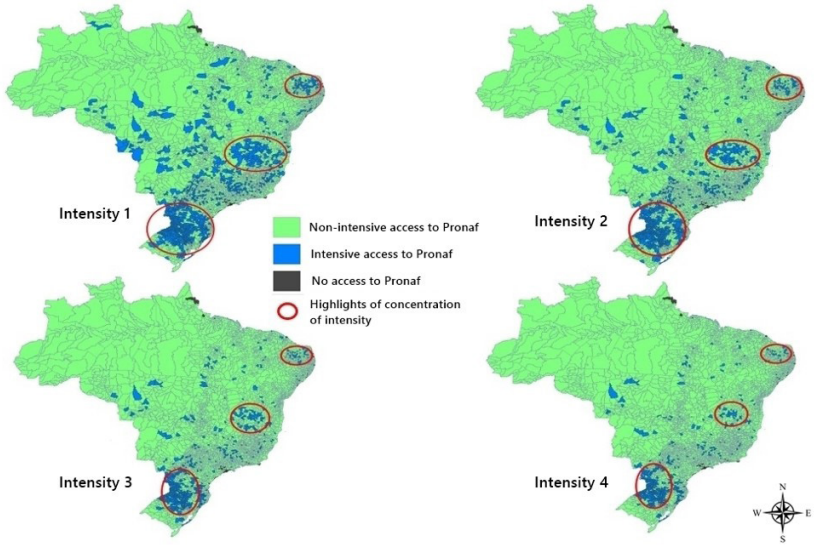

Figure 1. Intensity levels, access to Pronaf, and classification of representative family establishments into intensive and non-intensive, Brazil, 2017. Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).

Figure 2 shows the levels of intensity and access to Pronaf for establishments classified as Pronaf V. The concentration becomes more exclusive in the South region as levels increase.

The concentration of Pronaf access in the South region indicates that the patterns in Figure 1 are influenced by more developed farmers in southern municipalities. Pires (2013) highlights that Pronaf access intensities are connected to Pronaf V, revealing variations in credit volumes between Pronaf B and Pronaf V. This leads to increased heterogeneity among family farmers within the universe of FF.

Aquino & Schneider (2015) point out that it is important to consider that Pronaf has limitations to promote changes in the countryside. For the authors, the agricultural model that the Pronaf is intended is linked to a pattern of agriculture focused on the patterns of the conventional sectoral and productivist logic. Thus, the privileged FF is that specialized in agricultural activities integrated to the productive chains of the exporting agribusiness, which are the former Groups D and E, and which are now included in Group V.

Figure 3 exposes the intensity levels for family establishments classified as Pronaf B. The existence of intensive family establishments in all regions can be observed at level 1. As levels increase, concentration dispersed and forms new restricted concentrations. The Northeast and Midwest regions of Brazil and the mesoregions North, Jequitinhonha Valley and Mucuri Valley of Minas Gerais concentrate the largest portion of more impoverished establishments.

The concentration on access to Pronaf ends up penalizing farmers Pronaf B and farmers Pronaf A and A/C (Mattei, 2014).

Pires (2013) exposes that there is a demand from the farmer who makes up the potential group of access to Pronaf B even facing difficulties to access the Program. Thus, the situation presented by intensity 1 would be the best scenario for more farmers to access Pronaf.

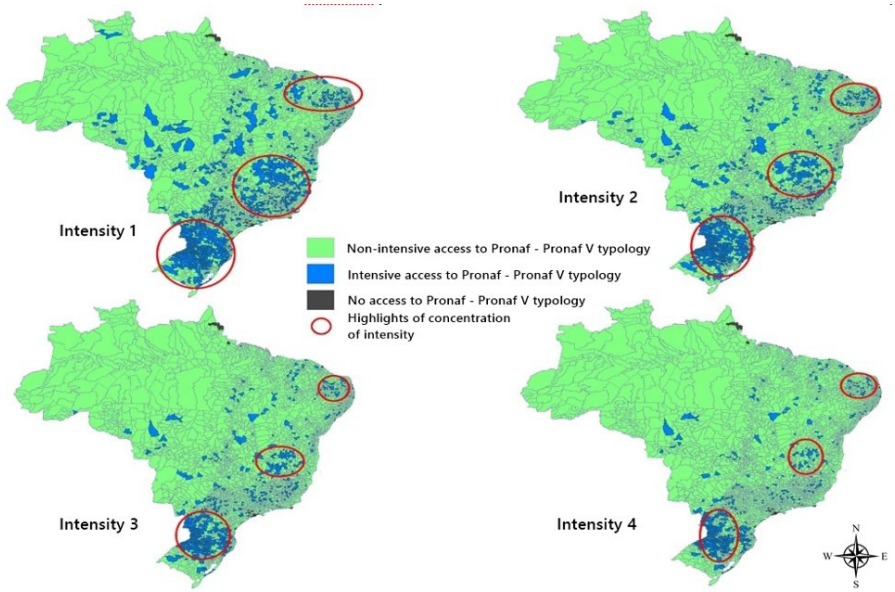

Figure 2. Intensity levels, access to Pronaf, and classification of representative family establishments classified as Pronaf V into intensive and non-intensive, Brazil, 2017. Source: Own preparation based on data from the Agricultural Census 2017 (Instituto Brasileiro de Geografia e Estatística, 2017).

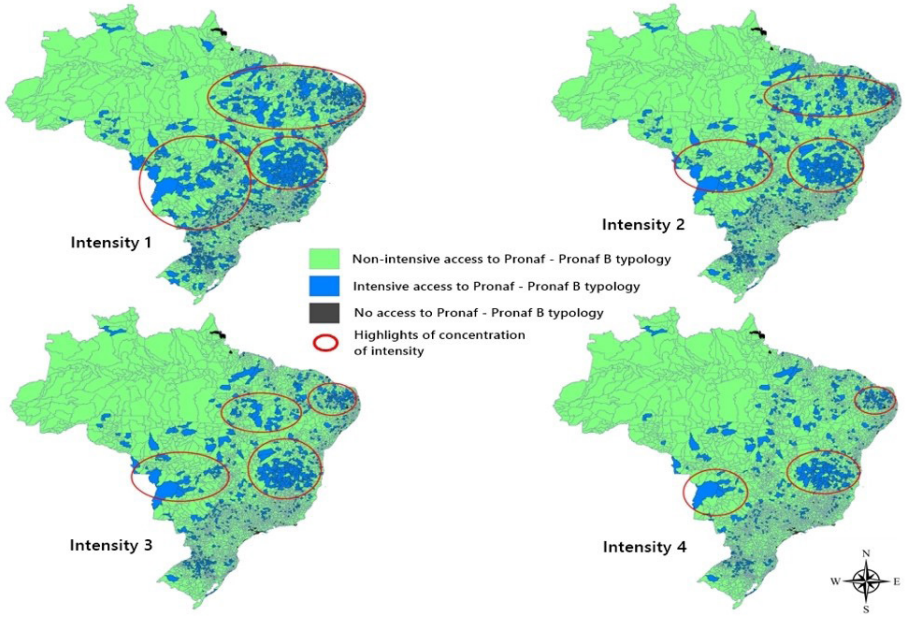

Figure 3. Intensity levels, access to Pronaf and classification of representative family establishments classified as Pronaf B in intensive and non-intensive, Brazil, 2017. Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).

