Agricultural Policy and the Quality of Public Expenditure in Agriculture: Evidence from Municipalities of Minas Gerais state, Brazil

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Abstract: Agriculture has a historical importance for the Brazilian economy. Comprehending the relevance of this sector to country’s economy, Federal Government has invested in several programs aimed at strengthening the agricultural sector. Seen this, we aimed at analyzing the quality of expenditure on agriculture-focused public programs. Focusing on municipalities of Minas Gerais state, we applied a bias-corrected Data Envelopment Analysis Model where the investment in programs of marketing support, risk management and rural credit were taken as inputs and the agricultural gross production value (GPV) was used as model’s output. Main results indicate that the state presented a relatively low quality on public expenditure in agriculture. Moreover, the municipalities whose economy depends the most of agricultural results presented the largest efficiency average. We concluded that government investments should be focused on municipalities with less-developed agriculture.


Introduction

Agriculture and livestock have a historical importance for the Brazilian economy. Data from the Center for Advanced Studies on Applied Economics (CEPEA/USP) point out that this sector accounted for at least 19% of Brazil’s gross domestic product (GDP) since 1996, when its series started. When considered by itself, the agricultural production responded for 3.6% of the Brazilian GDP in 2017, which is translated into more than BRL 235 billion\(^1\). Furthermore, agribusiness is even more important to Brazilian trade balance, have accounted, in 2017, for almost 45% of Brazil's total external sales (BRASIL, 2018). In addition, agriculture is also relevant in guaranteeing food security and income generation to rural population, combating rural exodus.

Comprehending the relevance of agriculture to country’s economy, Federal Government has invested in several programs aimed at strengthening the sector. Conducted by the Ministry of Agriculture, Livestock and Food Supply (MAPA), the Brazilian Agricultural Policy aims to increase agriculture yield, support farmers’ income and ensure the production flow. Accordingly, it comprehends three main pillars: rural credit, risk management, and

\(^1\) In values of 2010.
marketing support. The resources allocated to each pillar are annually determined through MAPA’s Agricultural and Livestock Plan according to government budgetary availability.

In recent years, given the recessionary scenario, there was an increase on the competition for public resources in Brazil. Therefore, government entities can be expected to be concerned with allocating resources in the most efficient way possible, i.e., to generate better results with the same level of public investments. Ultimately, budget resources are expected to be spent with quality. Since it is also true for the agricultural sector, the present paper seeks to analyze the quality of expenditure on agriculture-focused public programs in Brazil.

Taking efficiency as a proxy of quality, a Data Envelopment Analysis (DEA) model was applied to the municipalities of Minas Gerais state. Investment in agricultural programs were considered as inputs, while gross production values were used as outputs. Reasons to focus on Minas Gerais are threefold. It has diverse socioeconomic realities within its territory as Brazil does; its economy is also historically linked to agriculture as several local economies rely on agricultural activity; and it’s the Brazilian state with the largest number of municipalities, a methodological advantage.

As far as we know, no other study on the quality of public expenditure on the Brazilian agriculture has been carried out until this date. This fact increases the relevance of the results found by the present research. In Brazil, the great majority of analyzes focused on health and education (FARIA et al., 2008; ALMEIDA; GASPARINI, 2011; MACHADO JÚNIOR et al., 2011; SILVA; ALMEIDA, 2012; QUEIROZ et al., 2013; SAVIAN; BEZERRA, 2013). Identifying the municipalities for which agricultural investments are more efficient in generating economic results is important to define benchmarks which may be in-depth investigated.

In addition to this introductory section, this paper presents a review of resources allocation, efficiency and the quality of public expenditure in Section 2. Section 3 overview the Brazilian Agricultural Policy and its main programs. Section 4 describes the methodological procedures. Section 5 shows and discusses our results. Lastly, section 6 draws general conclusions and policy implications.

