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THE RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTION AND MUNICIPAL TAX REVENUE IN BRAZIL

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Abstract

This study proposes an analysis of the interaction between agricultural production and tax revenue in Brazilian municipalities. Brazilian municipalities can collect taxes on agricultural production, such as the Service Tax (ISS), and indirectly, through increases in the income of their residents, boost revenue through other tax sources. Thus, the research aims to understand how agricultural activity influences tax revenue at the municipal level, considering the economic dynamics of agricultural production. Therefore, the objective of this study is to identify the correlation between agricultural production and tax revenue in Brazilian municipalities. To achieve the proposed objective, a stochastic model was considered, allowing for the analysis of this relationship. By exploring this relationship through other variables included in the model, the study aims to contribute to the understanding of the factors that impact tax revenue from agricultural production and its implications for municipal development in Brazil. Through a robust quantitative analysis, a statistically significant correlation was identified between them. The results indicate that, on average, every thousand reais produced in the municipal agricultural GDP generates between five and seventeen reais in municipal taxes, depending on the proposed model specification. Specifically, it was observed that municipalities with higher agricultural production tend to present higher tax revenue, highlighting the importance of this sector for municipal finances. The conclusion emphasizes that enhancing agricultural production could significantly bolster municipal tax revenues, thus playing a crucial role in local financial health and development.

Keywords: Agribusiness; Agricultural Production; Brazilian Municipalities; Tax Revenue.

Resumo

O presente trabalho propõe uma análise da interação entre a produção agropecuária e a arrecadação fiscal nos municípios brasileiros. Os municípios brasileiros podem arrecadar impostos sobre a produção agropecuária, como o Imposto sobre Serviços (ISS) e indiretamente, por meio de acréscimos de renda de seus munícipes, aumentar a arrecadação por meio de outras receitas tributárias. Assim, a pesquisa busca compreender como a atividade agropecuária influencia a arrecadação fiscal em nível municipal, considerando a dinâmica econômica da produção agropecuária. Portanto, o objetivo deste trabalho é o de identificar a correlação entre a produção agropecuária e a arrecadação fiscal nos municípios brasileiros. Para alcançar o objetivo proposto um modelo de estocástico foi considerado, permitindo analisar a referida relação. Ao explorar essa relação, por meio de outras variáveis incluídas no modelo, o estudo visa contribuir para o entendimento dos fatores que impactam a receita fiscal proveniente da produção agropecuária e suas implicações para o desenvolvimento municipal no Brasil. Por meio de uma análise quantitativa robusta, identificou-se a existência de correlação estatisticamente significante entre elas. Os resultados apontam que, em média, cada mil reais produzidos no PIB Agropecuário municipal, produz-se entre cinco e dezessete reais em impostos municipais, dependendo da especificação do modelo proposto. Especificamente, observou-se que municípios com maior produção agropecuária tendem a apresentar uma maior receita tributária, destacando a importância desse setor para as finanças municipais. A conclusão sublinha que o aumento da produção agrícola poderia reforçar significativamente as receitas fiscais municipais, desempenhando assim um papel crucial na saúde financeira e no desenvolvimento local.

Palavras-chave: Agronegócio, Arrecadação Fiscal, Municípios Brasileiros, Produção Agropecuária.

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INTRODUCTION

Agricultural production has played a fundamental role in the Brazilian economy, being one of the main sources of wealth and employment. An expected consequence is that this sector also contributes to municipal revenues, allowing the public sector to operate where market solutions are limited.

The geographic and socioeconomic regions of Brazil impart unique characteristics to agricultural production in different areas, directly influencing tax collection dynamics.

The rationale for conducting this research lies in the existing gap in understanding the interdependence between agricultural production and tax collection in Brazilian municipalities. The scarcity of comprehensive research exploring this relationship in an integrated manner hinders the implementation of efficient strategies to enhance the economic and social benefits arising from agricultural activity.

By filling this gap, the research aims to offer relevant insights for public managers, policymakers, and other stakeholders, contributing to informed and effective decision-making. Furthermore, a deeper understanding of the relationship between agricultural production and tax collection can guide efforts to promote environmental sustainability and socioeconomic equity in rural areas.

Based on the above, the objective of this work is to identify the correlation between agricultural production and tax collection in Brazilian municipalities. To achieve this goal, a stochastic model was considered, as it allows for analyzing the relationship between tax collection in Brazilian municipalities and agricultural production, as detailed in the methodology of this research.

This work, in addition to this introduction, includes a literature review presenting an overview of agricultural production in Brazil, previous studies on the relationship between agricultural production and tax collection, and challenges and opportunities in the fiscal management of agricultural municipalities. Following this, a methodology section outlines the methodological strategies used to achieve the proposed objectives. This section includes the proposed model and details on sample data selection and inclusion/exclusion criteria. The main results and discussions are then presented, followed by conclusions and recommendations, and finally, the references.

