SCHOOL FEEDING PROGRAM AND PUBLIC FOOD PROCUREMENT FROM SMALLHOLDER FARMERS: Evidence from Brazil

1.   Introduction

In developing countries, smallholders face numerous impediments that prevent them from participating in large food markets such as global international markets and national public markets organized by the State to procure food for the institutional catering sector. like inadequate provision of physical and institutional infrastructure (Gelo et al, 2020). To help overcome some of these barriers, the federal State in Brazil uses its purchasing power to link these farmers to school feeding market, benefiting smallholders with incentives to compete with bigger farmers and pupils with possibly more nutritional meals (Pye-Smith, 2014). More specifically, since 2009, public schools in municipalities must dedicate at least 30 percent of their food procurement budgets to purchase food from "family farmers"[1]. International organizations such as the Food and Agriculture Organization of the United Nations consider the Brazilian school food program as a model for other developing countries (Miranda, 2018; Kelly and Swensson, 2017).

Nevertheless, survey data shows that the percentage of smallholder or family farmers products in school food procurement varies much with many municipalities buying almost nothing to almost everything from smallholder farmers (FNDE, 2020). Part of the explanation may come from the fact that, until very recently, the implementation of this law lacks coercive measures. Municipalities whose food procurement was below the 30 percent threshold did not face any kinds of financial consequences. However, if that was the only driver, most if not all municipalities should be below the requested percentage, evidence suggestes that factors beyond the lack of law enforcement are also part of the story. It is thus important to identify the factors that promote the successful implementation of public policy related to school food procurement in a developing country.

The goal of this paper is to identify the determinants of the proportion of family farm products in the food procurement of public schools in Brazil. To do so, we rely on an original database collected by Brazilian Geography and Statistics Institute (IBGE) and National Education Development Fund (FNDE). The database covers the food procurement for all the 5570 Brazilian municipalities (covering 154.060 public schools) from 2104 to 2017. We performed a quantitative analysis using cross section ordinary least squares (OLS) and fixed effects.

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[1] According to the Brazilian law (nº 11,326), a farmer is considered a family farmer if he or she: does not hold, in any way, an area greater than 4 (four) fiscal modules (that depending on the municipality varies from 50,000 to 1,100,000 square meters) predominantly use the labor force of the family itself in the economic activities of its establishment or enterprise; have income predominantly originated from activities linked to the farm; direct his or hers establishment or enterprise with his or hers family.

2. Institutional setting

According to the Brazilian Constitution, each level of government levels is responsible for certain public educational provision. The Federal level is responsible for higher education like universities, states are responsible for high school and secondary education and municipalities are responsible for secondary education, elementary school, and pre-kindergarten. Both States and municipalities can be responsible for secondary education (Brazil, 1988). In the rest of the paper, the focus of our analysis will be on elementary school at the municipal level.

a. The Brazilian school food program

One of the policies dedicated to the public educational sector is known as the school feeding program (PNAE in Portuguese). Since 2009, this program requires that, at least 30% of the resources passed on by the federal government for school feeding to the municipalities and states and federal schools should be used to procure foodstuffs from family agriculture (federal law number nº 11,947). This law apply to public school only as private schools do not receive public money for school feeding.

The federal entity who manages PNAE and transfers money to lower administrative levels is the National Education Development Fund (FNDE in Portuguese) a structure part of the Ministry of Education. The amount of money transferred from FNDE is based on the number of students enrolled in the previous year. It is a fixed amount per student in the whole country[2]. Another fundamental actor for PNAE is called "executing entity". It is responsible for the overall operation of the program at the local level, and this includes receiving the funds, creating the menu, publishing procurement calls, signing contracts, delivering daily meals and nutritional education. States, municipalities and even individual primary schools can play the role of executing entity. Municipalities are traditionally the executing entity for secondary and elementary schools and pre-kindergarten. States are traditionally the executing entity for secondary and high schools. Federal schools are the executing entity for themselves. However, if a municipality and the State agree, municipality can become responsible for school feeding management of State schools (usually high schools) that are located in its municipal area, receiving a specific amount of money for it.