**Resources allocation, efficiency and the quality of public expenditure**

Literature stresses that governments have some economic functions: to adjust income distribution among population, to stabilize the economy during crisis, and to allocate resources as efficiently as possible. These functions guide governments’ actions, such as the implementation of public policies aimed to promote the development of various sectors of the economy and, consequently, to increase of population’s well-being (Silva, 2009). Musgrave and Musgrave (1980) link these functions to the three spheres of government. The distributive function would be guided by the state and federal spheres, while the stabilizing function would
be controlled exclusively by the federal sphere. On the other hand, municipal, state and federal spheres would concurrently conduct the allocative function.

The research problem investigated on the present study lies on the government allocative function. Indeed, in a context where it is intended to analyze the quality of public expenditure, one must focus on government’s capacity of correcting market failures that impede the maximization of efficiency in resources allocation. These failures comprehend the set of conditions under which the economy is unable to distribute resources in an efficient manner, constituting the main reason for the government to implement its allocative function (Carvalho, 2001; Silva, 2009). In this sense, Longo and Troster (1993) consider the allocative function as fundamental to promote economic growth and development.

The pronounced financial constraints that all spheres of government has been facing in Brazil evidences how important it is to look at both the effectiveness and the efficiency of government resource allocation. In other words, in addition to analyzing whether the government is actually achieving its goals, it is also necessary to evaluate how the invested resources are being transformed into the expected results. The relevancy of efficient public expenditure is twofold. First, the bulk of government expenditure is financed by the taxes collected from all society. Second, financial constraint leads to relevant opportunity costs since investments must be guided to an economy sector in detriment of others (Costa, 2012).

Public sector’s productive process is given by a sequence of events culminating in the production of a plethora of outputs that ultimately leads to the outcome pursued by all governments: socioeconomic development. In a simplified way, this process is given by the allocation of public resources, which are processed through public management, generating products that ultimately improve population’s quality of life and raise local economic development level (SOLÀ; PRIOR, 2001). As a consequence, local governments must allocate their resources on the best way possible, in order to guarantee the desired outcomes through the improvement of the relationship between inputs and outputs. As exposed by Furtado (2004), economic development is intrinsically dependent on public efficiency, because it determines how the resources generated through economic growth are employed.

**The Brazilian Agricultural Policy and its distributive nature**

Following Lowi’s taxonomy, public policies can be distinguished in distributive, redistributive, regulatory and constituent. Distributive policies allocate society resources into specific segments. Redistributive policies, on the other hand, take resources from some interest groups to others. Regulatory and constituent policies respond, respectively, by the regulation of social or economic actions and by the rules governing other policies. Since it is sector-focused, it is possible to highlight the distributive nature of the Brazilian Agricultural Policy. Its programs are financed through taxes collected from the whole society, perfectly
matching the definition of a distributive policy. The pillars of the Brazilian Agricultural Policy and their main programs are briefly discussed below.

*Rural Credit*

Rural credit programs are ruled by the Rural Credit Manual (MCR), a document prepared by the Central Bank of Brazil (BCB). They offer credit lines at subsidized rates, enabling improvements for the agricultural activity, such as input purchase, asset investment, and production commercialization. Money is landed to farmers and agricultural cooperatives by commercial banks and credit cooperatives affiliated to the National Rural Credit System (SNCR). Costing credit is used to cover usual expenses of the production cycle, from inputs purchase to harvest period. Investment credit is destined to purchase machines and equipment, guarantying long-term benefits to the activity. Marketing credit is employed in the facilitation of production storage and supply (MAPA, n.d.).

Among the programs belonging to the credit pillar, one can stress the National Programme for Strengthening Family Farming (Pronaf) and the Medium-Scale Agricultural Producer Support Programme (Pronamp) as the most important ones. Primarily geared towards family farmers and agrarian reform settlers, Pronaf finances income-generating projects at lower interest rates. It is divided into different bands aimed at costing the agricultural activity through investments in machinery, equipment or production infrastructure, and agricultural and non-agricultural services (MDA, n.d.b). Pronamp, as well as Pronaf, finances agricultural projects and small expenses, such as those related to the maintenance of farmers’ livelihood. The programs differ in terms of the target audience: Pronaf is focused on family farming, whilst Pronamp is intended for medium-scale farmers (MAPA, 2013).