3.2. Steps of econometric analysis

3.2.1. First stage - Entropy Balancing and treatment analysis

The possible existence of selection bias may lead to a direct wrong comparison of the results of the control and treated groups (Rosenbaum & Rubin, 1983). Thus, it is used Entropy Balancing (EB)[6], a multivariate and non-parametric pairing method, created by Hainmueller (2012). The objective of EB is to obtain a more balanced paired sample, in which the control group is as similar as possible to the treated group.

The method aims to weigh up a set of variables (observable characteristics) of the control group (non-intensive family establishments) so that it becomes possible to compare it with the treated group (intensive family establishments). The focus is that the main difference between the two groups is the establishment be classified as intensive or not, aiming to eliminate the bias mentioned. For this, the mean of these variables is considered as the moment to be weighted so that the mean of the variables in the control group is as close as possible to the mean of these variables in the treated group.

3.2.2. Second Stage - Weighted Least Squares and the impacts of Pronaf access

The second stage focused on measuring the impacts of Pronaf access. The variables of result[7] adopted were the *Gross Value of Production* (GVP), which is the sum of vegetal and animal production (except agroindustry), measured in R$ 1,000, the *partial land productivity*, which is the division of GVP by the total area, measured in R$ 1,000/hectare, the *partial total labor productivity*[8], which is the division of GVP by the total number of people employed, measured in R$ 1,000/employee, the *partial family labor productivity,* which is the division of GVP by the total number of people in the occupied family, measured in R$ 1,000/employee, and profitability, which is subtraction of GVP by input expenditure, measured in R$ 1,000.

In this step the Weighted Least Squares[9] method was used based on the weights created in the first stage to measure the impacts for each of the outcome variables according to each intensity levels. For illustration, the following Equation 1 is given for the result variable GVP:

$$Ln(GVP) = \beta_0 + \beta_1 intensity_{pronaf} + \varepsilon_i \quad (1)$$

that the β_1 represents the Average Treatment Effect on the Treated (ATT) to measure the impact of access to Pronaf for each level of intensity on GVP. Hence, the treatment effects found are free of selection bias from the observable variables. The reasoning seen in (1) is analogous for the other variables. The variables were logarithmized, which made the ATT found be seen as a percentage impact of access to Pronaf on the outcome variable under study. Regarding the sign of the ATT, following the statistical significance, if it is positive, it indicates a favorable impact on the intensive family establishment, if negative, it indicates an unfavorable impact.

[6] According to Hainmueller (2012), the Propensity Score Matching (PSM) presents a practical limitation, since it requires more time to achieve a satisfactory equilibrium solution, unlike the Entropy Balancing method.

[7] The creation of these variables followed similar steps of Fortini et al. (2020).

[8] The sex and age of the worker were considered. The study used men and women employed with 14 years or more and employed staff (of both sexes) with less than 14 years. Men received weight 1, women weight 0.75 and under 14 years weight 0.5, as done in Helfand et al. (2015).

[9] A similar procedure was done by Fortini et al. (2020) and Freitas et al. (2020).

3.3. Source, description, and treatment of the data

The article used data from the 2017 Agricultural Census, located in the IBGE Automatic Recovery System (SIDRA) as a source of information about the establishment, the family farmer and whether he accessed the Pronaf. For the climatic variables, data from the Terrestrial Hydrology Research Group (THRG) were used. SIDRA presents the municipality as the lowest level of disaggregation, so the study adopted the idea that a municipality reflects an average behavior of the group of family establishments located in its territory. The description of the variables used is shown in Table 1.

Table 1. Description and source of the variables at the municipality level[1].

Variable	Description	Source
Man	Proportion of establishments whose manager is male.	CA
Owner	Proportion of land owners of the establishments.	
Age	Proportion of establishments by manager age groups (From 25 to less than 35, from 35 to less than 45, from 45 to less than 55, from 55 to less than 65, from 65 to less than 75, and 75 or more).	
Education	Proportion of establishments by education groups of the manager (Higher or Graduate, High School, Elementary School complete and Elementary School incomplete).	
Literate	Proportion of owners who declared they could read and write.	
Technical Assistance	Proportion of establishments that accessed technical assistance.	
Member of the cooperative	Proportion of establishments associated with a cooperative.	
Internet	Proportion of establishments with Internet access for technical information such as proxy for Internet access.	
Soil	Proportion of establishments that do soil preparation.	
Agricultural practice	Proportion of establishments that perform some agricultural practice in production.	
GVP	Proportion of the Gross Production Value (GVP) (in R$ 1,000) of the sum of vegetal and animal production (except agribusiness).	
Area	Proportion of the area (in ha), devoted to production.	
Labor	Weighted proportion of men and women 14 years old and older and under 14 years old that make up the total occupied people and total family occupied people in production.	
Capital	Proportion of tractors (in units) as a proxy for capital.	
Expenses	Proportion of expenses (in R$ 1,000) salaries paid, fertilizers, correctives, seeds, seedlings, pesticides, animal medicines, salt, feed, other supplements, purchase of machinery and vehicles, fuel, lubricants, and electric power.	
Profitability	Difference between GVP and input expenses as a proxy.	
Large Regions	Dummies regionals (South, Southeast, Northeast, and Midwest, with the North as the base region).	
Temperature	Average mean temperature anomaly (in ºC) for the year 2016.	THRG
Precipitation	Average mean precipitation anomaly (in mm) for the year 2016.	

Source: Own preparation based on data from the 2017 Agricultural Census (CA) (Instituto Brasileiro de Geografia e Estatística, 2017) and Terrestrial Hydrology Research Group (THRG), Princeton University. Note: [1] The municipality reflects the sum of the information from establishments that are in its territory.

The variables that express observable characteristics of the farmer and family establishment, such as schooling and expenditure on inputs, respectively, were aggregated at the municipality level and then divided by the number of family establishments in the respective municipality. Thus, the variables now represent a proportion for the municipality m in question, which will be characterized as a representative family establishment.

The study initially considered all municipalities that presented agricultural establishments that declared having accessed the Pronaf. Then, the variables to be used were selected. SIDRA data has some hidden values in different variables, such as area, where the X indicates that the data contains sensitive information. Thus, the municipalities that presented an X in the variables used were excluded from the sample.

Soon after, the proportion of Census variables was created to work with the idea of representative family establishment. To control the influences of outliers in the built database, 5% of the municipalities in the lower and upper limit were removed based on the proportion of the GVP variable. The study processed the data for FF and the typologies of Pronaf. Three bases were built, whose numbers of observations were: FF with 4,210, Pronaf B with 2,470 and Pronaf V with 2,317.

Finally, the climatic variables are highlighted because it can interfere in the family establishment, especially on the obstacles that can impose access to Pronaf. The article used the average monthly temperature, in degrees Celsius (C°), and the average monthly precipitation, in millimeters (mm) of the municipalities of period from 2006 to 2016 to create the climatic anomalies[10]. These variables were used in the first stage of the estimates. The data source was the THRG database, using the methodology described by Sheffield et al. (2006).