The last fundamental actor for PNAE is known as School Feeding Councils (CAE in Portuguese). These councils are responsible for monitoring school feeding programs at the state and municipal levels. Besides ensuring wise use of financial resources, CAEs encourage the efficient delivery of the program (Kelly and Swensson, 2017). The School Feeding Council (SFC) is a collegial body serving as a forum for decision making and advisory nature, it makes recommendations for the actors who is implementing the program. It is made of at least 7 full members: one political representative (the mayor or its secretaries in municipal), two members representing education workers and students, two members representing civil society representatives and two members representing parents. SFCs have the main function of ensuring the achievement of quality school meals, through the inspection of public resources transferred by the National Education Development Fund (FNDE), which complements the resources of the States, Federal District and Municipalities, for the

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[2] With exceptions to minorities who are 'quilombolas', those of African descent, and indigenous communities. These minorities receive more money than traditional students.

execution of the PNAE program. Therefore for some municipalities, the amount available is higher than the amount transferred through the program (FNDE, 2020)

Every year, all municipalities submit their food procurement invoices to be approved by SFC, thus allowing the federal government to make accounts. SFC has the power to disapprove the accounts the municipality provide, thus making them redo it before sending to FNDE or even hindering this process which can lead to the municipality not receiving the funds on the next year. FNDE is authorized to suspend transfers of PNAE to executing units if they fail to constitute the respective SFC, fail to present the book accounts of the resources previously received for the execution of the PNAE or to commit irregularities in the execution of the PNAE. Note however that the failure to reach the 30% target goal is not a requirement for the executing entities to keep receiving money from the federal government[3]. The municipality that does not accomplish applies the law risks being penalized[4]. There are some justifications that municipalities may claim for non-compliance with the law, they are especially related to the low or uncertain supply of the family farmer's products.

b. The organization of public tendering food markets

Public procurement in Brazil is regulated by the federal law nº 8,666/93. The Public Procurement Law regulates public procurement procedures and contracts entered by the government (administrative contracts) in the scope of the Federal, State and Municipal administrations. Competitive bidding for public procurement is the main procurement rule. The winner of the tendering is the cheapest supplier. This procurement system can be an obstacle for smallholders as their products are usually not the cheapest ones because they are unable to benefit from economies of scale.

To enhance family farms participation in the public food procurement process, municipalities are allowed to use what is called the "Public Call mechanism" (Miranda, 2018). Through this mechanism, eligible suppliers are not required to submit a bid or compete based on lowest price. Instead, procuring entities issue a public call for food procurement which defines the commodities, quantities, quality requirements, price, and delivery terms. Interested suppliers that meet the family farmers criteria submit a proposal stating the products and quantities they wish to sell to the program[5]. PNAE adopts the region mean price for a given product as reference prices, which aim to reflect local market prices. They must also consider transportation, processing, and tax costs. Prices are publicized in the public call

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[3] In May 2020, FNDE released the normative number 6 that says "The percentage not executed in accordance with the provision in the caput will be assessed when rendering accounts and the corresponding amount must be returned." This may be a fundamental difference on enforcement, as until now returning money to FNDE was not foreseen by law. FNDE is already giving support to the executing units on how this will be implemented. Our data however cover a period below this change in the enforcement of the school program.

4 The penalizations alternate between not receiving money on the following period and being obliged to return the money to the federal government.

[5] To participate in the program, smallholders and farmer organizations must obtain an eligibility declaration (Declaração de Aptidão ao PRONAF—DAP) which certifies their family farmer status.

for food procurement, so that farmers can decide if they want to sell their products for this price. If more than one supplier wants to sell, the municipalities prioritize local producers, and social minorities. There should be a wide call disclosure and the municipalities must make apparent the time and place of delivery, the quantity, and quality standard information so that family farmers can access public procurement opportunities (Schwartzman et al, 2017). Previous research shows a reluctance of local civil servants to use this mechanism. Some professionals either are unaware about it, do not know how to use it or fear of being accused of favoritism (Elias et al, 2019; Mossmann et al, 2017). Less than 10% of all bidding procedures carried out by the executing entities and registered in FNDE's official system between 2011 and 2018 were public calls (Conselho de Monitoramento e Avaliação de Políticas Públicas, 2020).

3.   Related literature

In this section, we review the existing literature on food public procurement. This survey mostly relies both on academic literature and on literature coming from international organizations.

a.   The factors affecting the amount of family farms in school food procurement in Brazil

In the Brazilian academic literature, the research about school feeding come from different academic fields, like health, education and social sciences. This literature helped us to survey the factors promoting or hindering food procurement with smallholder's products. Many of the factors identified in this literature are however very subjective and hard to quantify such as actors' partnership and inter-sectoral coordination (Schwartzman, 2017; Corrêa et al, 2017; Pedraza et al, 2018; Lopes et al, 2019; Cunha et al, 2017; Elias et al, 2019; Mossmann et al, 2017), community participation (Melo et al, 2016) or resistance to change (Elias et al., 2019; Mossmann et al., 2017). However, other factors are more easily transformed into quantitative variables, like the ones related to supply, such as close or abundant family farm products (Elias et al, 2019).

