The impact of cooperative membership on farm income

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ABSTRACT

Brazilian South and Southeast regions produced more than 50% of the Brazilian agricultural production in 2006. The Brazilian government has implemented several policies to enhance farm income on these regions such as policies towards enhancement of cooperatives production management. This directly affects farmers in these regions given that around 24% of them were members of cooperatives. In this paper, we estimate the effect of this membership on farms profitability, output supplies and input demands. To calculate these effects, we estimate a quadratic normalized restricted profit function using the Brazilian Agricultural Census of 2006 for the South and Southeast regions of Brazil. Preliminary results suggest a positive effect of cooperative membership on profit of about US$ 4.1 million per year. A positive effect of membership on output supplies and on input demand was found.

Key-words: Cooperatives, Agriculture, Restricted profit function.

JEL: Q1, Q11, Q13.

INTRODUCTION

Brazilian agriculture is clustered in the South and Southeast regions, which produced almost 60% of the national agricultural production in 2006 (Brazilian Institute of Geography and Statistics – IBGE, 2016). In Brazil, cooperatives have shown a remarkably participation in the Brazilian agricultural production. In 2013, cooperatives in the agricultural sector have generated 340 thousand direct jobs, 6% of the *Gross Domestic Product* and half of the agricultural production (Brazilian Cooperative Organization – OCB, 2014). Brazilian government has implemented a few policies to enhance cooperatives performance in the last two decades such as the *Programa de Revitalização das Cooperativas Agropecuárias Brasileiras* (RECOOP)[1], which might have led to increases on agricultural production in Brazil.

Public policies that focus on enhancing agricultural cooperatives' performance affect directly farmers on the South and Southeast regions given that around 24% of the 922,097 farms[2] were members of a cooperative. Helmberger and Hoss (1962) have concluded that cooperatives seek to provide stability and optimal production growth conditions for their members. There is also evidence that they seek to increase prices paid to members and enhance farmers' income (Bonus, 1986; Sexton, 1986; Staatz, 1987; Sexton; Iskow, 1988; Bialoskorski Neto, 2000; Valentinov, 2007).

A few papers have empirically investigated cooperative effects on prices, production and profitability, mainly for the United States agricultural sector and other countries. They have found evidence of a positive effect of cooperative membership on farms income. For Brazil, a few studies have indirectly found a positive effect of cooperative membership on agricultural

[1] This policy seeks to enhance cooperative management. A literal translation is "Agricultural Cooperatives' Recovery Program".
[2] In this paper, agricultural establishments are named farms.

technical efficiency (Helfand and Levine, 2004; Freitas *et al.,* 2014). In this paper, we estimate the effect of cooperative membership on farms profitability, output supplies and input demands using the Agricultural Census of 2006 for the South and Southeast regions of Brazil. We use a quadratic normalized restricted profit function as in Huffman and Evenson (1989) to estimate these effects.

Our analysis will allow policy makers to design and evaluate policies towards cooperative performance enhancements. We have considered corn, soybean, sugarcane and milk, which represents more than 65% of agricultural production value in these regions. In this version, we use the share of producers that are cooperative members as a proxy for cooperative membership[3]. Preliminary results suggest a positive effect of cooperatives on agricultural profits for most of municipalities in the South and Southeast regions of Brazil. We have found a positive effect of cooperatives membership on commodity supplies and input demands. Our results suggest that if the number of farmers members of a cooperative increase 5% we would observe a rise of 7% on milk supply.

BACKGROUD

The Agricultural Census of 2006 reported 5.2 million farms in Brazil, 37% in the South and the Southeast regions but these regions produced 59% of the national agricultural production (IBGE, 2016). In these regions, 90% of the farms were smaller than 100 hectares (IBGE, 2016)[4]. Nascimento (2016) suggests that, for Brazil, 70% of these farms are very poor. Sexton and Iskow (1988) argues that agricultural cooperatives can help diminish rural poverty by providing rural

[3] We have estimated using the farm scale data available at the IBGE headquarters but we have not obtained the results yet.
[4] Information on value of production, number of agricultural establishments (farms) and the number of them that is smaller than 100 hectares can be found on Table 836 of the SIDRA/IBGE (https://sidra.ibge.gov.br/tabela/836).

extension and other services. These cooperatives have a remarkable role on the dissemination of new technologies for crop production (planting, harvesting and post-harvest) processes in Brazil (Cechin, 2014).