LITERATURE REVIEW

Studies relating municipal tax revenues and agricultural production in municipalities appear to be little studied. Studies related to tax revenues are almost always linked to the productivity of the

agricultural sector. Works like Sene and Javed (2019) investigate the relationship between agricultural productivity and tax revenue in developing countries. The authors examine how increased agricultural productivity affects tax collection in these countries, and like most related studies, the results suggest that an increase in agricultural productivity is directly related to higher tax revenue.

This theoretical framework addresses some necessary themes to form a better understanding of the interaction between agricultural production and tax collection in Brazilian municipalities. First, the overview of agricultural production in Brazil will be examined, highlighting its economic and social importance as well as the main crops and livestock activities. Then, the Brazilian tax system related to agricultural activity will be analyzed, exploring the different types of taxation that apply to the agricultural and livestock sector, as well as their impacts on municipal, state, and national tax collection. Next, previous studies on the relationship between agricultural production and tax collection will be reviewed, examining existing research and main reflections on this topic to contextualize our analysis and identify knowledge gaps. Finally, the challenges and opportunities in the fiscal management of agricultural municipalities will be discussed, addressing issues such as the volatility of agricultural production and prices, rural infrastructure, land concentration, and rural development policies among other relevant topics for public policy formulation and regional development strategies.

OVERVIEW OF AGRICULTURAL PRODUCTION IN BRAZIL

Agricultural production in Brazil plays an important role in the national economy, being one of the main drivers of the country's development. With vast expansions of fertile land, a great diversity of climates and soils, and a highly diversified agricultural sector, Brazil stands out as one of the world's leading producers of food and agricultural commodities (COLUSSI, 2016).

According to estimates and data available from sources such as the World Bank, the United Nations Food and Agriculture Organization (FAO), and the United States Department of Agriculture (USDA), the largest agricultural GDPs in the world tend to be associated with countries that have a large proportion of their economy based on agriculture (FAO 2024; WORLD BANK 2024; USDA 2024). These countries generally have a combination of extensive agricultural land, diversified agricultural production, and a well-developed agricultural industry. The list of the largest agricultural GDPs in the world may vary but generally includes the following countries: United States, China, Brazil, India, Russia, Indonesia, France, Germany, Canada, and Australia. Some of these countries may still have significant growth potential in their agricultural production, and one way to verify this is by considering the level of utilization of their available land.

It is obvious to assume that a low land utilization rate may not mean a great upside for the agricultural frontier - this condition is always conditioned by various other factors such as adequate climatic conditions, soil quality, terrain topography, altitude, precipitation, irrigation, winds, frequency of extreme weather events, etc. (HAIRSTYLE, 2011).

Brazilian agriculture encompasses a wide range of crops, including grains such as soybeans, corn, rice, and wheat, as well as export crops like coffee, sugar, cotton, and tropical fruits. Livestock also plays a significant role in the country's agricultural production, with cattle, swine, poultry, and sheep farming in different regions (IBGE, 2024b).

PREVIOUS STUDIES ON THE RELATIONSHIP BETWEEN AGRICULTURAL PRODUCTION AND TAX COLLECTION

The relationship between agricultural production and tax collection has been the subject of interest in some international studies. Mabugu and Chitiga (2018) conducted a general equilibrium analysis to investigate the relationship between agricultural productivity and tax revenues in South Africa, concluding that changes in agricultural productivity not only affect production and employment in the agricultural sector but also increase tax revenues in different sectors of the economy.

Hossain (2017) and Mengistu and Tsegaye (2016) employed the ARDL (Auto Regressive Distributed Lag) approach to investigate the relationship between agricultural productivity and government tax revenue in Bangladesh and Ethiopia, respectively. They found identical results: increased agricultural productivity influences tax collection by the government over time.

Alia (2015) presents an empirical analysis of the relationship between agricultural production, government spending, and tax revenue in Pakistan. The study investigates how agricultural production and government spending affect tax collection over time. The findings provide a deeper understanding of the factors influencing tax revenue and can inform policies to promote economic growth and fiscal stability in Pakistan. Note that the studies cited in these last three paragraphs are limited to investigating productivity gains and tax collection: thus, this relationship is a stylized fact. Such evidence can provide clues related to the national reality: municipalities with higher agricultural productivity should significantly contribute to tax collection.

In national literature, some works have also sought to study this relationship, albeit indirectly. Oliveira and Galvão (2024), for example, address issues related to taxation in the agribusiness sector, focusing on ICMS (Tax on Circulation of Goods and Services) and ITR (Rural Land Tax), as well as discussing the application of accounting standard CPC 29. They discuss the main tax issues faced by

rural producers and agricultural companies, analyzing fiscal obligations, applicable rates, and possible tax planning strategies.