The data we rely on comes from various sources. The independent variables regarding number of schools, students, amounts of money transferred and school food procurement are from the FNDE annual census[6] which collect data from their programs such as PNAE. The dependent variable is also from FNDE but from a different database. Every year all municipalities and states are required to provide information and documents to confirm on how they used the money transferred from FNDE to procure school food. If they provide incorrect or false information they can be sued for public authorities. For this reason, it is a reliable data.

The other main source of data is the Brazilian Geography and Statistics Institute (IBGE in Portuguese). Specifically, their database called Basic Municipal Information Survey Munic 2014's edition (Pesquisa de Informações Básicas Municipais) is a census run every year in all 5,570 Brazilian municipalities. The question that where relevant for this research are on governance and education management information (specifically data on the variables number of SFC meetings, SFC parity, SFC year of creation, access information law, education budget responsibility under education organ, HR/population, civil servant contract and education management centralization in state level).

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[6] Publicly available here : https://www.fnde.gov.br/index.php/programas/pnae/pnae-consultas/pnae-dados-da-agricultura-familiar

The other database used from IBGE is Censo Agro 2006 edition[7] that is the main and most complete statistical research on agriculture structure and production in Brazil. We always used population and not sample data for all the 5,570 municipalities that was our analysis level, each observation relates to a municipality. The merging ID for the databases are the five digits code IBGE created and is adopted by many other research institutes in Brazil.

4. Methods

We want to investigate the determinants of the proportion of family farmers products in public school food procurement. Given the structure of our database, we use cross section ordinary least square regressions. Our main specification for the empirical model is the following:

$$y_i = \beta_0 + \beta_{1\ governance_i} + \beta_{2\ education\ public\ management\ i} + \beta_{3\ smallholder's\ products\ supply_i} + \beta_{4\ control\ i} + a_i + \varepsilon_i$$

Where: y_i is the mean percentage of smallholder's farmers product procurement over total food product procurement for a municipality between 2015 and 2017 i, $governance_i$ are the variables related to governance characteristics, *education management $_i$* are related education public management variables *smallholder's products supply$_i$* are the variables related to smallholder's products supply, *control i* are control variables (GDP/capita and population density, for instance), a_i are state fixed effects and ε_i is as the error term. We describe each variable later in the article. Given heterogenous biology and social and economic context of Brazil, we expect to mitigate how it affects harvest and family farm products procurement by controlling for state and mesoregion.

Addressing concerns about endogeneity is warranted if we suspect that some explanatory variables are correlated with the error term (i.e. an omitted variable bias), like low or insufficient human resources and school infrastructure for food storage (Sodré & Salamoni, 2016). The availability of logistic infrastructure may impact food prices because if the producer has a high delivery cost, he or she will have to take it into account when reformulating final prices and this can make these products less interesting for procurement. However, since we control for state and mesoregion fixed effects, which acts as a proxy for local specificities, this source of bias is potentially mitigated. Mesoregions were created by IBGE based on social characteristics, geography, and spatial articulation.

Another source of bias could come from the presence of reverse causality. This would be the case if, for instance, smallholder's farmers start to produce more in response to school feeding demand. Such bias would overestimate the effects of supply on our dependent variable. However, we do not suspect this bias to be a major issue in our analysis because our supply variables are measured way before (10 years earlier) our measurements of food product procurement. Moreover, the law was applied from 2010 on after the measurements of supply variables used in our model, which makes our estimates out of reverse causality issues. Finally, we are not concerned by multi-collinearity issues. Indeed, the independent variable are not highly correlated together.