Brazil has a long history of public policies toward cooperatives. During the 1970s and 1980s, Brazilian government used cooperatives to implement policies focused on providing rural extension and more access to domestic and international markets. At the transition of the 1980s to the 1990s, the government stopped using this strategy. The number of cooperatives in this sector faced a downfall affecting their members (Presno, 2001; Bialoskorski Neto, 2005). On the 2000s, the government carried on programs that incentivized cooperatives to do investments, managerial improvements, and to overcome their weakened financial situation. Current policies have been focused on strengthen the relation market-farmers.

Three policies have contributed to cooperative expansion in Brazil. Established in 1998, the RECOOP sought to extend cooperatives debt payments and to conceive the SESCOOP (National Cooperatives' Learning Service), which is a reliable source of information for cooperatives in Brazil. The PRODECOOP[5] took place in 2003 and focused on improving cooperatives competitiveness by incentivizing production modernization. Since 2009, the PROCAP-AGRO have sought to recover and restructure the agricultural cooperative assets by encouraging members to give more contributions.

These policies also have sought to overcome market oscillations effects on agricultural performance. The commodity price crisis occurred in 2001 have led to a sharp decrease on the number of cooperatives in Brazil. Its recover was observed only in 2004 (OCB, 2014). Figure 1

[5]Cooperative Development Program for Value Aggregation Agricultural Production (Programa de Desenvolvimento Cooperativo para Agregação de Valor à Produção Agropecuária - PRODECOOP) and Agricultural Cooperatives' Capitalization Program (Programa de Capitalização das Cooperativas Agropecuárias - PROCAP-AGRO).

displays this information. It occurred because of the increase on farms and cooperatives debts. After recovering from the crisis, the number of members exceeded 1 million farmers in 2013 (OCB, 2014).

[Figure 1]

Cooperatives have a strong presence on several commodity markets in Brazil; e.g. 74% of wheat, 57% of soybeans, 48% of coffee, 44% of cotton, and 43% of corn production reaches the market through cooperatives (OCB, 2011; OCB, 2013; OCB, 2014). Milk production also has high participation of cooperatives, around 40%, although it has been observed a decline on milk production (Chaddad, 2011). In the input side, members of cooperatives use higher level of pesticide, 76% higher than non-members, and fertilizer, 65% higher than non-members (IBGE, 2012).

Number of cooperatives members is also clustered in the South and Southeast regions of Brazil, as the agricultural production. See Table 1. Around 32% of the farmers are members of cooperatives in the South region, followed by the Southeast region, 18% (IBGE, 2012). These values are higher than the national average, of 14%. We also observed that larger farms – with more than 1000 hectares – have a higher percentage of members, around 39% of the farms in the South region (IBGE, 2012). The South and Southeast of Brazil comprise seven states, where Minas Gerais was the largest state producer accounting for 27% of the total Agricultural *Gross Domestic Product* of these two regions, Rio Grande do Sul with 22%, and Sao Paulo with 17% (IBGE, 2012).

There are several factors that have contributed to agricultural development of these regions, such as infrastructure, distance to consumer market and climate and soil characteristics (Helfand; Brunstein, 2001). Higher productivity on coffee, rice, and sugarcane production are observed in these regions due to climate and soil characteristics, compared to other regions. Corn, soybean, sugarcane and milk represent 65% of the agricultural production value generated in these regions (IBGE, 2016).

[Table 1]

Although there is evidence that cooperatives have contributed to improve agricultural performance in Brazil, there are few papers that have investigated directly this topic. Bialorskosky Neto (2006) uses a simple linear regression model to investigate this topic. He finds evidence that cooperatives increase farmers' income in the state of São Paulo. On the other hand, a few papers that have indirectly studied this topic, applying methods such as Stochastic Frontier (Freitas *et al.*, 2014; Galawat; Yabe, 2012) and Data Envelopment Analysis (Helfand; Levine, 2004). Overall, these papers identify higher technical efficiency among cooperative farmers compared to non-cooperative farmers.

