Credit and off-farm income: an analysis of the PRONAF on family-owned farms in Brazil

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Off-farm work is one of rural households' most important sources of income diversification (Bedemo et al., 2013; Minale, 2018), used mainly as a strategy to smooth income variability. The search for off-farm jobs might be associated with the lack of or a weak credit market. Access to credit can have two opposite outcomes on off-farm job search: access to (rural) credit can reduce the search for off-farm jobs if this search was driven by a way of obtaining or supplementing income, or it can increase the search in cases where farmers are looking for an opportunity to access jobs with greater levels of human capital and earnings. In this paper, we estimate the impact of a subsidized state line of credit, the National Program for Strengthening Family Agriculture (Pronaf), designed for family-owned farms, on off-farm activities in Brazil.

Even though a higher income as a result of additional income from off-farm work can help farmers access credit, there are mixed results on this relationship in the literature. The empirical evidence has demonstrated mixed effect of credit on income obtained from off-farm work (Ellis, 2000; Barrett et al., 2001, Kousar and Abdulai, 2016; Nguyen et al. 2021). However, there is also evidence in the literature about the influence of income obtained from off-farm activities on rural credit (Amjad and Hasnu, 2007; Key, 2020).

Therefore, it appears that the relationship between rural credit and income obtained from off-farm work presents the problem of simultaneity. Based on the identification strategy, the Instrumental Variables approach was adopted to separate the exogenous variation in access to Pronaf over off-farm work. We created the variable of interest, which is binary and represents access or not to Pronaf, based on the concept of intensity. We used a threshold to classify the representative family establishment as intensive or not, considering the access to the Program. We calculated the proportion of establishments (P_m) that accessed Pronaf in a given municipality m, the proportion of establishments that accessed Pronaf in Brazil (P_M), in addition to its standard deviation (P_M^{dp}). Then, if $P_m > P_M + 0{,}5P_M^{dp}$, the representative family establishment is classified as **intensive** in access to Pronaf and receives a value of 1, otherwise, it receives a value of 0 and is classified as **non-intensive**. Given this, the identification strategy must look for sources of exogenous variation in access to Pronaf. In other words, factors that affect the chance of access to credit independently of the unobservable characteristics of farmers. Adopting the instrumental variables approach may be an appropriate strategy in this scenario. An adequate instrument allows separating the exogenous variation in access to Pronaf.

The number of bank branches (or their existence) in a given municipality is the instrument proposed as a source of exogenous variation in access to Pronaf. We believe that a higher number of bank branches (or the fact that it exists or not) in a given municipality can influence the increase in access to Pronaf, given that family farmers will have more search options to access the Program's resources. This is a valid instrument because as the number of bank branches increases, greater the chance of access to Pronaf. It is also a redundant instrument, as it does not affect the family farmer on working on paid off-farm activity (refer to Table 3).

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We estimated eight models, four via OLS and four via IV. In model (1), no control variable was used, while model (2) only included characteristics of the municipality where the family agricultural establishment is located. In model (3), we included the farm's specificities. In model (4), we used farmer characteristics. The number of observations for all models was the same, consisting in 5140 Brazilian municipalities.

This article used different data sources to achieve the proposed objective (Table 1). The source of information regarding family farmers and their establishment was the 2017 Agricultural Census, accessed through the Brazilian Institute of Geography and Statistics (IBGE, 2023) Automatic Recovery System (SIDRA). This Census contains information regarding access or not to Pronaf, as well as farmers who declared having obtained income from off-farm work. Regarding climate (temperature and precipitation), we used the data sourced from the Terrestrial Hydrology Research Group (THRG), using the methodology described by Sheffield, Goteti, and Wood (2006) (refer to Table 2 for descriptive statistics).

Table 1 – Description and source of variables, at municipality level

Variable	Description	Source
off-farm labor	Share (proportion) of farmers who obtained income through off-farm work.	CA 2017
Access to Pronaf	Share of farmers who accessed rural credit via Pronaf. A variable used to create the binary variable intensity of access to Pronaf, where 1 indicates that the representative family establishment is intensive and 0 otherwise.	
Bank branch	Number of bank agencies that offer rural credit via Pronaf per municipality.	ESTABAN
Characteristics of the Municipality		
Population	Population of the municipality in 2016.	IBGE
GDP *per capita*	Gross Domestic Product (GDP) per capita in 2016. Variable created by dividing GDP by population, both from 2016.	
Temperature anomaly	Climate temperature anomaly for the period 1987-2016.	THRG
Precipitation anomaly	Climate precipitation anomaly for the period 1987-2016.	
Northeast	Northeast Macroregion of Brazil.	CA 2017
Southeast	Southeast Macroregion of Brazil.	
South	Southern Macroregion of Brazil.	
North	Northern Macroregion of Brazil	
Central-West	Central-West Macroregion of Brazil.	
Characteristics of Family Farm		
Internet access	Share of establishments with internet access.	CA 2017
Vehicle	Share of establishments that own vehicles.	
Livestock	Share of establishments whose main economic activity is livestock farming and breeding other animals.	
GVP	The share of the Gross Value of Production (GVP) (in thousand R$) of the sum of plant and animal production (except agribusiness)	
Area	The average area of establishments in hectare.	
Characteristics of Family Farmer		
DAP	The number of farmers possessing the Declaration of Aptitude for Pronaf (DAP) in the municipality (DAP is a necessary but not sufficient condition to obtain credit via Pronaf).	CA 2017
Owner	Share of farmers who own the land they manage.	