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[7] There is now a new edition on this census for the year 2017, however we do not use it so that our regressors are observed before their outcome variable.Censo Agro 2006 is publicly available here: https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2006/segunda-apuracao

a. Dependent variable

Our dependent variable relies on the proportion of family farmer's products bought by a given municipality. This information is available annually in the FNDE database from 2015 to 2017. Specifically, we use the mean of these three available years as dependent variable in our model. We do so to control for potential harvest variations on the period as it may effect family farmers who usually do not have the technology to mitigate climate hazards. So, in a bad harvest year, there would be much less smallholder's farmers product procurement than in a good one. Moreover, controlling for fixed effects in our regressions, we potentially alleviate the effect of climate hazards affecting harvests.

b. Independent variables

Botkins and Roe (2018) analyzed the determinants of school districts' Food To School (FTS) participation in the United States, this program promotes national or more localized agricultural systems through school food programs. In their research, they distinguish supply side factors from community characteristics and school district characteristics. Adapting their framework, we distinguish for each municipality three groups of determinants explaining family farms procurement: governance, education management and family farm supply.

Governance

To address governance at the municipality level, we rely on three broad aspects established by the UN Statistical Commission in 2015 (Praia Group on Governance Statistics, 2020): non-discrimination and equality, participation, and openness. IBGE already adopted them as a guide in their studies. The proxy for participation is the number of School Feeding Council meetings in the last 12 months. The proxy for non-discrimination and equality we use from our database is SFC (school feeding council) parity. This is a dummy variable that takes the value 1 when there is at least one representative for each stakeholder recommended by a federal law in SFC and zero otherwise. The proxy for institutionalization is in which year SFC was crated, the older, the better.

For openness, the proxy we rely on is the access to information law in the municipality. In Brazil, thanks to a federal law, any citizen can ask for federal public information like budget or spending. Some municipalities also have similar laws through which citizens can access family farm procurement that year for example.

Education management

Education public management considers civil servants who work on it and School Feeding Council, that help us understand how each municipality deals with school feeding. In this group of determinants, we distinguished several features suggested by previous literature and interviewed specialists. These features are: specificity, quality and outsourcing. Specificity means school feeding is managed by an education organ, like a secretary. The proxy for specificity is a dummy variable that takes the value 1 when the education budget is under education organ responsibility, 0 otherwise. It was originally a categorical variable whose possibilities were mayor, education

organ and other. If education budget is under education organ responsibility, it probably means it is not treated in a general way as it would be if under mayor or others responsibility.

For education public management quality proxy, we use human resources in education management by population, as with more human resources, we assume that the municipality would be more able to innovate in public procurement methods like public call mechanism and buy more from family farmers. We also argue that where there are proportionally more civil servants, public policies implementation would be more effective. The second proxy for education public management quality is the type of labor contract for civil servants. We classified and ranked them in five types based on their duration and formality of their job contracts. Human resources contracted in the most formal manner is called "*estatutário*", they were selected in a formal and impersonal process, they can be fired only for cause. The variavle The variable we created shows the proportion of estatutários over total education management related human resources.

According to Schwartzman (2017), a negative factor for more family farmers products procurement is precarious legal framework, which creates doubts and legal uncertainty for managers on public procurement subject. Depending on civil servant type of contract, they would be more or less confident on using public calls. A more tenured position may have mixed effects. On one hand, a permanent position means higher quality because it is a more complex, objective and neutral hiring process that leads to civil servants more independent from mayor's party color. On the other hand, civil servant can be more susceptible to organizational inertia. This can be a barrier for using the public call mechanism that facilitate smallholder's products purchase. For these two proxies, the variable we have access to accounts for human resources managing education in general, not specifically for school feeding program only.

The fourth variable for the education public management is outsourcing activities. Outsourcing in this case is when the municipality hires a private company to work on any part of school feeding activities, like buying food products, producing, or delivering meals. Machado et al (2018) found outsourcing to be a negative factor for more family farm procurement. According to the authors, in outsourced school feeding management, the decision-making role of food purchase is assigned to private companies, and they not necessarily prioritize procuring food from family farmers, which may indicate the need for greater control, regulation and support for such management modalities. Outsourcing is a dummy variable for the management mode of schools' canteen in a given municipality. It takes the value 1 if one of the activities related to school feeding are outsourced to a private company, 0 otherwise. Improvement of school feeding is as yes or no question posed in 2014 in Basic Municipal Information Survey-"Munic" database. It asks if there was an improvement that year. We consider it to be a proxy for political motivation towards public schools. Education budget law existence is a dummy variable taking the value of one if there is a municipal law specifying how education budget should be spent and zero otherwise. This would be positively related to more smallholder's product procurement as there would be more concern about education budget including school feeding budget.

Supply characteristics

Another relevant set of variables are related to smallholders' food supply availability, capturing how much products are available and close for the municipality to procure. The variables are the percentage of smallholder's establishments over total agricultural

establishments, the percentage of smallholder's agriculture production over total agricultural production and rural population over total population. According to Schwartzman et al (2017) more supply has a positive association with more family farm procurement.