Adamseged et al. (2019) note that it is not only the total amount of rainfall that matters for agricultural production, but also how it is regular and distributed. Thus, this study calculated the climatic anomalies for the decade 2006-2016 in relation to the year 2016, which precedes the 2017 Agricultural Census to analyze whether these variables impacted the establishments in 2017. Equation 2 below shows the calculation[11] of the temperature anomaly.

$$temperature\_anomaly_m^{2016} = \frac{mean\_temp_m^{2016} - mean\_temp_m^{2006-2016}}{stand\_dev_m^{2006-2016}} \quad (2)$$

that the $mean\_temp_m^{2016}$ refers to the mean temperature of the year 2016 for the municipality m, while $mean\_temp_m^{2006-2016}$ and $stand\_dev_m^{2006-2016}$ refer respectively to the mean temperature and standard deviation of the decade 2006-2016 for this same municipality m. Analogous reasoning is done for the precipitation anomaly.

4. Results and discussion

4.1 Descriptive data analysis

Table 2 shows the number of farms eligible for Pronaf, along with those reporting access for each region and Brazil. Pronaf V had the most observations and the highest access rate in comparison to its potential audience (17.16% of the total).

[10] For Angelocci & Sentelhas (2010), a climate anomaly can be characterized when meteorological variables, such as temperature, undergo a large fluctuation of one element in its climatological series at a given time. They point out that this fluctuation is represented by a strong deviation from the pattern previously seen in its variations.

[11] The creation of climate anomalies followed in the footsteps of Adamseged et al. (2019).

Table 2. Number of establishments in relation to access and potential access to Pronaf for family farming (FF) and its Pronaf typologies for regions and Brazil, 2017.

Typology	Pronaf Status	N	NE	MW	S	SE	Brazil
FF	Potential	384,594	1,133,715	215,544	591,412	635,629	2,960,894
(4,210)	Accessed	12,017	46,961	12,065	98,149	48,828	218,020
	% of access	3.12%	4.14%	5.60%	16.60%	7.68%	7.36%
FF – Pronaf V	Potential	82,529	55,846	78,594	320,886	175,451	713,306
(2,470)	Accessed	4,522	3,913	6,517	87,203	20,260	122,415
	% of access	5.48%	7.01%	8.29%	27.18%	11.55%	17.16%
FF – Pronaf B	Potential	170,459	760,402	69,210	144,006	215,097	1,359,174
(2,317)	Accessed	2,478	29,376	2,086	4,223	11,344	49,507
	% of access	1.45%	3.86%	3.01%	2.93%	5.27%	3.64%

Source: Own elaboration after processing the data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017). Notes: Number of municipalities in parentheses.

In the case of FF, the South of Brazil had the most accesses, with 16.60% in relation to the potential public. The Northeast region was only ahead of the North, with 4.14% of accesses in relation to the potential public. The low value in relation to the other regions can be justified by the high number of establishments classified as potential public Pronaf.

Pronaf B concentrates the largest share of establishments in Brazil, however, most accesses are in Pronaf V. The Northeast concentrates the largest number of the potential public of Pronaf B and the smallest number of Pronaf V. This region concentrates the largest fraction of less capitalized farmers in Brazil, where many are below the rural poverty line (Bianchini, 2015). The South is where the most capitalized farmers are located (Mattei, 2014), being also the region with the highest number of accesses in relation to the potential public of Pronaf V.

Figure 4 shows the number of agricultural establishments that accessed the Pronaf according to the Pronaf B and Pronaf V typologies at the Federative Units level in Brazil in 2017. The states of Bahia, Minas Gerais, Ceará, Piauí and Pernambuco concentrated the largest number of producers classified as Pronaf B. Pires (2013) analyzes the total value of credit agreements by groups for the regions of Brazil, in the period 2000-2010, and notes that these states and including Paraiba, were where the public of Pronaf B prevailed (76% of the total).

The high number of accesses in Bahia and Minas Gerais is since these states stand out in the number of accesses to Pronaf Microcredit B (Pires, 2013). Minas Gerais is the only state outside the Northeast region to have a considerable amount of these accesses.

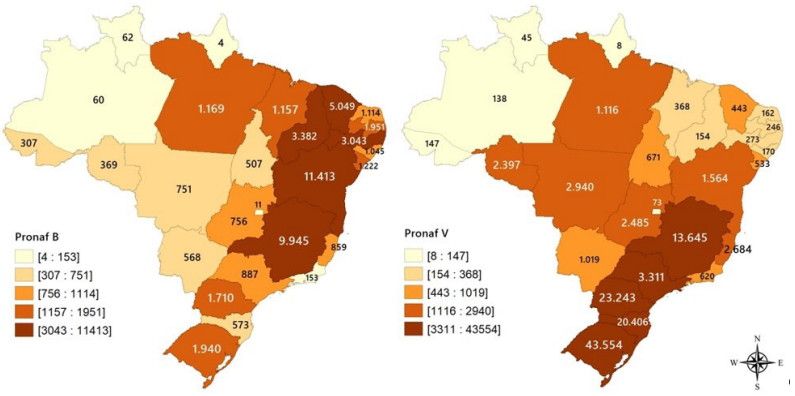

Figure 4. Number of family establishments that accessed Pronaf by Federative Unit of Brazil according to Pronaf B and Pronaf V typologies, 2017. Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).

Regarding the Pronaf V typology, the states that concentrate the largest portion of family establishments with access to Pronaf are Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, and Minas Gerais. Rio Grande do Sul contains 43,554 establishments classified as Pronaf V, which declared having access to funding. This portion is greater than the sum of establishments in the Southeast, Midwest, North and Northeast regions, which shows its strong presence in FF.

Minas Gerais stands out in both typologies. For Pires (2013), the presence of the State in both types is possible because it presents regions that are strongly inserted in the focus of capitalist expansion, directed mainly to the internal and external markets, and regions such as the Jequitinhonha Valley, that present a significant number of farmers in poverty.

4.2 Entropy Balancing and robustness tests[12]

The objective was to build two groups, treated and control, in which the only difference between them was whether the family farm was intensive or not in access to Pronaf for the analysis of FF and of the Pronaf V and Pronaf B typologies. After the pairing of the groups, through the Entropy Balancing, the averages approached significantly, according to the *t* Test of Equality of Means[13]. The joint robustness of the variables employed in the first stage was also verified through other tests. The Table 3 showed a reduction in the mean value of bias.

Table 3. Robustness tests for each level of intensity in the analysis of access to Pronaf according to family farming and its typologies of Pronaf from the Agricultural Census 2017 (Instituto Brasileiro de Geografia e Estatística, 2017).