*Risk Management*

The agricultural activity is surrounded by a wide variety of risks related to weather instability, market conditions and the business environment. These risks may translate into farmers’ income losses and, in order to avoid this possibility, the Brazilian government has established some initiatives focused on agricultural risk management. Dealing with risk mitigation, transfer and response, these programs benefits small-, medium-, and large-scale farmers (World Bank, 2015). In this context, two relevant programs are the Program for the Support of Rural Insurance Premium (PSR) and the Family Farming Insurance (SEAF).

PSR is a Federal Government program that provides economic subsidies for the acquisition of agricultural insurance policies. Its main objectives are the reduction of the insurance premium paid by farmers and the diffusion of insurance throughout national territory. Specifically, the focus of this program relies on medium- and large-scale farmers. On the other hand, SEAF – also known as “PROAGRO Mais” – is intended for family farmers who access
Pronaf. This program was developed to ensure that the farmer cultivates his crop safely, meeting an old claim made by small-scale farmers: an insurance with guaranteed income (MDA, n.d.a).

**Marketing Support**

Is through the marketing support programs, especially the National School Feeding Programme (PNAE) and the Food Acquisition Programme (PAA), that the government helps the family farming to outflow its production. These programs guarantee farmers visibility in the market, inserting them in the commercialization and consumption route, mainly through government purchases. These programs can generate social and economic capital, enabling the establishment of a powerful virtuous circle, by injecting millions into local economies of Brazilian municipalities (“Apoio à comercialização”, 2016).

With PAA, Federal Government ensures the purchase of food directly from family farming actors, distributing it through social organizations, which distribute it to those in food insecurity or store it when necessary (Maluf et al., 2015). PNAE, however, consists on the transfer of financial resources from the Federal Government to the states and municipalities for the acquisition of food for school meals, being that, approximately 30% of the food should be obtained directly from family farmers or organizations (Brasil, 2014).

**Methodology**

**Bootstrap Data Envelopment Analysis**

There are, in literature, some techniques used to the estimation of production frontiers and relative efficiency scores. Among the non-parametric ones, Data Envelopment Analysis (DEA) is one of the most employed. This technique, established by Farrell (1957) and disseminated by Charnes et al. (1978), is based on linear programming. Through the application of a DEA model, it is possible to estimate relative efficiency scores for the analyzed municipalities, which are considered as proxies for the quality of public expenditure in agriculture. The problem of estimating efficiency scores at the municipal level consists of obtaining an estimate of the set of production possibilities, S, for the analyzed municipalities. Therefore, each municipality is classified as a decision-making unit (DMU) that transforms N inputs into M outputs.

The DEA model used in the present study is output-oriented. Is this case, the efficiency is defined in terms of how the DMUs can generate more and better outputs with the same quantity of inputs. Since the Brazilian Agricultural Policy deals with critical aspects regarding country’s economy and the livelihood of hundreds of thousands of people, it is believed that the volume of resources allocated to its programs will not be indiscriminately reduced, but rather will seek to achieve better results with a given level of investment. Therefore, the quality
of public expenditure in agriculture is evaluated in terms of how much production value is generated with the same level of investment. Specifically, the employed model is given by the following equation

\[
D_{\theta}^{S_h}(x_i, y_i) = \inf_{\theta > 0} \{\theta > 0 : (x_i, y_i) \in S\},
\]

wherein \(D_{\theta}^{S_h}(\cdot)\) denotes output-oriented Shepard’s distance; \(x_i\) and \(y_i\) denote, respectively, inputs and outputs related to each DMU; \(\theta\) denotes efficiency scores, with \(0 < \theta < 1\) to inefficient DMUs and \(\theta = 1\) to the efficient ones.