Control variables

Finally, we control for sociodemographic and economic municipality characteristics. First, GDP/capita in 2015 captures much information, like how much tax money might be available for implementing public policies, how educated is the population, how developed is the economy in that municipality. This control is particularly important because the municipalities are required to complement school feeding budget with their own financial resources. This would facilitate smallholder's products procurement as they are usually more expensive than traditional products.

Then, we control for population density, which is a proxy for school geographical dispersion. A higher density is possibly associated with less dispersion which possibly means less costly transportation for family farm products, which would make it easier to buy them. On the other hand, higher density population can be also related to a more urban municipalities, where the access to smallholders would be more difficult. The sense of association between this variable and family farm procurement is thus unclear.

Number of schools by population refers to the number of public schools in each municipality. Problems with logistic and transportation are a negative factor for more family farmers products procurement according to Vilela (2018) and Triches and al (2018). We expect this variable to be negatively related to smallholders' farmers product procurement as with more schools there would be higher transportation delivery cost. Table 1 summarizes how independent variables are related to more family farm products procurement.

Table 1: Independent variables and why they were chosen

Factor	Variable	Description	Expected relation with dependent variable
		Independent variables	
Governance	number of SFC meetings	How many meetings dis SFC take last years?	Positive
Governance	SFC parity	Does SFC follow representatives proportion	
Governance	SFC year of creation	In which year SFC was created.	Negative
Governance	Access information law	If there is a municipality law that helps citizens and press to access public management information	Positive
Education management specificity	education budget responsibility	Education budget is under educational organ responsibility	positive
Education management quality	HR/population	Proportion of civil servants on population	Positive

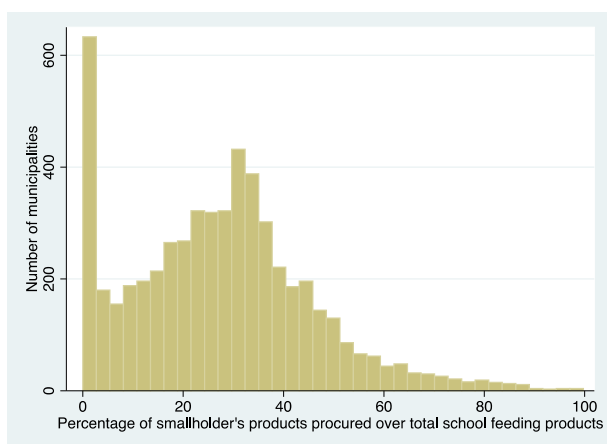|			
Education management quality	public server contract	Proportion of civil servants with no contract on total civil servants	Positive
Education management descentralization	outsourcing food processing activities in 2014	Outsourcing food processing activities in 2014	Negative
smallholder's supply	% family rural establishments / total establishments 2006	Proportion of family farms quantity on total farms	Positive
smallholder's supply	% family farming production	Proportion of family farms of rice, black beans and manioc production on total farms	Positive
smallholder's supply	% rural pop 2010	Proportion of rural population on total population	Positive
Control variables			
Control variables	GDP/capita 2015	GDP/Capita	Positive
Control variables	GDP/capita 2015 squared		
Control variables	Population density	municipality area/capita in km	Positive
Control variables	Improvement of school feeding	The municipality adopts targeted actions regarding improvement of school feeding	Positive
Control variables	Education budget law existence	If there is the allocation values for education provided by law	Positive
Control variables	Number of schools	How many are in each municipality	Negative

Source: authors

5. Results and discussions

5.1. Descriptive analysis

Figure 1 below depicts how smallholder's products procurement is distributed through municipalities. The first striking result is the fact that more than 600 municipalities (around 10% of the number of municipalities) bough almost no food from family farmers. This is surprising because from the time of collection of our data, the law on school food procurement was already 5 years old. Most municipalities buy between 20% and 40% of food products coming from family farmers. Nevertheless, some municipalities were procuring almost 100% of their school feeding products from smallholders. 3,110 municipalities procure less than 30% from family farmers, which means they do not accomplish the law minimum goal and other 2,460 accomplish the law.

Figure 1: Repartition of the share of family farms products in municipal food procurement

Source: research data

The following table represents the mean percentage of family farm procurement by region. Brazil is a very diverse and large country. Institutions, culture and nature differ much across the country; however, they can be more similar within socio economic regions and heterogenous from one another. For this reason, it is interesting to compare the regions.