Typology (Obs.)	Intensity level (Treated)	Sample[1]	*Pseudo R²*	*LR > chi²*	*p > chi²*	B	R
FF	1	UP	0.258	1,250.27	0.00	130.5*	2.57*
(4,210)	(1,107)	P	0.000	0.00	1.00	0.0	1.05
	2	UP	0.312	1,328.01	0.00	150.6*	2.41*
	(860)	P	0.000	0.00	1.00	0.0	1.06
	3	UP	0.356	1,291.45	0.00	170.0*	2.09*
	(651)	P	0.000	0.00	1.00	0.2	1.09
	4	UP	0.373	1,173.53	0.00	180.9*	1.84
	(521)	P	0.000	0.00	1.00	0.3	1.07
FF – Pronaf V	1	UP	0.324	972.21	0.00	158.9*	1.51
	(730)	P	0.000	0.02	1.00	0.7	1.31
	2	UP	0.362	976.67	0.00	175.2*	1.18
(2,470)	(583)	P	0.000	0.00	1.00	0.1	1.18
	3	UP	0.388	909.87	0.00	190.5*	0.98
	(451)	P	0.000	0.00	1.00	0.2	1.20
	4	UP	0.397	818.63	0.00	198.1*	0.83
	(363)	P	0.000	0.00	1.00	0.4	1.13
FF – Pronaf B	1	UP	0.102	275.60	0.00	81.1*	0.74
	(622)	P	0.000	0.04	1.00	1.1	1.07
	2	UP	0.117	273.68	0.00	89.7*	0.76
	(468)	P	0.000	0.00	1.00	0.0	1.02
(2,317)	3	UP	0.116	236.38	0.00	91.2*	0.79
	(369)	P	0.000	0.00	1.00	0.0	0.89
	4	UP	0.139	235.24	0.00	103.8*	0.67
	(277)	P	0.000	0.00	1.00	0.1	0.73

Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).
Notes: [1] Paired (P) and unpaired (UP) sample; * If B > 25; R outside the range [0.5;2]. Family Farming (FF).

The Pseudo R^2 test showed a significant reduction for all levels observed after Balacing. Sianesi (2004) points out the relevance of verifying this test before and after pairing to analyze the explanatory power of the variables used in Balancing.

[12] The estimation results were obtained by Stata 16 software.

[13] The averages and the test of means before and after Balancing have not been presented because there is a page limit for the article. This data can be made available by the authors upon request.

The Likelihood Ratio (RL) test showed that after balancing, the independent variables were jointly significant since there is a considerable drop in results between before and after. The p-value was not statistically significant for all levels after balancing and the null hypothesis that the group means are equal was not rejected.

Rubin (2001) reports that B is the value of the number of standard deviations between the means of the distributions of the x among the analyzed groups, while R is the ratio of the variances of x in these groups. He recommends that B be less than 25 and that R be within the closed range between 0.5 and 2, so that robustness is achieved by balancing[14].

4.3 Impacts of Pronaf access on the performance variables of Brazilian family farming in general and its typologies in Pronaf

4.3.1 Impacts of Pronaf access – Family farming (FF) as a whole

This study initially evaluated the impact of Pronaf access on representative intensive establishments to FF, encompassing four levels intensity, without distinguishing between Pronaf typologies. The hypothesis that the impacts might be influenced by these typologies led to a preliminary descriptive analysis, and the data are available in Table A1 of Appendix A.

Table A1 showed the means for each performance measure by intensity level. For FF as a whole, the averages for intensive establishments were higher than the averages for non-intensive. This pattern persisted for the Pronaf V typology but was reversed for Pronaf B.

These relationships confirm the diversity within FF and the influence of the Pronaf V typology on FF outcomes. Therefore, the impact results presented in Table 4, which showed positive effects on gross production value and negative effects on partial land productivity, among outhers, underscore the significance of considering diverse farmer profiles within the context of Pronaf in the analyses conducted in this study.

Table 4. Impacts of Pronaf access on performance measures for each intensity level according to family farming, 2017, Brazil.

Performance Measure	Result	Intensity level			
		1	2	3	4
Gross Value of Production	ATT	4.33%	4.52%	5.27%	4.97%
	Coefficient	0.0433**	0.0452**	0.0527***	0.0497***
		(0.0212)	(0.0203)	(0.0191)	(0.0187)
Partial Land Productivity	ATT	-10.47%	-8.03%	-8.56%	-7.91%
	Coefficient	-0.1047***	-0.0803***	-0.0856***	-0.0791***
		(0.0271)	(0.0259)	(0.0246)	(0.0237)
Partial Total Labor Productivity	ATT	-	3.78%	5.22%	4.81%
	Coefficient	0.0325^{NS}	0.0378*	0.0522***	0.0481**
		(0.0220)	(0.0210)	(0.0198)	(0.0194)
Partial Family Labor Productivity	ATT	-	-	3.77%	3.24%
	Coefficient	0.0246^{NS}	0.0284^{NS}	0.0377*	0.0324*
		(0.0217)	(0.0206)	(0.0193)	(0.0190)
Profitability	ATT	-	-	-	-
	Coefficient	-0.0018^{NS}	0.0011^{NS}	0.0087^{NS}	0.0303^{NS}
		(0.0236)	(0.0225)	(0.0212)	(0.0213)

Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).
Notes: The measurements have been linearized. Average Treatment Effect on the Treated (ATT). Standard errors in parentheses. Statistically significant at 1% (***), at 5% (**) and at 10% (*); ^{NS} Not significant.

[14] For the analysis of FF and its Pronaf typologies, the number of observations of the control group was variable. Keeping the group fixed could compromise the relationship between the concentration patterns of access to Pronaf and the intensity levels, which would tend to overestimate the impacts. The estimates were tested with the fixed group, and it was observed that the values increased for almost all levels, and there was a problem of robustness.

In terms of gross production value (GPV), intensive family establishments accessing Pronaf showed an increase in GPV compared to non-intensive ones, consistent with findings by Freitas et al. (2020). This supports the hypothesis that impacts on intensive establishments are influenced by the presence of Pronaf V establishments, which tend to have higher GPV than Pronaf B producers, as shown in Table A1.

Regarding the intensity levels, there was a gradual increase in the impact on GVP from the first to the third level, indicating that Pronaf continues to positively affect the production of intensive establishments, even with increased access concentration. According to Table A1, the average GVP for intensive FF establishments also increased gradually and reached its maximum value at the fourth level, characterized by higher concentration. However, when evaluating the Pronaf impact at this level, a reduction in the effect was observed from 5.27% to 4.97%, even in the presence of an average increase in GVP.

This reduction suggests a possible maximum concentration threshold for accessing the Program without negatively affecting its positive effects on FF, even with fewer establishments. However, Zeller & Schiesari (2020) indicated that as more family's access Pronaf, the Program's intensity also increases. The authors defined intensity as the average contract value, while this study used access to Pronaf as the measure. In this context, the first level, with more intensive establishments, showed a lower impact of Pronaf access on VBP (4.33%) compared to a larger effect (5.27%) for a smaller portion of establishments. These findings are crucial for understanding the behavior of Pronaf, justifying further research in a concentration setting.

The negative and statistically significant impacts of Pronaf access on partial land productivity at all intensity levels are also related to the heterogeneity of FF. The results indicated that intensive FF did not exhibit higher land productivity compared to non-intensive FF. Previous studies, such as those conducted by Magalhães et al. (2006) and Santos (2010), also found negative results for farmers who accessed Pronaf.

The first intensity level, with lower access concentration and more intensive establishments (1,107), showed the most negative effect (-10.47%). Many establishments at this level were classified under Pronaf B, which typically has less capital and smaller production areas, negatively impacting land productivity and FF outcomes. Conversely, the fourth level had a less negative effect (-7.91%) on this productivity. This implies that the intensive establishments at this level were more frequently classified under Pronaf V, indicating higher capitalization and larger properties, which may have reduced the negative effect.