Returns to scale were empirically determined through the test proposed by Simar and Wilson (2002). Since the null hypothesis was not rejected, we considered constant returns to scale. In order to turn around the deterministic nature of DEA models, Simar and Wilson (1998, 2000) derived a statistical model for efficiency analysis that enables the performance of inferences using bootstrap technique. This model also corrects for sampling bias, making it possible to estimate bias-corrected scores and their respective confidence intervals.

**Mean-comparison test**

In order to complement the efficiency analysis used to measure the quality of public expenditure in agricultural programs, a mean-comparison test is also performed. This kind of test verifies if differences in means are statistically significant or not, working upon the null hypothesis that two or more means are equal. In the present analysis, municipalities are grouped according to the importance of the agricultural sector to local economy. A one-way analysis of variance (Anova) is conducted, in order to examine if the mean efficiency level is different among all groups.

Confirming that at least one mean is statistically different from the others, we perform separated t-tests for independent samples in order to identify what groups are statistically different among each other. That is, it will be possible to see if the means of all pairs of groups are statistically different, or whether this difference is only observed for the extreme groups. Ultimately, it is believed that the participation of agriculture in municipal economies may influence local government actions, possibly affecting the efficiency levels achieved by each municipality, what may generate different efficiency means for groups with in which agriculture is more (or less) important.

**Data**

Prior to choosing the application of the DEA model, it is necessary to define the decision-making units (DMUs) and to select the variables to be used as inputs and outputs of the efficiency model. The municipalities of Minas Gerais state are used as the DMUs of the efficiency model. Our sample comprises 206 of Minas Gerais’ 853 municipalities, since we...
excluded those municipalities that were completely urbanized and those that presented zero value for some of the variables used in the DEA model.

Input variables were chosen according to the objective of this study, which is to analyze the quality of public expenditure in agricultural programs. Seen this, these variables were constructed by summing the investments made in two programs related to each of the agricultural policy pillars: PAA and PNAE accounted for marketing support, PSR and SEAF for risk management, and Pronaf and Pronamp for rural credit.

The agricultural gross production value (GPV) was used as model’s output, working as a proxy of farmers’ income. This specific measure was chosen in order to enable the analysis of the complete agricultural sector, considering all different cultures produced by farmers. DEA models advocate for homogeneous DMUs, which would force us to analyze specific agricultural products. However, we consider that, as a monetary measure, the GPV is capable to equate this problem, making different products comparable to each other – what would not be possible if considered the agricultural production, for example.

Inputs and output variables were gathered from several sources. Investments made to PAA, PNAE and SEAF were obtained, respectively, from the Ministry of Social Development, the Ministry of Education, and the Ministry of Agrarian Development. The values invested on the PSR were taken from MAPA’s Agricultural Insurance Atlas. Pronaf and Pronamp data, on the other hand, came from the Central Bank of Brazil’s Rural Credit Matrix. The base year of analysis is 2015.

Results and discussion

Table 1 presents the descriptive statistics for inputs and output employed in the efficiency model. It is observed that an expressive amount of public resources was destined to rural credit programs, averaging almost BRL 12 million. This value were approximately 35 times greater than the mean expenses for marketing support and risk management together. The mean GPV was of almost BRL 118 million, presenting an expressive dispersion as the calculated standard deviation was 1.27 times greater than its means. This could be a consequence of the large amplitude presented by this variable. A similar pattern was observed for the inputs, with emphasis on marketing support. This variable exhibited a standard deviation 2.25 times greater than its mean value.

In general, the bias-corrected model generates lower efficiency scores than the regular (biased) model. Consequently, no municipality reached a bias-corrected score of one. Even so, it would be naïve to simply consider all the analyzed sample as being inefficient in generating agricultural value through government investments. The obtained average for the bias-corrected efficiency scores was of 0.3173, a relatively low value. However, a great dispersion was identified, as scores varied from 0.0114 to 0.8772. The great heterogeneity that
characterizes the analyzed sample is better comprehended through the Figure 1, in which the bias-corrected scores estimated for the municipalities of Minas Gerais are depicted.