Table 2: Characteristics by Region

Region name	North	Northeast	Southeast	South	Midwest
Number of states	7	9	4	3	4
Number of municipalities	450	1794	1668	1191	467
% of family farm procured for public schools (average from year 2015 to 2017)	19.61%	22.08%	26.88%	42.37%	18.84%
Family farm establishments mean	0.8236279	0.8623924	0.6991865	0.8276682	0.6407217
Family farm production mean (in value terms)	0.7331928	0.8115728	0.4776979	0.5787455	0.306938

Source: authors

North is the largest region in geographic area, and it has the lowest number of municipalities, which means that municipalities are bigger there and smallholders may have to deal with longer distances to deliver their product and higher costs. Due to Amazon Forest location, part of its land is protected by law and cannot be used for agriculture production. Northeast region has the second largest percentage of

family farms establishments over total agriculture establishments and the largest percentage of family farm's production over total production. Despite the supply availability, the proportion of family farms 'products in school food procurement remains relatively low.

Southeast region contributes to the largest share of Brazil's GDP, the most developed economic activities and the largest Brazilian metropoles (Sao Paulo and Rio de Janeiro). In 2016, it had the worst family farm products procurement percentage mean, around 18% (IPEA, 2019) despite the highest percentage of family farms establishments. South region is the region with the lowest social inequalities in Brazil. It is the only region whose family farm products procurement percentage mean in 2016 was greater than 30% (IPEA, 2019). Midwest is known by its large conventional agriculture livestock farms and has the lowest percentage of family farms establishments. That may be correlated to the fact that it has the lowest family farm product procurement percentage.

In table 3 we describe some descriptive statistics for the whole sample of municipalities. The first striking result is the fact that the mean of the family farm products procured is still below the legal target. The number of SFC meetings in around six, which means they meet every two months. More than 90% of SFC follow the stakeholder composition required by law. The mean year of SFC creation is 2001, three years after its creation was required by law but eight years before the 30% rule. Less than 20% of the municipalities presents an access information law, which is not required by a federal rule and may indicate that it is hard for citizens to get informed about how public policies are implemented.

Regarding education management, we see that for almost half of the sample, education budget responsibility is under education organ and not under the mayor's office or other organ responsibility. This may indicate that municipalities with education organ have a more specific management towards education. There is around 0.02 education civil servant per habitant and from these, around 9% are *estatutário*. Around 5% of the municipalities outsource at least some activity in school feeding. And less than 20% of the municipalities in São Paulo state uses the centralized management option which is also a negative factor for more family farm procurement according to Machado et al (2018). More than 90% of the respondents of IBGE's Munic survey informed there were school feeding improvement in the previous year, but they were not required to provide evidence on this. For more than 80% of the sample, there was a law regulating education budget, which possibly makes education management more specific in line with the education budget responsibility under education organ variable.

Regarding food items supply, the mean for percentage family rural establishments over total establishments 2006 and the percentage of family farming production over total agriculture production indicates that supply itself may not be an issue for PNAE implementation, however, some details around it, like price and access may be in the way for municipalities to procure more from family farmers. Rural population was around 36% that is expected considering Brazilian population heavily migrated to the cities in the middle of the last century.

Most control variable exhibit an important standard deviation showing large differences between municipalities. Some municipalities have GDP/capita values close to high income countries and for other, closer to low income countries. Population density is also very heterogenous. There are municipalities very sparsely populated with nature mostly preserved and other with high people concentration,

like São Paulo. For number of schools , there is a standard deviation is around three time of the value of the mean. There are around 27 schools in each