Partial total labor and family labor productivities had positive impacts at all intensity levels, indicating that Pronaf access led to better labor returns in intensive establishments compared to non-intensive ones. Total labor productivity showed an inverted U-shaped pattern, peaking at the third level, like GVP impacts, which aligns with Briggeman et al. (2009) suggestion of non-linear impact due to credit constraints.

Table A1 supports the observation that the impacts on labor productivity were possibly more influenced by intensive establishments classified under Pronaf V, as the averages for these two productivities were not higher for intensive establishments compared to non-intensive ones for the Pronaf B typology. Kageyama (2003) and Magalhães et al. (2006) found a positive impact of access to Pronaf on land productivity in their analyzed samples.

The averages and mean tests conducted before Entropy Balancing revealed that municipalities with higher Pronaf access displayed statistically significant, less negative results for temperature and precipitation anomalies compared to those classified as non-intensive. These negative values reflect the adverse effects of climatic conditions and help explain why Pronaf tends to be more concentrated in specific regions of Brazil. These effects can lead to production issues and additional challenges, such as default, prompting financial institutions to adopt more stringent measures in assessing the risks associated with Pronaf contracts.

Finally, this study underscores the importance of analyzing climatic factors in the results presented in Table 4. Felema et al. (2013) emphasize the need for a careful approach when assessing important performance variables, such as land productivity, over a single period, as agricultural production is intrinsically linked to climatic variables.

4.3.2 Impacts of Pronaf access: Typology Family farming (FF) – Pronaf V

The second analysis examined how Pronaf access affected representative intensive establishments classified as Pronaf V, representing the most capitalized and developed farmers with the potential for Pronaf access. Table 5 data showed positive impacts on GVP and partial productivities of total labor and family labor for these intensive establishments. However, no statistically significant influence on profitability and partial land productivity was found.

Table 5. Impacts of Pronaf access on performance measures for each intensity level according to Pronaf V typology of family farming, 2017, Brazil.

Performance Measure	Result	Intensity level			
		1	2	3	4
Gross Value of Production	ATT	5.12%	4.86%	4.56%	4.53%
	Coefficient	0.0512***	0.0486***	0.0456***	0.0453***
		(0.0104)	(0.0101)	(0.0097)	(0.0094)
Partial Land Productivity	ATT	-	-	-	-
	Coefficient	0.0086^{NS}	0.0133^{NS}	0.0118^{NS}	0.0078^{NS}
		(0.0246)	(0.0230)	(0.0210)	(0.0198)
Partial Total Labor Productivity	ATT	4.96%	4.66%	4.19%	5.02%
	Coefficient	0.0496***	0.0466***	0.0419***	0.0502***
		(0.0138)	(0.0132)	(0.0127)	(0.0124)
Partial Family Labor Productivity	ATT	4.06%	4.01%	3.23%	3.81%
	Coefficient	0.0406***	0.0401***	0.0323***	0.0381***
		(0.0116)	(0.0111)	(0.0106)	(0.0104)
Profitability	ATT	-	-	-	-
	Coefficient	0.0085^{NS}	0.0037^{NS}	-0.0105^{NS}	-0.0118^{NS}
		(0.0105)	(0.0101)	(0.0096)	(0.0095)

Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).
Note: The measurements have been linearized. Average Treatment Effect on the Treated (ATT). Standard errors in parentheses. Statistically significant at 1% (***); ^{NS} Not significant.

The results show that intensive establishments benefited from Pronaf access, experiencing positive effects on production and labor returns compared to non-intensive ones. This is likely because Pronaf V-classified producers, who tend to have more access potential, often receive substantial funding, contributing to these positive outcomes. Additionally, the data in Table A1 indicates significant average differences favoring intensive establishments, especially in terms of GVP, which could have influenced these positive impacts.

However, the measured impact for all three measures shows a decrease from the first to the third intensity level for labor productivities and a further decrease until the fourth level for GVP. These results may suggest that intensive establishments could be using Pronaf resources inefficiently and/or inappropriately in their production activities, particularly in the case of the impacts on GVP, which decreased from 5.12% at the first level to 4.53% at the fourth level.

The impacts on profitability and partial land productivity did not show statistical significance at any of the assessed intensity levels. This suggests that access to Pronaf may not have effectively improved the situation of intensive establishments. Furthermore, the analysis of the averages profitability and partial land productivity, as presented in Table A1, did not reveal a significant difference between intensive and non-intensive establishments.

One possible explanation for this scenario is that intensive establishments may not have effectively managed the resources obtained through Pronaf. Additionally, inherent limitations in the dataset used may have contributed to the lack of statistical significance.

These observations align with the findings of Alves et al. (2012), who identified that economically less successful producers tend to possess larger assets, more hectares, and lower land productivity compared to successful producers. Helfand et al. (2014) also emphasized that larger establishments, whether belonging to FF or not, tend to have lower land productivity compared to smaller establishments.

4.3.3 Impacts of Pronaf access: Typology Family farming (FF) – Pronaf B

The third analysis examined the impact of Pronaf access on intensive establishments classified as Pronaf B, which represents a significant portion of less capitalized and less developed family farmers. The findings in Table 6 showed negative impacts on all performance measures, suggesting that intensive Pronaf access does not enhance productivity compared to non-intensive establishments. It's important to note that these results were thoroughly analyzed, considering the Program's role and the circumstances of family farmers in the Pronaf B typology, as well as the limitations of the data.

Table 6. Impacts of Pronaf access on performance measures for each intensity level according to Pronaf B typology of family farming, 2017, Brazil.

Performance Measure	Result	Intensity level			
		1	2	3	4
Gross Value of Production	ATT	-2.54%	-3.04%	-3.56%	-
	Coefficient	-0.0254*	-0.0304**	-0.0356***	-0,0202^{NS}
		(0.0139)	(0.0138)	(0.0138)	(0.0136)
Partial Land Productivity	ATT	-8.71%	-7.78%	-7.39%	-6.99%
	Coefficient	-0.0871**	-0.0778**	-0.0739**	-0.0699**
		(0.0348)	(0.0346)	(0.0348)	(0.0347)
Partial Total Labor Productivity	ATT	-4.25%	-4.90%	-5.34%	-3.08%
	Coefficient	-0.0425**	-0.0490***	-0.0534***	-0.0308*
		(0.0171)	(0.0170)	(0.0169)	(0.0164)
Partial Family Labor Productivy	ATT	-3.56%	-4.37%	-5.19%	-3.76%
	Coefficient	-0.0356**	-0.0437***	-0.0519***	-0.0376**
		(0.0162)	(0.0161)	(0.0162)	(0.0158)
Profitability	ATT	-15.77%	-18.31%	-20.02%	-14.87%
	Coefficient	-0.1577***	-0.1831***	-0.2002***	-0.1487***
		(0.0432)	(0.0430)	(0.0437)	(0.0423)

Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).
Note: The measurements have been linearized. Average Treatment Effect on the Treated (ATT). Standard errors in parentheses. Statistically significant at 1% (***), at 5% (**) and at 10% (*); ^{NS} Not significant.