Carvalho *et al*. (2015) investigate the relationship between taxes in agribusiness and their impact on production and transportation costs of agricultural activities. The authors examine the tax burden on agribusiness, including not only direct taxes such as ITR and ICMS but also indirect taxes and fees on commercial transactions. They propose an economic analysis that differentiates between production costs and transaction costs, highlighting how taxes can affect each of these components. Additionally, the authors discuss the effects of taxes on agribusiness competitiveness, considering their influence on agricultural product prices and the profitability of rural activities.

Furthermore, research has been conducted to understand how specific fiscal policies, such as tax incentives and exemptions, impact tax collection related to agricultural activity. Souza (2004) analyzes the importance of ITR as a source of revenue for municipalities, highlighting its economic and social relevance. The study examines the impact of ITR on municipal finances, considering aspects such as revenue collection, resource distribution, and investments in local public policies. Additionally, the article discusses the issue of tax waiver related to ITR, exploring possible reasons for the low collection of this tax by municipalities. The author examines factors such as lack of enforcement, inadequate tax legislation, and resistance from rural landowners to paying the tax. Finally, the article suggests strategies to increase the effectiveness of ITR as a source of municipal revenue and reduce the fiscal waiver associated with this tax, including measures such as improving tax legislation, strengthening enforcement, and promoting awareness about the importance of ITR for local development.

Chagas Neto, Silva Ferreira and Souza (2020) conducted a descriptive analysis comparing the growth rates of own revenues with those of the Municipal Participation Fund (FPM) and sectoral GDP. Their econometric model revealed that population size and the service sector GDP positively impacted municipal revenues. Conversely, reliance on the FPM was found to induce “Fiscal Laziness,” resulting in inefficiency in own revenue collection. This study provides valuable insights into factors affecting tax collection efficiency in Brazilian municipalities, emphasizing the need for reducing dependence on federal transfers to enhance local fiscal performance.

Vieira, Ávila, and Lopes (2020) examines the relationship between socio-economic development and tax efficiency in municipalities within Minas Gerais, Brazil. The study investigates how effectively local governments in Minas Gerais utilize tax revenues to foster socio-economic progress. The fiscal added value of agriculture showed a large variation (122.10%). This is because the group concentrates municipalities from all population strata, with 55% corresponding to small municipalities, characterized by predominantly agricultural economic production. It also includes the municipality with the highest

tax revenue per capita, approximately R$1. 271.10, corroborating the statement by Baião *et al*. (2017), that municipalities with higher GDP per capita have a greater capacity to generate tax revenue.

Despite advances in these studies, there are still gaps to be filled, especially regarding the understanding of causal mechanisms and complex dynamics governing the relationship between agricultural production and tax collection. Therefore, this study aims to contribute to advancing knowledge in this area.

CHALLENGES AND OPPORTUNITIES IN THE FISCAL MANAGEMENT OF AGRICULTURAL MUNICIPALITIES

The fiscal management of municipalities with a strong agricultural presence faces a series of challenges and at the same time presents opportunities for economic development. Understanding and effectively dealing with these challenges is essential to promote solid fiscal management capable of meeting the specific demands of rural areas (MORAES, 2006).

One of the main challenges faced by agricultural municipalities concerns the volatility of production and the prices of agricultural products, which can significantly impact municipal tax collection. Climatic fluctuations, market conditions, and government policies are some of the factors that affect this volatility, requiring flexible and adaptable fiscal management to changes in economic and environmental conditions (MORAES, 2006). Torezani *et al*. (2016) used an input-output matrix to calculate the effects of soybean crop failures in Rio Grande do Sul, exploring how these events affected not only the agricultural sector but also other interconnected sectors of the economy. Unfortunately, the article does not provide specific information about the impact of soybean crop failures on revenue collection. As expected, the concern was not with direct revenue collection through municipal taxes but rather with the collected ICMS. The concentration of land and the lack of access to land for small farmers are also important challenges that affect the fiscal management of agricultural municipalities. Agrarian reform and land regularization policies can contribute to a more equitable distribution of land and promote inclusive and sustainable rural development.

Despite the challenges, agricultural municipalities also present unique opportunities for economic growth and improving the quality of life of rural communities. Investment in agricultural technology, technical training, and adding value to agricultural products can increase the productivity and profitability of the agricultural sector, generating jobs and income for the local population. Additionally, policies to encourage agribusiness, such as rural credit lines, agricultural insurance, and technical assistance programs, can stimulate rural entrepreneurship and strengthen the local economy.

The diversification of agricultural production and the integration of production chains can also open new business opportunities and increase the sector's resilience to external shocks.