Age	Share of establishments by age groups of the manager (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).	
Education	Share of managing farmers by education groups (Higher or Postgraduate, High School, Completed Elementary School, and Incomplete Elementary School).	
Member	The share of farmers members of cooperatives and (or) unions.	

Note: CA 2017 = 2017 Agricultural Census (September 30, 2017); ESTABAN = Banking Statistics by Municipality of the Central Bank of Brazil; THRG = Terrestrial Hydrology Research Group; IBGE = Brazilian Institute of Geography and Statistics.
Source: The authors.

Table 2 – Descriptive statistics of the variables used in the research, average per municipality, Brazil, 2017

Variable	Avg. Per Municipality[1]	Std. Dev.	Family Farm (total units.)	%
off-farm labor (farms)	70.03	95.41	371,721	9.69
Access to Pronaf (farms)	50.81	77.49	269,205	7.02
Bank branch (units)	3.37	35.14	-	-
Characteristics of the Municipality				
Population (thous.)	34.4	212.38	-	-
GDP *per capita* (thous. BRL)	21.05	19.70	-	-
Northeast (farms)	1076.7	962.66	1,803,479	46.99
Southeast (farms)	432.06	501.38	685,680	17.87
South (farms)	563.91	509.33	665,418	17.34
Central-West (farms)	490.38	460.50	221,650	5.78
North (farms)	1,114.09	1,192.95	461,232	12.02
Characteristics of Family Farm				
Internet access (farms)	65.62	78.85	348,335	9.08
Vehicle (farms)	164.97	232.23	875,636	22.82
Livestock (farms)	343.95	416.15	1,825,663	47.57
Area (thous. hectares)	15.04	22.89	-	-
Gross Value of Production (GVP) (thous. BRL)	19,231	25,914	-	-
Characteristics of Family Farmer				
DAP (farmers)	258.19	367.94	1,370,514	35.71
Owner (farmers)	464.94	568.45	2,467,886	64.31
From 25 to under 35 years of age (farmers)	62.46	100.47	331,529	8.64
From 35 to under 45 years of age (farmers)	119.88	159.81	636,320	16.58
From 45 to under 55 years of age (farmers)	166.81	182.54	885,446	23.07
From 55 to under 65 years of age (farmers)	175.22	175.42	930,060	24.24
From 65 to under 75 years of age (farmers)	124.41	130.61	660,363	17.21
Incomplete elementary education (farmers)	287.09	324.23	1,523,892	39.71
Complete primary education (farmers)	184.99	243.79	981,930	25.59

Complete high school (farmers)	89.89	91.00	477,137	12.43
Higher Education or Postgraduate (farmers)	20.34	21.49	107,977	2.81
Member of cooperatives and (or) unions (farmers)	290.72	393.48	1,543,159	40.21
Family Farm	**722.96 farms**	**800.51 farms**	**3,837,459**	**100.0**

Source: The authors.
Note: [1] 5,308 municipalities.

We found that, in a municipality with intensive Pronaf, there is, on average, a reduction of 14.2% in the proportion of farmers who carry out paid off-farm work (Table 4). These results corroborate those obtained by Bedemo et al. (2013) for Ethiopia. According to this author, off-farm activity is linked negatively with access to rural credit in that country. This result indicates that access to credit allow farmers to focus on on-farm activities.

Table 3 – Hausman Endogeneity Test

Controls	**(1)**	**(2)**	**(3)**	**(4)**
Characteristics of the municipality	No	Yes	Yes	Yes
Characteristics of family farming establishments	No	No	Yes	Yes
Characteristics of Family Farmer	No	No	No	Yes
F-statistic	0.0009	0.2581	4.8475	5.6847
P-value	0.9924	0.6114	0.0277	0.0171
Intensity of access to Pronaf	Exogenous	Exogenous	Endogenous	Endogenous

Source: The authors.