The impact of Pronaf access on GVP was less negative at the first intensity level (-2.54%). This level had more intensive establishments spread across Brazil. In contrast, level four had concentrated intensive establishments in specific areas of the Northeastern region and in the state of Minas Gerais within the Northern, Vale do Jequitinhonha, and Vale do Mucuri mesoregions. However, despite the higher number of Pronaf access instances in these areas, the contract values tend to be low due to various factors like production capacity, market access, climate conditions, and default risks. This explains why the GVP impact at the highest level is the most negative, even though it's not statistically significant.

This study highlights that within the Pronaf B typology, some farmers face worse socio-economic and productive conditions and rely on Pronaf for their subsistence near the poverty threshold. Silva et al. (2007) found that Pronaf B farmers in the poorest areas of the greater Northeast region face more challenges in accessing credit compared to Pronaf B farmers in the poorest areas of the Southern of Brazil. This aligns with the findings in Table 6.

Negative impacts indicate that temperature and precipitation anomalies had a detrimental effect. The mean test was not statistically significant for any of these climatic variables in the last three intensity levels and indicates that access to Pronaf did not mitigate the negative effects. Climate change tends to disproportionately affect poor farmers in the Brazilian semi-arid region,

Moreira et al. (2014) found that some Pronaf B beneficiaries were forced to sell all their cattle to repay the loan by the end of the credit period. For the authors, these farmers struggled to generate income beyond subsistence levels due to unfavorable climate conditions and the fear of loan default. Anjos et al. (2009) also observed a higher default rate among Pronaf B family farmers, especially in the greater Northeastern region.

In terms of Pronaf access impacts on partial land productivity, the least negative impact was -6.99% for 277 intensive establishments at the highest intensity level, while the most negative impact was -8.71% for 622 intensive establishments at the first level. This trend of decreasing values was also evident in Table A1, where the average productivity was higher for non-intensive establishments, but gradually decreased for both types of establishments.

Within Pronaf B, some farmers face challenging socioeconomic conditions, and accessing Pronaf is crucial to their survival. The Agroamigo program, a rural microcredit initiative under Pronaf's Group B, has played a significant role in helping these farmers, especially in the Brazilian Northeast. Costa et al. (2018) found that Agroamigo improved production for small farmers facing socioeconomic challenges in some areas of the Ceará state.

Pires (2013) argues that Pronaf alone cannot drive the development of Pronaf B farmers and suggests that integrating these farmers into the economy will require more than just a credit policy. Wesz Junior (2021) further emphasizes the need for Pronaf to be closely aligned with other initiatives, including technical assistance and commercialization policies.

Therefore, this study believes that to strengthen Pronaf B farmers is essential to improve coordination between Pronaf access and food commercialization programs such as PAA (Food Acquisition Program) and PNAE (National School Feeding Program). Zeller & Schiesari (2020) point out that most farmers who access these programs belong to the category Pronaf V.

Moreover, connecting Pronaf access with technical assistance and rural extension programs is crucial for achieving positive impacts. Nevertheless, these programs encounter challenges when dealing with less capitalized family farms (Grisa et al., 2014). They often prioritize more capitalized, productive, and market-oriented FF. Thus, reforms and adjustments in both Pronaf and these programs in Brazil are necessary for Pronaf to effectively support family farming.

5. Conclusions

This study aimed to investigate the impact of access to Pronaf on the performance of family farming establishments in Brazil and the concentration behavior of this Program. Three analyses were conducted: one for family farming without disaggregation and two with disaggregation for the Pronaf B and V typologies.

Some results for family farming seemed to have been influenced by the Pronaf V or Pronaf B Typology. These situations indicated that analyzing family farming without taking into account the profiles of farmers can be misleading, demonstrating that conducting the three analyses is an important contribution to the literature.

The analyses using four levels of Pronaf access intensity, categorizing family establishments as intensive (treated) and non-intensive (control). The levels ranged from low to high concentration. This approach contributed to the literature and revealed interesting findings. Some impacts did not follow a linear pattern; instead, they displayed a negative parabolic trend. This suggests that Pronaf might have a gradually increasing positive effect until it reaches its peak with higher access concentration. Further research should explore this hypothesis in greater detail to determine the optimal concentration level for maximizing the Program's positive impact.

The negative impacts on intensive Pronaf B establishments demonstrate that this intensity did not prove to be a differential. This raises the hypothesis that being intensive in Pronaf access may not represent adequate and/or efficient results for the farmer and their property. However, these results were obtained according to the database used and the treatment and analysis adopted, which may have generated some limitations in the present study.

Regarding the regional concentration of Pronaf access, more evident patterns were found in the Southern region for family farming and the Pronaf V typology. For the Pronaf B typology, more present patterns were observed in the Central-West and Northeast regions of Brazil and in the Northern region of Minas Gerais. With more recent data, this study verifies that the concentration in Pronaf access still persists in the country.

In terms of policy implications, the research highlights the importance of Pronaf acting more integrated with food marketing programs to strengthen the production of Pronaf B farmers since these programs tend to benefit Pronaf V farmers more and are more integrated into the market. The research also emphasizes the urgent need for greater coordination between Pronaf and technical assistance and rural extension policies, especially in the Northern and Northeastern regions, as access only through the Pronaf B Group will not be able to improve the socioeconomic and productive issues of these farmers.

There is also a need to review different aspects of Pronaf, such as the contractual requirements of loans, which tend to be stricter for Pronaf B farmers; contract values, which tend not to be consistent with the social and productive situation of the farmer, as observed in the Northeast; and the attitude of financial institutions, which still tend to prefer financing more capitalized and dynamic producers, such as Pronaf V farmers concentrated in the South.

For future research recommendations, there is the investigation of a possible maximum concentration limit for Pronaf that does not affect its positive impacts and the analysis for the Northern region of Minas Gerais and the Northeast and Southern regions of Brazil, with 2017 Agricultural Census data at the producer level. These regions expose significant counterpoints within the universe of Brazilian family farming, which tends to bring important reflections to the planning and action of the Pronaf financing policy. Regarding the limitations of the research, it is worth noting the impossibility of accessing microdata from the Census at the farmer level. However, even with this limitation, the results found are relevant to the debate about Pronaf.

Acknowledgements

The authors thank the financial support of the National Council of Scientific and Technological Development (CNPq).

References

Adamseged, M. E., Frija, A., & Thiel, A. (2019). Dynamics of rural livelihoods and rainfall variability in Northern Ethiopian Highlands. *Climate Risk Management*, *25*, 100195. http://dx.doi.org/10.1016/j.crm.2019.100195

Alves, E., Silva e Souza, G., & Rocha, D. P. (2012). Lucratividade da agricultura. *Revista de Política Agrícola*, *21*(2), 45-63.

Angelocci, L. R., & Sentelhas, P. C. (2010). *Variabilidade, tendência, anomalia e mudança climática*. ESALQ/USP. Material didático de uso na disciplina LCE 306 – Meteorologia Agrícola. Dept. de Engenharia de Biossistemas - setor de Agrometeorologia.

Anjos, F. S., Caldas, N. V., Silva, F. N., Valente, G. B., & Silva, M. M. (2009). Estudo sobre a inadimplência em contratos do Pronaf no Brasil. *Geografia*, 34(3), 473-486.

Aquino, J. R., & Schneider, S. (2015). O Pronaf e o desenvolvimento rural brasileiro: avanços, contradições e desafios para o futuro. In C. Grisa & S. Schneider (Orgs.), *Políticas públicas de desenvolvimento rural no Brasil* (pp. 53-81). Porto Alegre: Editora da UFRGS.