Moreira and Teixeira (2014) analyze the role and importance of agricultural research for the country's sustainable development, examining the strategies and programs implemented by the government to promote scientific and technological advancement in this field. They discuss topics such as the financing of agricultural research, the institutional structure supporting research, partnerships between public and private institutions, and the challenges faced in implementing effective policies for the sector. They emphasize the need for continuous investments in agricultural research to improve productivity, sustainability, and the competitiveness of Brazilian agribusiness in the global market. Although the text does not specifically mention the return of incentives in the form of taxes, investments in agricultural research can potentially generate returns that reflect on tax collection, including municipal taxes.

Therefore, taking advantage of these opportunities and addressing the challenges requires an integrated and collaborative approach involving the government, the private sector, research institutions, and civil society. Investing in efficient fiscal management and sustainable development of agricultural municipalities is fundamental to ensuring a prosperous and equitable future for Brazil's rural areas.

METHODOLOGY

This study employs a quantitative approach based on the analysis of secondary data from IPEADATA. A multiple regression analysis will be conducted to investigate the relationship between agricultural production and municipal tax revenue in Brazil, incorporating relevant control variables. Additionally, statistical techniques will be used to validate the proposed model, including tests for multicollinearity, heteroskedasticity, and other regression assumptions. This methodological approach will allow for a robust and objective analysis of the relationship between the variables of interest, providing important insights for understanding the determinants of municipal tax revenue in the context of Brazilian agricultural production.

Proposed model

To model the relationship between agricultural production and municipal tax revenue in Brazil using the Ordinary Least Squares (OLS) method, a linear regression model is adopted. In this model, the dependent variable is municipal tax revenue, and the independent variable is agricultural production.

In addition to the dependent variable, other control variables are considered to capture the best possible results and thus avoid the omission of important variables (GUJARATI; PORTER, 2000).

The proposed Composite Linear Regression Model for this research can be described as follows:

$$Y_i = \beta_0 + \beta_1 X_{agriculture} + \beta_2 X_{control\ 1} + \beta_3 X_{control\ 2} + \gamma_1 D_1 + \gamma_2 D_2 + \ \dots + \gamma_m D_m + \varepsilon_i$$

Onde:

Y_i *represents the total tax revenue of municipal taxes in municipality i;*
$X_{agriculture}$ *is the municipal Gross Domestic Product (GDP) from agriculture in municipality i*
$X_{control\ 1}, X_{control\ 2}$ *are control variables such as "Employed personnel in agricultural establishments" and "Planted or harvest-destined area"*
D_1, D_2, D_m *are dummy variables such as "Mayor's party" and "Geographic region"*
β_0 *é a intercept*
$\beta_1, \beta_2, \dots, \beta_k$ *are the coefficients associated with the variables of interest and control*
$\gamma_1, \gamma_2, \dots, \gamma_m$ *are the coefficients associated with the dummy variables*
ε_i *is the error term.*

After evaluating the model, a statistical analysis was conducted to assess the significance of the coefficients, the adequacy of the model fit, and the validity of the assumptions. These procedures involve the use of hypothesis tests: the F-test for the overall significance of the model, and residual analysis to verify the model's adequacy to the collected data (GUJARATI; PORTER, 2000).

Before committing to the modeling, it is important to ensure that the assumptions of linear regression are met. This includes the linearity of the relationship, the independence of residuals, homoscedasticity (constant variance of residuals), and the normality of residuals (GUJARATI; PORTER, 2000).

To address these, appropriate procedures were followed. For the multicollinearity problem, the variance inflation factor (VIF) value for one or more independent variables was checked—a VIF greater than 10 is often considered problematic. Regarding heteroscedasticity, White's test verified the model's robustness, and for correction, the variables were obtained in their per capita form when applicable. This procedure also helped ensure the normality and linearity of the residuals. The Durbin-Watson tests are presented in Table 2 and show no evidence of residual autocorrelation (GUJARATI; PORTER, 2000; MAAS; HOX, 2004).

Sample Data Selection and Inclusion and Exclusion Criteria

A set of variables was selected to obtain evidence that could address the research problem. It is important to note that the selection of variables is based on the plausibility of their characteristics concerning the problem, but there are always many limitations related to them, some perfectly observed, others deduced. In any research, it is always a non-trivial task, for example, to align the research assumptions with the available information or with the possibility of producing such information.

Thus, a set of variables, all extracted from the IPEADATA database, were selected. The name, description, and year of the variables are presented in Table 1.

Table 1 – Name, Description, and Year of Variables Used in the Model

Variable Name	Description	Year
Municipal tax revenue per capita	Total collection of municipal taxes (IPTU, ITBI, and ISS), including overdue taxes, fines, and interest - INACTIVE - R$ () - Institute for Applied Economic Research – RECPROPCH	2019
Municipal Agricultural GDP per capita	Municipal GDP (value added at basic prices) - agriculture (2010 prices) - R$ (thousand), at 2010 prices () - Brazilian Institute of Geography and Statistics – PIBAG	2019
% Employment in agriculture	People employed in agricultural establishments - total (Agricultural Census) - Person () - Brazilian Institute of Geography and Statistics – EMPAG	2017
% Rural population	Ratio between rural resident population and total resident population	2010
Regional Dummy	Variable corresponding to the five regions of the country	-
Political Dummy	Variable corresponding to the parties of the mayors of the respective municipalities. Dummies were incorporated for the ten largest party representations, and the rest were classified as "other parties." The representations were: PMDB (1051), PSDB (779), PP (524), PSD (515), PSB (404), PDT (347), PR (524), DEM and PTB (270), and PT (258). Others (859).	2019

Source: IPEADATA.