A few papers have empirically investigated this topic for the United States agricultural sector. McNamara *et al.* (2001) have investigate how cooperatives affects agriculture in Colorado and Indiana using input-output matrix analysis. Their findings suggest a positive effect of cooperatives on jobs and income. Folsom (2003) also uses this methodology to investigate this topic for the state of Minnesota. Their results indicate that cooperatives generate a positive effect on agricultural production. Jardine *et al.* (2014) investigate the effects of a fishermen's cooperative in Alaska using a difference-in-differences estimation strategy. They find that the cooperative was able to improve fishery quality and prices, in addition to overcome market failures.

Milford (2004) finds evidence of higher price paid to producers by cooperatives for coffee in Mexico. She also finds that cooperatives have a pro-competitive effect on producers. Cazzuffi

(2013) uses a propensity score matching method to investigate this topic for Italy. Her findings suggest a positive effect of cooperative membership on prices and that is associated with higher access to technical assistance. Bernard *et al.* (2008) and Rodrigo (2012) investigate cooperative effects in the rural area of Ethiopia estimating agricultural total factor productivity. They find a stronger effect of cooperatives among non-poor farmers.

In this paper, we estimate the effect of cooperative membership on farm profit, output supplies and input demands using a restricted profit function at municipality scale. This will allow to evaluate policies implemented by the government to promote agriculture through cooperatives.

THEORETICAL FRAMEWORK

There is a widespread literature on the estimation of restricted profit function. The latter function represents the profit in the short run where some of the inputs have little or zero mobility during a short period, which implies time and cost to adjust (Huffman; Evenson, 1989), named quasi-fixed inputs. We model cooperative membership as a quasi-fixed input since it affects commodity supply but it is not flexible as labor given some conditions that the farmer must be fulfill to become a member[6].

According to Lau (1976), a multi-output and multi-input production can be represented considering y_i, $i = 0, 1, \dots, n + m$, as vector of inputs and outputs. y_0 represents the normalized output, $y_i > 0$, $i = 0, 1, \dots, n$ the *n* outputs, and $y_i < 0$, $i = n + 1, \dots, n + m$ the m inputs. The quasi-fixed factors such cooperative membership are represented by z_k, where $z_k \geq 0$, $k = 1, \dots, K$. A normalized restricted profit function is $\pi = F(p_1, \dots, p_n, p_{n+1}, \dots, p_{n+m};\ z_1, \dots, z_K)$

[6] See Shumway (1988), Huffman and Evenson (1989), Fulginiti; Perrin (1990) and Schuring *et al.* (2011) for application of this framework.

where $p_i = P_i/P_0$, P_0 represents the price of the normalize output y_0, and P_i is the nominal price of each other input and output y_i, $i = 1, \dots, n + m$.

$$\pi = F(\boldsymbol{p}, \boldsymbol{z}) \tag{1}$$

where π is the normalized restricted profit ($\pi = \pi'/P_0$, where π' is the nominal profit), p is a vector of $n + m$ normalized prices, and z is a vector of K quasi-fixed inputs. The normalized restricted profit function is homogeneous of degree one with respect to prices (which is imposed by dividing by one of the prices), non-decreasing in output prices and non-increasing in input prices (monotonicity in inputs and outputs), symmetric (which is also imposed in the estimation), and is convex in prices (second order derivatives matrix is positive semidefinite).