Table 3: Descriptive Statistics whole sample

Variable	Type	Obs	Mean	Std. Dev.
		Dependent variable		
Family farm percentage	Percentage	5,565	0.27	0.18
		Independent variable		
		Governance		
Number of SFC meetings	Count	5,397	6.69	4.84
SFC parity	Dummy (1 if yes)	5,432	0.91	0.29
In which year SFC was created	Dummy (1 if yes)	5,359	2,001.00	5.6
Access information law	Dummy (1 if yes)	5,568	0.19	0.39
		Education management specificity		
Education budget responsibility under education organ	Dummy (1 if yes)	5,507	0.49	0.5
HR/population	Percentage	5,505	0.02	0.01
Civil servant contract	Percentage	5,532	0.09	0.24
Outsourcing school catering food processing activities in 2014	Dummy (1 if yes)	5,462	0.05	0.23
Education management centralization	Dummy (1 if yes)	645	0.186047	0.389446
Improvement of school feeding	Continuous and positive values only	5,547	0.94	0.23
Education budget law existence	Continuous and positive values only	5,565	0.84	0.37
		Smallholder's supply		
% family rural establishments / total establishments 2006	Percentage	5,548	0.78	0.16
% family farming production	Percentage	5,421	0.63	0.32
% rural pop 2010	Percentage	5,565	0.36	0.22
		Control variables		
GDP/capita 2015	Continuous and positive values only	5,565	20,726.76	21,606.46
GDP/capita 2015 squared	Continuous and positive values only	5,565	133.9413	52.79179
Population density	Continuous and positive values only	5,565	108.3	572.36
Number of schools	Continuous and positive values only	5,570	27.65224	73.90843

Source: research data

      a. Multivariate regressions

In this section, we present results from our empirical strategy. All estimations include use the average of the family farm procurement as the dependent variable with fixed effects. In model 1, we regress governance independent variables. In model 2 we regressed education management independent variables. In model 3 we regressed family farm supply independent variables. In model 4 we regressed governance, education management and family farm supply that were significant at least at 5% level in models 1, 2 and 3.

In table 5 we show all regressions using state fixed effects and in table 6, mesoregion fixed effects. In model 1, variable number of SFC meetings was significant as we expected. We suspected more meetings could be related to less family farm procurement as too many meetings could be related to a more bureaucratic environment harming family farmers, or there would be an optimal number of SFC meetings, we tested and did not find evidence on this. SFC parity and year of creation, proxies for non-discrimination and equality and program institutionalization were not significant. Possibly, these characteristics are important, but they are not captured by quantitative variables. Access information law is also not significant. Possibly being able to access information is not encouragement enough for citizens to do it. Therefore, only one out of the four governance variables were significant.

In model 2, education budget responsibility under education organ is significant and has a positive coefficient, as expected. HR/population is also significant, but has opposite sign to the one we expected, as less civil servants for education by population would lead to more family farm procurement. One could suspect of collinearity problems with other variables, but this was not the case as we tested. It was negative possibly because having more human resources working in public education management may create a more complex environment that can create difficulties for a public policy to be implemented.

Public server tenure contract was significant with a positive sign in the regression with state fixed effects, confirming our second prognosis about this variable: more tenure civil servants are related to more family farm procurement possibly because they are less dependent on mayor's will and more focused on doing what is required by law. Outsourcing food processing activities is significant and negative as Machado et al (2018) predicted. School improvement was significant only at 10% with a positive sign as predicted. Education budget law existence was significant with a positive sign as predicted. Five out of six education management variables were significant at 5% confidence level.

In model 3, all family farm supply variables were significant with a positive sign at 1% confidence level in regressions with state fixed effects, in accordance with Botkins and Roe (2018), Elias et al (2019) and Machado et al (2018). This emphasizes how important access to family farm supply is for executing this program, even though it seems not to be enough. For control variables, GDP/capita has a positive sign and GDP/capita squared has a negative sign indicating there might be an optimal GDP/capita level for family farmers products procurement to reach its maximum. Population density is significant and has a negative sign, but it does not correlate with other independent variables specially the ones on family farm supply group as we expected. It aligns with Machado et al (2018) for whom small scale municipalities would benefit from this characteristic to procure more smallholder's products as public management is less complex so public policies are more easily implemented. Number of schools/populations is significant and negative in all models except the one with education management variables.

The highest R^2 (33.8%) is found in model 4, that combines all three kinds of factors and uses mesoregion fixed effects.