As can be observed, the variable "Per capita collection," the dependent variable of the proposed model, is the same, according to IPEADATA, encompassing the taxes within the municipality's jurisdiction: taxes, fees, and improvement contributions. Therefore, it does not pertain exclusively to taxes collected from agricultural activities but rather to the entire revenue derived from economic activities, assets, etc., within the municipal limits.

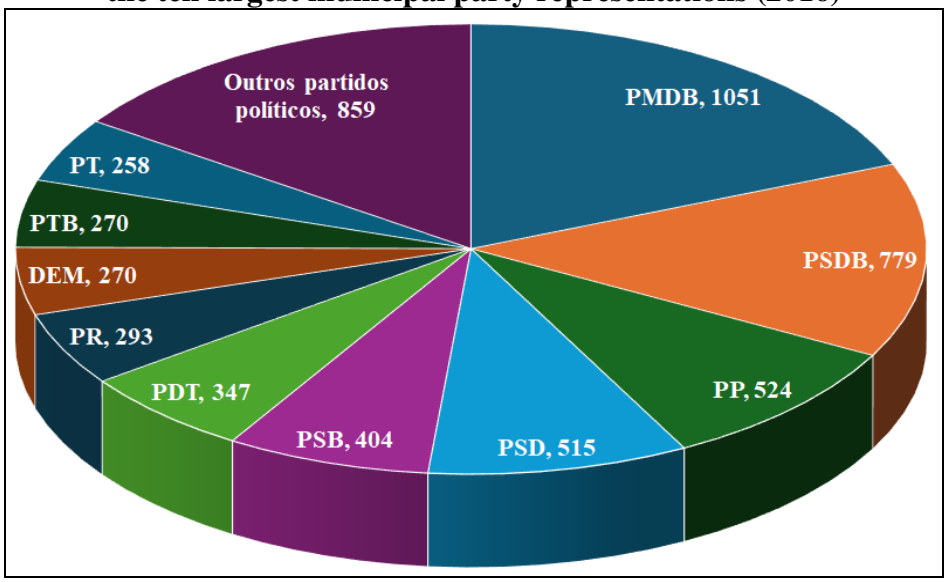
For all selected years, the variable adhered to two principles: the most recent available year and, simultaneously, compatibility with other variables to ensure coherence in their correlations.

The dependent variable "Municipal Agro GDP per capita," according to IPEADATA, is equivalent to the sum of final consumption of goods and services valued at market prices, also equivalent to the sum of primary incomes. The agricultural sector refers to the GDP calculation from the production perspective, comprising agricultural establishments producing for both the market and self-consumption. Furthermore, according to IPEADATA, the scope of this activity includes the following segments: agriculture, livestock farming, forestry production, fishing, and aquaculture.

The other variables used in the model, namely, "% of Labor Force Employed in Agriculture," "% Rural Population," "Regional Dummy," and "Policy Dummy," are control variables employed to enhance the model's specification.

Subsequently, Graph 1 presents the number of mayors from the ten largest municipal party representations. At that time, there was almost a supremacy of the PMDB, now known as MDB.

Graph 1 - Number of mayors from the ten largest municipal party representations (2016)



Source: Self elaboration.

In the Graph, it is evident that the PMDB and the PSDB, together, represented nearly one-third of the mayors in the year 2016. However, there is a significant party fragmentation considering that "Other political parties" (Outros partidos políticos) are the second-largest representation in the Figure. Currently, the party representation looks very different, with parties like PL not even appearing among the top ten representations, and União Brasil didn't even exist yet. Thus, with new simulations using more recent data, it would not be surprising to see significant changes related to party representations.

It is important to emphasize that control variables are used to manage or adjust the effects of other independent variables on the dependent variable. They serve to isolate the effect of an independent variable of interest, eliminating or minimizing the influence of other variables that may distort the relationship between the independent variable of interest and the dependent variable. Thus, they can bring a set of benefits to the model, such as reducing bias, controlling for confounding factors that may obscure the true relationship between the independent variable of interest and the dependent variable, assessing indirect effects on the dependent variable, and increasing the precision of parameter estimates (STOCK; WATSON, 2020).

The variable "% of Labor Force Employed in Agriculture," according to IPEADATA, encompasses all individuals, with or without pay, who were engaged in services related to establishment activities, except those performing work for contractors.