**Table 1.** Descriptive statistics of input and output variables used in the efficiency model.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marketing support (BRL)</td>
<td>313,105</td>
<td>704,226</td>
<td>11,664</td>
<td>7,300,000</td>
</tr>
<tr>
<td>Risk management (BRL)</td>
<td>32,122</td>
<td>51,797</td>
<td>64</td>
<td>308,490</td>
</tr>
<tr>
<td>Rural credit (1,000 BRL)</td>
<td>11,905</td>
<td>11,760</td>
<td>154</td>
<td>75,000</td>
</tr>
<tr>
<td><strong>Outputs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross production value (1,000 BRL)</td>
<td>117,430</td>
<td>149,426</td>
<td>487</td>
<td>908,849</td>
</tr>
</tbody>
</table>

Source: Research results.

The analyzed municipalities were segregated into three groups according to the mean (0.3173) and the standard deviation (0.2213) calculated for the bias-corrected efficiency scores. The municipalities with scores one standard deviation above the mean (0.5386) were considered as highly efficient. On the opposite way, those which presented scores one standard deviation below the mean were allocated to the low efficiency group. The remaining municipalities – with scores located around the mean – were classified into the medium-level group. This last group accounted for the largest number of municipalities (134), followed by the small-level group (38) and the high-level one (34). That is, approximately 65% of the analyzed sample presented medium-level efficiency scores.

It is observed that the majority of municipalities dropped prior to the efficiency analysis are located on the eastern half of the state, comprehending large portions of the regions of Norte de Minas, Jequitinhonha, Vale do Mucuri, Vale do Rio Doce, and Zona da Mata. Those regions are historically recognized as having the lowest socioeconomic levels within the state, which is even more pronounced for their rural areas. Considering the exclusion rules applied in this research, it can be understood as an evidence that some of the agricultural-focused public policies are not reaching those localities.

Conversely, the analyzed municipalities are mainly spread throughout the western half of the state. The bulk of units with high efficiency is located in the regions of Noroeste de Minas, Triângulo Mineiro/Alto Paranaíba, and Sul/Sudoeste de Minas, which are primarily marked by a well-developed commercial agriculture. Anyway, three exceptions were find for municipalities located in the Zona da Mata region – besides being characterized by the predominance of family farming, some of its municipalities have a highly-profitable coffee
production which may induce government investments. A similar geographical pattern is observed for the medium-level group, despite presenting more municipalities.

![Bias-corrected efficiency scores, Minas Gerais state. Source: Research results.](image)

**Figure 1.** Bias-corrected efficiency scores, Minas Gerais state.
Source: Research results.

On the other hand, the municipalities classified into the low-level group are more evenly distributed within the state of Minas Gerais. Indeed, the units of this group are located in almost all the regions of the state. This demonstrates that the incidence of low efficiency has not a so much powerful geographical dependence as observed for the higher levels of efficiency. In spite of the geographical dispersion, clusters of low-efficient municipalities are observed for the Norte de Minas e Central Mineira regions. It must be stressed, again, that these regions are characterized by a relatively poor rural area, mainly inhabited by family farmers.

Going further, one can say that the quality of public expenditure in agriculture may be closely related to the relative importance that this sector has for the municipal economy as a whole. Thinking about that, we divided the analyzed municipalities into groups constructed according to the contribution percentage of the agricultural sector to the gross production value (GPV). We followed the same criteria previously used for the efficiency groups. Posteriorly, we compared the mean bias-corrected efficiency of those groups, as indicated in Table 2.
Table 2. Descriptive statistics for bias-corrected inefficiency scores by groups of participation of agriculture in gross production value (GPV).