Aquino, J. R., Gazolla, M., & Schneider, S. (2018). Dualismo no campo e desigualdades internas na agricultura familiar brasileira. *Revista de Economia e Sociologia Rural*, *56*(1), 123-142. http://dx.doi.org/10.1590/1234-56781806-94790560108

Aquino, J. R., Radomsky, G. F. W., Spohr, G., Peñafiel, A. P. P., & Radomsky, C. W. (2014). Dimensão e características do público potencial do Grupo B do Pronaf na região Nordeste e no estado de Minas Gerais. In S. Schneider , B. Ferreira & F. Alves. *Aspectos multidimensionais da agricultura brasileira: diferentes visões do Censo Agropecuário* (Cap. 3, pp. 77-105), Brasília: IPEA.

Belik, W. (2015). A heterogeneidade e suas implicações para as políticas públicas no rural brasileiro. *Revista de Economia e Sociologia Rural*, *53*(1), 9-30. http://dx.doi.org/10.1590/1234-56781806-9479005301001

Bianchini, V. (2005). Políticas diferenciadas para a Agricultura Familiar: em busca do Desenvolvimento Rural Sustentável. In F. B. Botelho Filho. *Agricultura familiar e desenvolvimento territorial: contribuições ao debate* (Vol. 5, No. 17, pp. 81-98). Brasília: Centro de Estudos Avançados Multidisciplinares. Núcleo de Estudos Avançados.

Bianchini, V. (2015). *Vinte anos do Pronaf, 1995-2015 - Avanços e desafios*. Brasília: SAF/MDA.

Brasil. (2006). Lei 11.326, de 24 de julho de 2006. Estabelece as diretrizes para a formulação da Política Nacional da Agricultura Familiar e Empreendimentos Familiares Rurais. *Diário Oficial [da] República Federativa do Brasil*, Brasília.

Briggeman, B. C., Towe, C. A., & Morehart, M. J. (2009). Credit constraints: their existence, determinants, and implications for U.S. farm and nonfarm sole proprietorships. *American Journal of Agricultural Economics*, *91*(1), 275-289. http://dx.doi.org/10.1111/j.1467-8276.2008.01173.x

Ciaian, P., Fałkowski, J., & Kancs, A. (2012). Access to credit, factor allocation and farm productivity: evidence from the CEE transition economies. *Agricultural Finance Review*, *72*(1), 22-47. http://dx.doi.org/10.1108/00021461211222114

Costa, E. M., Duarte, S. P. S., Marinho, F. Z., Khan, A. S., & Araújo, J. A. (2018). Efeitos heterogêneos do programa Agroamigo sobre os pequenos produtores rurais. *Revista Economica do Nordeste*, *49*(2), 43-61. http://dx.doi.org/10.61673/ren.2018.633

Del Grossi, M. E. (2019). *Algoritmo para delimitação da agricultura familiar no Censo Agropecuário 2017, visando a inclusão de variável no banco de dados do Censo,disponível para ampla consulta*. Brasília: FAO.

Felema, J., Raiher, A. P., & Ferreira, C. R. (2013). Agropecuária brasileira: desempenho regional e determinantes de produtividade. *Revista de Economia e Sociologia Rural*, *51*(3), 555-573. http://dx.doi.org/10.1590/S0103-20032013000300008

Fortini, R. M., Braga, M. J., & Freitas, C. O. (2020). Impacto das práticas agrícolas conservacionistas na produtividade da terra e no lucro dos estabelecimentos agropecuários brasileiros. *Revista de Economia e Sociologia Rural*, *58*(2), e199479. http://dx.doi.org/10.1590/1806-9479.2020.199479

Freitas, C. O., Silva, F. A., & Teixeira, E. C. (2020). Crédito rural e desempenho produtivo na agropecuária brasileira. In J. E. R. Vieira Filho & J. G. Gasques. *Uma jornada pelos 20 contrastes do Brasil: Cem anos de Censo Agropecuário* (Cap. 20, pp. 281-294). Brasília: IPEA. https://doi.org/10.38116/978-65-5635-011-0

Grisa, C., Wesz Junior, V. J., & Buchweitz, V. D. (2014). Revisitando o Pronaf: velhos questionamentos, novas interpretações. *Revista de Economia e Sociologia Rural*, *52*(2), 323-346. http://dx.doi.org/10.1590/S0103-20032014000200007

Hainmueller, J. (2012). Entropy balancing for causal effects: a multivariate reweighting method to produce balanced samples in observational studies. *Political Analysis*, *20*(1), 25-46. http://dx.doi.org/10.1093/pan/mpr025

Helfand, S. M., Magalhães, M. M., & Rada, N. E. (2015). Brazil's agricultural total factor productivity growth by farm size (No. 609, IDB Working Paper Series). Washington: Inter-American Development BanK. https://doi.org/10.18235/0000157

Helfand, S. M., Moreira, A. R. B., & Bresnyan Junior, E. W. (2014). Agricultura familiar, produtividade e pobreza no Brasil: evidências do Censo Agropecuário 2006. In S. Schneider, B. Ferreira & F. Alves (Eds.), *Aspectos multidimensionais da agricultura brasileira: diferentes visões do Censo Agropecuário 2006* (pp. 279-311). Brasília: IPEA.

Instituto Brasileiro de Geografia e Estatística - IBGE. (2006). *Sistema IBGE de Recuperação Automática de Dados (SIDRA) - Censo Agropecuário 2006*. Rio de Janeiro: IBGE.

Instituto Brasileiro de Geografia e Estatística - IBGE. (2017). *Sistema IBGE de Recuperação Automática de Dados (SIDRA) - Censo Agropecuário 2017.* Rio de Janeiro: IBGE.

Kageyama, A. (2003). Produtividade e renda na agricultura familiar: efeitos do PRONAF-crédito. *Agricultura em São Paulo*, *50*(2), 1-13.

Magalhães, A. M., Silveira Neto, R., Dias, F. M., & Barros, A. R. (2006). A experiência recente do PRONAF em Pernambuco: uma análise por meio de propensity score. *Economia Aplicada*, *10*(1), 57-74. http://dx.doi.org/10.1590/S1413-80502006000100004

Mattei, L. (2014). Evolução do crédito do pronaf para as categorias de agricultores familiares a e A/C entre 2000 e 2010. *Revista Economica do Nordeste*, *45*(3), 58-69. https://doi.org/10.61673/ren.2014.119

Moreira, V. S., Silveira, S. F. R., & Motter, K. Z. (2014). Avaliação de impacto do Pronaf B sobre a satisfação de agricultores familiares em municípios de Minas Gerais. *Estudos Sociedade e Agricultura*, *22*(2), 432-456.

Nascimento, C. A. (2008). P*luriatividade, pobreza rural e políticas públicas: uma análise comparada entre Brasil e União Européia*. Fortaleza: *Banco do Nordeste do Brasil*.

Pereira, E. L., & Nascimento, J. S. (2014). Efeitos do Pronaf sobre a produção agrícola familiar dos municípios tocantinenses. *Revista de Economia e Sociologia Rural*, *52*(1), 139-156. http://dx.doi.org/10.1590/S0103-20032014000100008

Pires, M. J. S. (2013). *Contradições em processo: um estudo da estrutura e evolução do Pronaf de 2000 a 2010* (No. 1914, Texto para Discussão). Brasília: IPEA.