The importance of the variable "% of Labor Force Employed in Agriculture" seems obvious. Considering that taxation is strongly related to economic activity and to the number of people involved and the number of people to be taxed, its inclusion allows controlling for such effects related to Agricultural GDP.

Following that, the variable "% Rural Population" controls for effects of land availability and comparative advantages.

Next, the main results observed from the regression model, as well as other evidence perceived during this research, will be presented.

RESULTS AND DISCUSSION

In this section, results from simulations conducted using various Ordinary Least Squares (OLS) models will be presented and discussed, considering the best fit to identify the effects of Agribusiness on municipal taxation.

Table 2 presents the results of OLS regression models relating Municipal Agro GDP per capita to municipal per capita revenue - six models are presented. These models correspond to those that showed the best fit and most robust results, considering that dozens of regressions were performed, including adding and removing variables and transforming them to address issues arising from model consistency and efficiency. The first model is a simple regression, and as new models are presented, more control variables are included.

It is important to note that the mentioned table only includes variables that are statistically significant, meaning those whose p-value suggests that the sample data are unlikely to have occurred if the null hypothesis were true, thus indicating strong evidence against the null hypothesis. Therefore, as will be observed, only a few acronyms of political party UFs appear.

It was not an easy task to associate the findings of the proposed models with others available in other previous publications. The reason is simple and obvious: considering the specificity of this research, the authors were unable to identify studies that make the same relationship between variables. However, even though they are not the same, we sought to make such an association based on likelihood.

Table 2 - Results of OLS Regression Models relating Municipal Agro GDP per capita to per capita revenue

Variables/Statistics	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Municipal Agro GDP per capita	0.008*	0.017*	0.014*	0.005*	0.013*	0.005*
% of Labor Force Employed in Agriculture	-	-0.822*	-0.221*	-0.312*	-0.216*	-0.304*
% Rural	-	-	-0.006*	-0.004*	-0.006*	-0.004*
Regional Dummies	No	No	No	Yes	No	Yes
AM	-	-	-	-0.081***	-	-0.080***
MA	-	-	-	-0.078*	-	-0.084*
CE	-	-	-	-0.050***	-	-0.050***
RN	-	-	-	-0.073**	-	-0.070**
PB	-	-	-	-0.090*	-	-0.095*
PE	-	-	-	-0.082*	-	-0.085*
AL	-	-	-	-0.090**	-	-0.092**
ES	-	-	-	0.111*	-	0.104*
RJ	-	-	-	0.160*	-	0.169*
SP	-	-	-	0.246*	-	0.243*
PR	-	-	-	0.088*	-	0.085*
SC	-	-	-	0.233*	-	0.235*
RS	-	-	-	0.197*	-	0.201*
MS	-	-	-	0.201*	-	0.186*
MT	-	-	-	0.214*	-	0.206*
GO	-	-	-	0.072*	-	0.067*
Political Dummies	No	No	No	No	Yes	Yes
PDT	-	-	-	-	0.052*	0.043**
PSDB	-	-	-	-	0.072*	0.037**
N	5564	5564	5564	5564	5564	5564
R2	0.007	0.100	0.153	0.229	0.157	0.231
F-test	39.318	309.640	334.622	39.318	86.278	44.988
Durbin-Watson	1.712	1.781	1.834	1.986	1.838	1.988

Source: Self elaboration.

Note: * represents statistical significance at the 0.05 level, ** represents statistical significance at the 0.01 level, and *** represents statistical significance at the 0.001 level.]

As observed in the table, Model 1 presents a simple regression of Municipal Agro GDP per capita against municipal per capita revenue. This initial result indicates that, on average, for every thousand reais produced in Municipal Agribusiness GDP, eight reais would be transformed into municipal taxes, as described in Table 1. However, it's important to note the very low R-squared and the absence of control variables, which renders the model a simple correlation.

The inclusion of Models 2 and 3 significantly alters the estimator of the variable of interest, moving from 0.008 to 0.017 and 0.014, respectively. Furthermore, the impact of "% of Labor Force Employed in Agriculture" and "% Rural" is observed - their signs are negative and statistically significant. These pieces of evidence suggest that municipalities with a higher percentage of the labor force employed in agriculture, as well as a larger rural population compared to urban, tend, on average,

to have lower municipal revenue. However, Agriculture seems to bring more wealth and, therefore, indirectly contributes to the increase in municipal per capita revenue.

Model 4 is a repetition of Model 3, with the inclusion of regional dummy variables. Twenty-five variables representing Brazilian states are added, except for Minas Gerais, which serves as a comparison variable with the others. The estimator of Municipal Agro GDP per capita goes to 0.005 and seems to achieve its best fit due to the control of regional variables.