Table 4: Regressions using family farm percentage as dependent variable

Mean family farm procurement percentage	State fixed effects				Meso fixed effects			
	Model 1	Model 2	Model 3	Model 4	Model 1	Model 2	Model 3	Model 4
Governance								
Number of SFC meetings	0.0928**			0.0858*	0.106**			0.0918**
	(0.0464)			(0.0468)	(0.0459)			(0.0462)
SFC parity	0.523				0.386			
	(0.752)				(0.740)			
SFC year of creation	0.00976				0.0108			
	(0.0388)				(0.0381)			
Access information law	0.666				0.461			
	(0.590)				(0.584)			
Education management								
Education budget responsibility under education organ		2.017***		1.953***		1.818***		1.762***
		(0.467)		(0.472)		(0.462)		(0.467)
HR/population		-114.7***		-100.7***		-84.91***		-84.67***
		(28.77)		(29.19)		(28.66)		(28.76)
Public server tenure contract		2.092**		1.978**		1.286		
		(0.852)		(0.861)		(0.860)		
Outsourcing food processing activities in 2014		-2.037**		-1.822*		-2.111**		-1.824*
		(0.968)		(0.990)		(0.959)		(0.970)
Improvement of school feeding		1.681*				1.057		
		(0.953)				(0.941)		
Education budget law existence		1.201**		1.150*		1.356**		1.324**
		(0.591)		(0.600)		(0.584)		(0.590)
Family farm supply variables								
% family rural establishments / total establishments 2006			11.42***	10.12***			6.382***	6.707***
			(2.138)	(2.237)			(2.259)	(2.037)
% family farming production			2.231**	2.567***			0.919	
			(0.952)	(0.986)			(0.987)	
% rural pop 2010			4.446***	5.883***			2.792**	4.510***
			(1.356)	(1.422)			(1.382)	(1.444)
Control variables								
GDP/capita 2015	-9.01e-05***	-7.76e-05**	-0.000155***	-0.000134***	-0.000124***	-0.000107***	-0.000152***	-0.000129***
	(3.18e-05)	(3.24e-05)	(3.23e-05)	(3.35e-05)	(3.23e-05)	(3.30e-05)	(3.29e-05)	(3.37e-05)
GDP/capita 2015 squared	0.0527***	0.0505***	0.0946***	0.0905***	0.0732***	0.0671***	0.0907***	0.0858***
	(0.0150)	(0.0151)	(0.0154)	(0.0159)	(0.0156)	(0.0158)	(0.0160)	(0.0163)
Population density	-0.0015	-0.00162***	-0.00158***	-0.00199***	-0.00137***	-0.00142***	-0.00158***	-0.00203***
	(0.000382)	(0.000381)	(0.000551)	(0.000562)	(0.000424)	(0.000424)	(0.000589)	(0.000567)
Number of schools/ population	-933.1***	-242.2	-1,617***	-1,247***	-941.2***	-391.2	-1,370***	-1,004**
	(336.9)	(360.3)	(351.5)	(403.8)	(338.8)	(364.0)	(354.7)	(406.9)
State FE	yes	yes	yes	yes	no	no	no	no
Mesoregion fixed effects	no	no	no	no	yes	yes	yes	yes
Constant	-3.535	14.50***	0.606	1.466	2.585	21.59***	15.66***	14.85***
	(77.84)	(4.130)	(4.243)	(4.659)	(76.50)	(4.141)	(4.377)	(4.493)
Obs	5,325	5,291	5,502	5,100	5,325	5,291	5,502	5,163
R squared	0.279	0.278	0.285	0.293	0.332	0.331	0.328	0.338

Source: research data

6. Concluding Remarks

Our analysis illuminates that many governance, education management and supply factors are associated with smallholder's products procurement in Brazilian school feeding program.

As School Feeding Program is socially and culturally influenced by the geographic region it is implemented on, it is a challenge to quantify the factors that relates to its diverse output. Many aspects are intrinsically qualitative like the nutritionist and mayors or public managers willingness to promote this public policy or how organized family farmers are in a municipality. For other aspects there is no country wide data available on it. This is possible the reason in our best model we explain less than 35% of the sample.

This research contribution relies mostly on the kind of data we use. We choose to use a not a qualitative deep and geographically limited information like most studies before this did, but to use a broad and not so specific data collect in each of all 5,570 municipalities in Brazil.

There seems to be more and less adequate structure to implement PNAE that should be incentivized country wide, such as more active governance resources. Interestingly, not all SFC (a democratic and formally powerful governance asset) characteristics was found to be highly significantly related to the outcome. Possibly its members are not aware of how to use its power. Regarding smallholder's supply, there should be more support for them so that municipalities can more easily access their production. There are already in Brazil policies and organizations with this focus that help with technical support and financial access.

The last practical recommendation for public policies managers is to take into account each municipality smallholder's supply and governance context so that they acknowledge the diversity we found in the country and specify stimulating goals for the ones who are already able to overcome the 30% federal rule target and special attention and feasible goals for the ones who are still below the initial target. For future research, we recommend the investigation if where there is more smallholder's products procurement, they experience higher revenue.

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