<table>
<thead>
<tr>
<th>Participation of agriculture in GPV</th>
<th>N° of DMUs</th>
<th>Mean</th>
<th>SD</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>30</td>
<td>42.66</td>
<td>8.94</td>
<td>76.82</td>
<td>33.42</td>
</tr>
<tr>
<td>Medium</td>
<td>139</td>
<td>19.48</td>
<td>6.61</td>
<td>32.75</td>
<td>7.27</td>
</tr>
<tr>
<td>Low</td>
<td>37</td>
<td>3.65</td>
<td>2.24</td>
<td>6.96</td>
<td>0.19</td>
</tr>
</tbody>
</table>

Source: Research results.

Municipalities were allocated to the group with low participation of agriculture in GVA if they presented percentage values smaller than 7.17%, while the high group consisted of municipalities with percentage values greater than 32.85%. The remaining formed the medium group. It can be clearly seen in Table 2 that the group in whose municipalities’ agriculture responds to a larger share of GPV are those with higher mean bias-corrected efficiency. On the contrary, those municipalities with the lowest quality of public expenditure in agriculture were related to low levels of participation of agriculture in GPV. In order to provide statistical validation to this affirmation, we conducted a One-Way ANOVA analysis, in which we found significant (at better than the 1% level of confidence) differences among the three groups. Therefore, a pairwise comparison was conducted, enabling the verification if the means of the bias-corrected scores were equal or not between the groups under analysis. Results are presented in Table 3.

Table 3. Mean-comparison test of bias-corrected inefficiency scores for groups of participation of agriculture in gross production value (GPV).

<table>
<thead>
<tr>
<th>Groups</th>
<th>Tukey’s t statistic</th>
<th>p-value</th>
<th>Difference of means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium vs. Low</td>
<td>2.09</td>
<td>0.095</td>
<td>7.83</td>
</tr>
<tr>
<td>High vs. Low</td>
<td>6.26</td>
<td>0.000</td>
<td>31.15</td>
</tr>
<tr>
<td>High vs. Medium</td>
<td>5.72</td>
<td>0.000</td>
<td>23.32</td>
</tr>
</tbody>
</table>

Source: Research Results.

The statistical results presented in Table 3 support the idea that those municipalities in which agricultural production has a bigger importance in local economy tend to have higher efficiency levels. This result implies that the larger is the agricultural relevance, the bigger is quality of expenditure in agriculture-focused public programs for the municipalities of Minas Gerais. Moreover, the statistics presented in Table 3 reinforce the fact that the high-level group has an average score significantly larger than the ones recorded for the other groups.
Conclusions and policy implications

This study aimed to evaluate the quality of public expenditure in agriculture for the municipalities of Minas Gerais state, Brazil. We conducted an output-oriented DEA model, considering constant returns to scale. Some of our results corroborate the hypotheses that we previously raised. Indeed, it was perceived that the mean efficiency presented by the analyzed DMUs was significantly low. Interestingly, municipalities for which the agricultural sector is relatively more important were those that comparatively presented the largest efficiency scores. This is evidence that the dependence on the economic results of this sector makes the municipalities invest the resources in the most efficient way possible, presenting higher quality in their expenditures.

It was also observed that efficient municipalities were concentrated in those regions where agricultural activity is more developed and capitalized, like Noroeste, Sul/Sudoeste and Triângulo Mineiro/Alto Paranaíba. On the other hand, the municipalities that presented the lowest efficiency scores are located in regions mainly characterized by small-scale family farming. Perhaps the quality of public expenditure in agriculture is linked to the regional characteristics of agricultural production models.

These conclusions could guide agricultural policy makers to pay more attention on municipalities in which the presence of family farming prevails. Specifically, by focusing on the quality of public expenditures, the Federal Government should invest in enforcement mechanisms to increase efficiency in the conduct of agricultural production programs. In doing so, the discrepancy observed regarding efficiency scores might decrease in the future.

The main limitations of this study relate the cross-sectional nature of the used database. The findings regarding the quality of public expenditure on agriculture could be expanded by incorporating more years into the analysis and the possible use of a panel DEA model. In addition, we focused on only one Brazilian state. Similar analyzes for other regions could complement the state of the art.

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