Table 4 – Results of econometric estimates of the causal relationship of interest between the intensity of access to Pronaf and the proportion of family farmers who carried out paid off-farm work, Brazil, 2017

Variable	**(1)**		**(2)**		**(3)**		**(4)**	
	OLS	**IV**	**OLS**	**IV**	**OLS**	**IV**	**OLS**	**IV**
Intensity of access to Pronaf	0.018*** (0.0023)	0.019 (0.039)	0.015*** (0.0027)	-0.004 (0.039)	0.005* (0.003)	-0.106* (0.059)	0.004 (0.003)	-0.142** (0.067)
Constant	0.1006*** (0.001)	0.1005*** (0.007)	0.005** (0.002)	0.117*** (0.005)	0.080*** (0.005)	0.073** (0.008)	0.145*** (0.034)	0.069 (0.051)
Number of Bank branch	-	-0.0003** (0.0001)	-	0.002*** (0.0006)	-	0.0015** (0.0005)	-	0.0014** (0.0005)
Constant	-	0.1914*** (0.005)	-	0.082*** (0.015)	-	-0.060** (0.0174)	-	-0.53*** (0.1355)
R^2	-	0.0006	-	0.2433	-	0.2952	-	0.3408
Partial R^2	-	0.0006	-	0.0026	-	0.0014	-	0.0013
F-Statistic	-	4.10	-	12.41	-	8.77	-	9.23
P-value	-	0.0430	-	0.004	-	0.0031	-	0.0024
Controls								
Municipality	No	No	Yes	Yes	Yes	Yes	Yes	Yes

Farms	No	No	No	No	Yes	Yes	Yes	Yes
Farmer	No	No	No	No	No	No	Yes	Yes
Obs.	5,308	5,308	5,308	5,308	5,308	5,308	5,308	5,308
Sub-Identification Test								
LM Statistics (Kleibergen-Paap)								
13.36***								
Weak Instrument Test – Robust Inference								
Wald Test (Anderson-Rubin) - χ^2 Statistics								
5.58**								
LM Test (Stock-Wright) - χ^2 Statistics								
5.31**								
Weak Instrument Test [1]								
F Statistics (Kleibergen-Paap)								
9.23								

Source: The authors.

Note: Tests for model (4) of IV. Robust standard errors are in parentheses. *** p<0.01, ** p<0.05 and * p<0.1. (1) Critical value at maximum bias 10% - 16.38; Critical value at maximum bias 15% - 8.96; Critical value at maximum bias 20% - 6.66; Critical value at maximum bias 25% - 5.53.

Therefore, it is necessary to continually debate, evaluate, and improve the guidelines and operationalization of Pronaf. In its regulations, the Program's policy expresses its support for non-agricultural activities carried out within the family establishment, allowing income from off-farm work, for example, to make up the annual gross family income to access rural credit. These regulations also include support for different segments of family farming, especially those most vulnerable, through different special lines of credit. However, the operationalization of Pronaf, carried out mainly by financial institutions that are resistant to non-conventional activity projects, has demonstrated a bias towards more conventional activities and with a focus on certain regions, farmer profiles, and certain products, making with unconventional credit lines left unsupported and the margin of Pronaf credit lines more focused on on-farm agricultural activities.

We emphasize that we are finalizing the paper's estimations using microdata at the farm level. Thus, we seek to overcome the limitations imposed by using aggregated data.

References

Amjad, S., & Hasnu, S. A. F. (2007). Smallholders' access to rural credit: Evidence from Pakistan. *The Lahore Journal of Economics*, *12*(2), 1-25.

Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food policy*, *26*(4), 315-331.

Bedemo, A., Getnet, K., Kassa, B., & Chaurasia, S. P. R. (2013). Off-farm labor supply decision of adults in rural Ethiopia: Double hurdle approach. *Journal of Agricultural Economics and Development*, *2*(4), 154-165.

Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries. *Journal of agricultural economics*, *51*(2), 289-302.

IBGE. Instituto Brasileiro de Geografia e Estatística. Dados do Censo Agropecuário 2017. Available online: https://sidra.ibge.gov.br/ pesquisa/censo-

agropecuario/censo-agropecuario-2017/resultados-definitivos (accessed on 22 Oct. 2023).
Key, N. (2020). Off-farm income, credit constraints, and farm investment. *Journal of Agricultural and Applied Economics*, *52*(4), 642-663.
Kousar, R., & Abdulai, A. (2016). Off-farm work, land tenancy contracts and investment in soil conservation measures in rural Pakistan. *Australian Journal of Agricultural and Resource Economics*, *60*(2), 307-325.
Minale, L. (2018). Agricultural productivity shocks, labour reallocation and rural–urban migration in China. *Journal of Economic Geography*, *18*(4), 795-821.
Nguyen, H. T. T., Pham, X. H., & Kondo, T. (2021). The impact of non-farm activities on agricultural investment in Vietnam: the difference made by credit constraints levels. *Studies in Agricultural Economics*, *123*(3), 141-152.
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.