Still observing Model 4, a sui generis fact is noted: the regional division of the country. Interestingly, all Brazilian states in the North and Northeast regions have negative signs - those that are statistically significant are shown in the table - when compared to Minas Gerais. On the other hand, the states comprising the Southeast, South, and Midwest regions, all without exception, have positive signs and statistical significance. Thus, it seems that factors related to these states significantly contribute to municipal revenue. Infrastructure, human capital, market conditions, institutional environment, etc., contribute to such a result.

Model 5 removes regional dummies and inserts political dummies. The ten largest municipal party representations of the time were included, and each representation was being compared to those that were not identified as such. The intention was to capture the political effect on municipal revenue. Among the ten represented parties, only PDT and PSDB provided evidence that they differed from the others with their positive and statistically significant estimators. However, the control variables "% of Labor Force Employed in Agriculture" and "% Rural" show a negative impact on revenue, in the order of 0.304 and 0.004. This result seems unsurprising since people employed in the agricultural sector and residing in rural areas seem to pay fewer taxes.

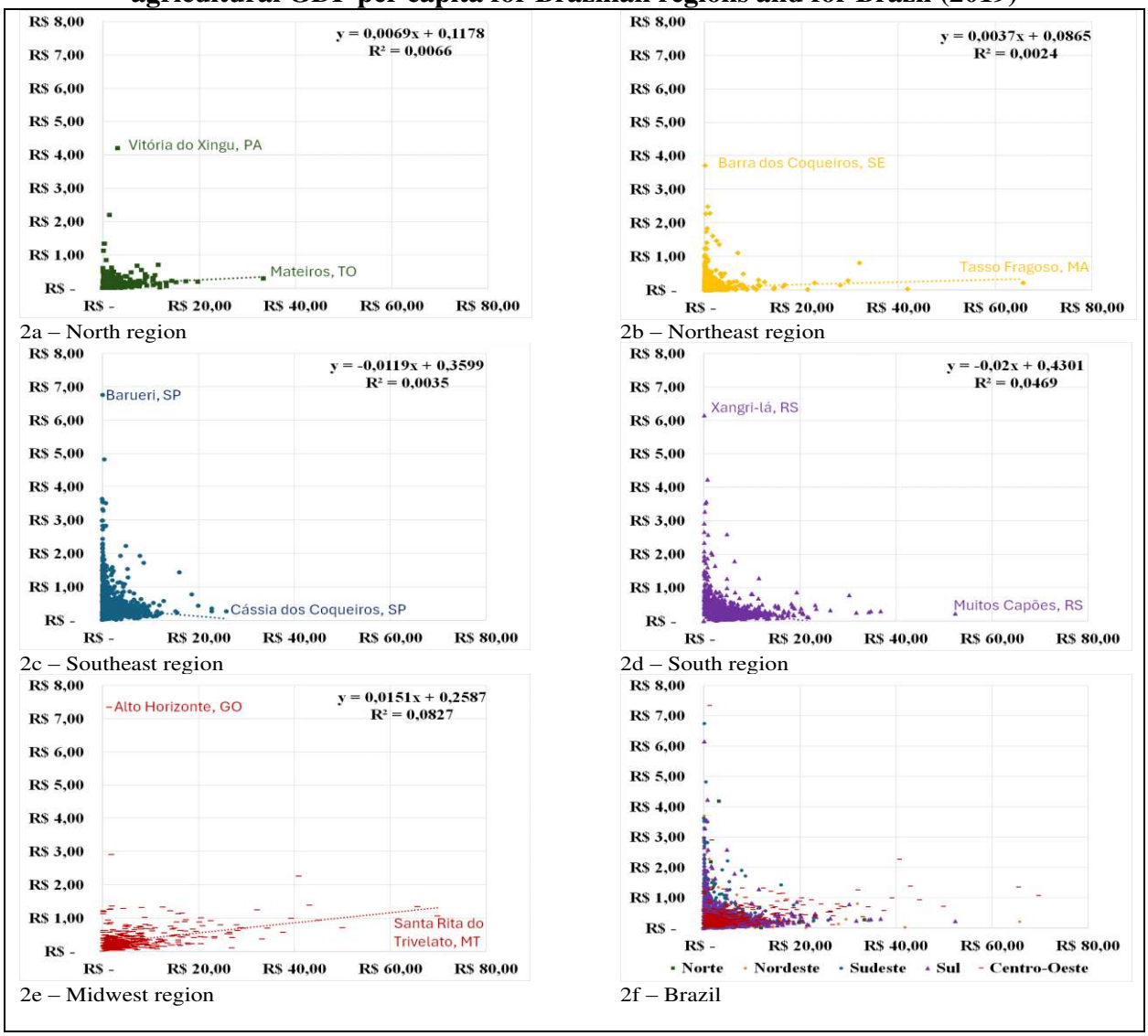
Finally, Model 6 brought together all variables. The results show that the impact of Municipal Agribusiness GDP per capita on Municipal Revenue was 0.005. Thus, it can be inferred that for every thousand reais produced in agribusiness within municipal boundaries, an average of five reais is expected in municipal revenue.