Rosenbaum, P. R., & Rubin, D. B. (1983). The central role of the propensity score in observational studies for causal effects. *Biometrika*, *70*(1), 41-55. http://dx.doi.org/10.2307/2335942

Rubin, D. B. (2001). Using propensity scores to help design observational studies: application to the tobacco litigation. *Health Services and Outcomes Research Methodology*, *2*(3/4), 169-188. http://dx.doi.org/10.1023/A:1020363010465

Santos, G. R., & Santana, A. S. (2020). Panorama da diversidade produtiva e de renda na agropecuária brasileira: uma breve incursão nos dados do Censo de 2017. *Boletim Regional, Urbano e Ambiental*, *23*, 59-71. http://dx.doi.org/10.38116/brua23art4

Santos, R. B. N. (2010). *Impactos da restrição ao crédito rural nos estabelecimentos agropecuários brasileiros* (Tese de doutorado). Departamento de Economia Rural, Universidade Federal de Viçosa, Viçosa.

Schneider, S. (2003). Teoria social, agricultura familiar e pluriatividade. *Revista Brasileira de Ciências Sociais*, *18*(51), 99-121. http://dx.doi.org/10.1590/S0102-69092003000100008

Schneider, S., Mattei, L., & Cazella, A. A. (2004). Histórico, caracterização e dinâmica recente do Pronaf - Programa Nacional de Fortalecimento da Agricultura Familiar. In S. Schneider, M. C. Silva & P. E. M. Marques (Orgs.), *Políticas públicas e participação social no Brasil rural* (pp. 21-50). Porto Alegre: Pub. UFRGS.

Sheffield, J., Goteti, G., & Wood, E. F. (2006). Development of a 50-year high-resolution global dataset of meteorological forcings for land surface modeling. *Journal of Climate*, *19*(13), 3088-3111. http://dx.doi.org/10.1175/JCLI3790.1

Sianesi, B. (2004). An evaluation of the swedish system of Active Labor Market Programs in the 1990s. *The Review of Economics and Statistics*, *86*(1), 133-155. http://dx.doi.org/10.1162/003465304323023723

Silva, F. F., Correa, V. P., & Neder, H. D. (2007). Estudo comparativo da distribuição de recursos do PRONAF Crédito e Infraestrutura nas regiões Sul e Nordeste do Brasil: uma abordagem estatística. In A. C. Ortega & N. Almeida Filho. *Desenvolvimento Territorial, Segurança Alimentar e Economia Solidária* (pp. 123-158). Campinas: Alínea.

Souza, P. M., Fornazier, A., Souza, H. M., & Ponciano, N. J. (2019). Diferenças regionais de tecnologia na agricultura familiar no Brasil. *Revista de Economia e Sociologia Rural*, *57*(4), 594-617. http://dx.doi.org/10.1590/1806-9479.2019.169354

Wesz Junior, V. J. (2021). o Pronaf pós-2014: intensificando a sua seletividade? *Revista Grifos*, *30*(51), 89-113. http://dx.doi.org/10.22295/grifos.v30i51.5353

Zeller, M., & Schiesari, C. (2020). The unequal allocation of PRONAF resources: which factors determine the intensity of the program across Brazil? *Revista de Economia e Sociologia Rural*, *58*(3), e207126. http://dx.doi.org/10.1590/1806-9479.2020.207126

Received: April 17, 2023.
Accepted: October 23, 2023.
JEL Classification: C01; Q14; Q18.

Appendix A. Mean of the performance variables

Table A1 – Mean of the performance variables of the representative establishments by level of intensity of access to Pronaf, 2017, Brazil.

Typology	Variable	Intensity 1		Intensity 2		Intensity 3		Intensity 4	
		I	NI	I	NI	I	NI	I	NI
Family Farming (FF)	Gross Production Value (in thousand R$)	51.7347	31.5958	55.2411	32.1805	59.3844	32.7769	62.2740	33.3064
	Partial Land Productivity (in thousand R$ per hectare)	2.8907	2.0587	3.1334	2.0577	3.3189	2.0870	3.4554	2.1111
	Partial Total Labor Productivity (in thousand R$ per employed person)	23.6382	14.6801	25.2157	14.9357	27.1875	15.1787	28.4345	15.4258
	Partial Family Labor Productivity (in thousand R$ per employed person)	26.7550	17.4178	28.2924	17.7116	30.2201	17.9803	31.4915	18.2321
	Input Expenses (in thousand R$)	23.3200	13.5510	24.8299	13.8837	26.8916	14.1494	28.6558	14.3493
	Profitability (in thousand R$)	28.4146	18.0448	30.4112	18.2968	32.4928	18.6275	33.6182	18.9572
	Number of Representative Establishments	1,107	3,103	860	3,350	651	3,559	521	3,689
FF – Pronaf V	Gross Production Value (in thousand R$)	77.5077	61.6140	79.9007	62.1128	81.9372	62.8209	83.6849	63.3182
	Partial Land Productivity (in thousand R$ per hectare)	3.6780	3.0853	3.8010	3.0935	3.8502	3.1287	3.9089	3.1488
	Partial Total Labor Productivity (in thousand R$ per employed person)	32.7889	25.1245	33.9889	25.3508	35.1036	25.6666	36.0900	25.8908
	Partial Family Labor Productivity (in thousand R$ per employed person)	37.3362	31.2155	38.3180	31.3889	38.9987	31.6899	39.8217	31.8534
	Input Expenses (in thousand R$)	34.4295	23.2007	36.3914	23.4693	38.2946	23.8890	40.2803	24.1485
	Profitability (in thousand R$)	43,0782	38.4133	43.5094	38.6435	43.6426	38.9319	43.4046	39.1696
	Number of Representative Establishments	730	1,740	583	1,887	451	2,019	363	2,107
FF – Pronaf B	Gross Production Value (in thousand R$)	5.5969	5.7430	5.5686	5.7379	5.5095	5.7405	5.5315	5.7271
	Partial Land Productivity (in thousand R$ per hectare)	0.5234	0.7001	0.5174	0.6869	0.5122	0.6793	0.4802	0.6761
	Partial Total Labor Productivity (in thousand R$ per employed person)	2.7661	2.9440	2.7249	2.9396	2.6789	2.9374	2.6657	2.9275
	Partial Family Labor Productivity (in thousand R$ per employed person)	3.0700	3.2601	3.0291	3.2546	2.9759	3.2532	2.9513	3.2441
	Input Expenses (in thousand R$)	5.1880	5.2851	5.2324	5.2657	5.1886	5.2724	4.8506	5.3145
	Profitability (in thousand R$)	0.4089	0.4579	0.3362	0.4722	0.3210	0.4682	0.6809	0.4127
	Number of Representative Establishments	622	1,695	468	1,849	369	1,948	277	2,040

Source: Own preparation based on data from the 2017 Agricultural Census (Instituto Brasileiro de Geografia e Estatística, 2017).
Note: I = Intensive; NI = Non-Intensive; The input expenses variable is not an outcome but was included because it is used in the calculation of profitability.