This result, despite being obtained by different methodological propositions, is corroborated by the works of Aliz (2015), Chagas Neto, Silva Ferreira, Souza (2020), Hossain (2017), Mabugu and Chitiga (2018), Mengistu and Tsegaye (2016) and Vieira and De Ávila (2020), and others.

Regarding regional variables, it is observed that municipalities located in Paraíba, Alagoas, and Pernambuco, respectively, are those that collect less as Municipal Agribusiness increases, while municipalities located in São Paulo, Santa Catarina, and Mato Grosso, respectively, are those that collect more as Municipal Agribusiness increases.

Graph 2 presents six graphs plotting municipal per capita revenue versus Municipal Agribusiness GDP per capita with data from 2019, the same used to obtain regression data. In these graphs, the relationship is observed within the five regions and Brazil as a whole.

Graph 2 – Plot of municipal per capita revenue versus municipal agricultural GDP per capita for Brazilian regions and for Brazil (2019)



Source: Self elaboration. Research data.

Again, and in a slightly more detailed manner, the differences between Brazilian regions can be perceived. The states of São Paulo and Rio de Janeiro have the highest average municipal per capita revenues – 53 and 45 cents of a real, respectively. On the other hand, the state of Paraíba has the lowest average municipal per capita revenue – five cents, followed by the states of Amazonas and Maranhão with only six cents each.

Regarding the values of average Municipal Agribusiness GDP per capita, the state of Mato Grosso has the highest value – R$ 9.48, followed by its neighbor Mato Grosso do Sul – R$ 7.10, and Rio Grande do Sul – R$ 5.98. On the other hand, the state of Paraíba appears with the lowest average Municipal Agribusiness GDP per capita – R$0.51, followed by the states of Rio de Janeiro – R$0.56, and Pernambuco with R$0.73 only.

Regarding the political variable, once again, it is observed that municipalities governed by the PDT and the PSDB are those that present the highest conditional averages regarding municipal revenue. It is difficult to explain such a phenomenon; After all, this result proves to be statistically significant in the presence of regional variables and other control variables. This result seems to evidence a stronger revenue-raising "DNA" of these parties, facing a stronger agribusiness.

CONCLUSIONS AND RECOMMENDATIONS

In this study, the relationship between agricultural production and municipal tax revenue in Brazil was investigated. Through robust quantitative analysis, a statistically significant correlation between them was identified. The results indicate that, on average, for every thousand reais produced in Municipal Agribusiness GDP, between five and seventeen reais are generated in municipal taxes, depending on the model specification. Specifically, it was observed that municipalities with higher agricultural production tend to have higher tax revenue, highlighting the importance of this sector for municipal finances.

Additionally, it was found that the impact of "% of Labor Force Employed in Agriculture" is significant. In both cases, their signs are negative and statistically significant. Such evidence suggests that municipalities with a higher percentage of the labor force employed in agriculture, as well as a larger rural population compared to urban, tend, on average, to have lower municipal revenue.

Two other characteristics were tested and proved to be significant in municipal tax revenue in Brazil, namely: the state in which the municipality is located and the political party to which the mayor is affiliated. Regarding the states, all those located in the Midwest, Southeast, and South regions brought positive and statistically significant impacts, while those that made up the North and Northeast Regions either had negative effects or were not significant. The state of Minas Gerais was taken as the comparison state. Regarding political parties, municipalities governed by the PSDB and the PDT showed positive effects, while the others did not show statistical significance in their hypothesis tests.

Thus, it is concluded that agribusiness, in addition to its recognized ability to generate wealth, can also significantly contribute to municipal revenue. This capacity is evidently related to other characteristics of the municipality.

This study contributes to understanding the effects that agribusiness brings to municipal tax revenue in Brazil, as the results provide insights that can be useful for policymakers, municipal managers, and decision-makers, highlighting the need for policies that promote sustainable development of the agricultural sector as a strategy to strengthen municipal finances.

It is important to recognize that this study has some limitations, such as: the analysis did not consider other factors that may influence municipal tax revenue, such as demographic, economic, and political characteristics specific to each region. For future research, we suggest a more detailed analysis that considers variables involving the characteristics and explores other relevant variables for a more complete understanding of the proposed relationship in this study.

Finally, it is understood that the findings of this study may have practical implications for public managers and decision-makers. It is worth noting the importance of policies that encourage the development of the agricultural sector, such as investments in rural infrastructure, access to agricultural credit, and technical training for farmers. Additionally, fiscal policies that recognize the contribution of agricultural production to municipal revenue can be implemented, such as fiscal incentives for sustainable agricultural activities and programs to support rural development. These measures not only strengthen municipal finances but also promote inclusive economic growth and reduce regional inequalities.

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