Once we normalized the restricted profit function by one of the output/input prices, we can obtain the numeraire supply/demand by

$$\frac{\partial \pi}{\partial p_0} = y_0^* = \pi^* - \sum_{j=1}^{n+m} p_i \, y_i^* \tag{2}$$

The cooperative membership effect on the profit can be obtained as

$$\lambda_k = \frac{\partial F}{\partial z_k} = \lambda_k(\boldsymbol{p}, \boldsymbol{z}), k = 1, \dots, K \tag{3}$$

where λ_k is also known as the shadow price of z_k (Huffman; Evenson, 1989; Nadiri, 1982). It can also be translated to an elasticity

$$\epsilon_{yz} = \frac{\partial y_i^*}{\partial z_k} \cdot \frac{z_k}{y_i^*}, k = 1, \dots, K; i = 1, \dots, m + n. \tag{4}$$

DATA AND EMPIRICAL MODEL

Data

We use data from the Brazilian Agricultural Census of 2006 at municipality scale for the South and Southeast regions of Brazil. We observe 2130 municipalities (1074 in the South and 1056 in the Southeast of Brazil), controlling for outliers. Helfand *et al.* (2015) also control for outliers using the Ag. Census of 2006. Table 2 displays descriptive statistics for the entire sample.

[Table 2]

(i) Outputs:

We defined the outputs to use in our model based on the total value of production of crops and livestock products. Four outputs were chosen: soybean, milk, sugarcane and corn; which represented 65% of the agricultural gross value of production in the South and Southeast of Brazil in 2006. Figure A1, in the Appendix, illustrates the spatial distribution of these outputs.

(ii) Inputs:

- Labor: the average wage (price) of hired workers was calculated by the ratio of annual expenditure and the number hired workers. In the Agricultural Census of 2006, the latter measure is estimated in as a weighted measure that consider differences between adult males, women and children. Thus, the estimated average wage (price of hand-labor factor) take into account these differences.
- Fuel: it is the sum in tons of alcohol, charcoal, gas (LPG), gasoline, and diesel. They were converted to tons using the information on Petrobras (2015). Fuel prices were calculated by dividing total expenditure on fuels by the fuel quantity in tons.

(iii) Fixed Factors:

- Irrigated area: it is measure in hectares. The cost of implementation and its maintenance is not available in the Agricultural Census 2006, thus area irrigated was considered as a quasi-fixed input.

- Family labor: it includes rural landowners and their relatives which work in the farm[7]. It is included as a quasi-fixed input given that it does not adjust in the short-run.

- Cooperative Membership: it was considered as a quasi-fixed input given that it might be necessary to incur in costs to become a member, and the existence of pre-establish contracts on commodity supply imposes a restriction on the flexibility of the membership. To measure this variable we use a proxy, the share of farmers that have answered "yes" to the question "are you a member of a cooperative?". On average, 24% of our sample answered yes to this question. These values ranges from zero to one, and has a higher average for the South (32%) than for the Southeast (18%) region of Brazil. Figure 2 illustrates the geographical distribution of this variable. We observe greater proportion of farmers that are members in states where agriculture has a larger role in economy and are more socio-economic developed.

[Figure 2]

Empirical Estimation

We approximate the restricted profit function (Eq. 1) using a quadratic[8] function[9] form as in Schuring *et al.* (2011) for each municipality $s = 1, \ldots, 2130$ (subscript for municipality s is dropped hereafter for simplicity)

[7] The Agricultural Census also calculates a weighted measure to account for differences in the labor with respect to adult male, female and child as the hired labor.

[8] For more details about these functional forms, see Diewert (1974), Lau (1976) and Diewert (1971). Chambers *et al.* (2013) indicated that the quadratic normalized is superior than the other functional forms using a Monte Carlo simulation.

[9] For more details about this approach, see Lau (1976) and Nadiri (1982).

$$\pi = \alpha_0 + \sum_{i=1}^{n+m} \alpha_i \, p_i + \sum_{k=1}^{K} \gamma_k \, z_k + \frac{1}{2} \sum_{i=1}^{n+m} \sum_{j=1}^{n+m} \beta_{ij} \, p_i p_j + \frac{1}{2} \gamma_{kl} z_k z_l + \sum_{i=1}^{n+m} \phi_{ik} \, p_i z_k + \varepsilon_\pi \tag{5}$$

where p_i represents the normalized prices of *n* outputs and *m* inputs, *i* = *n*+*m* outputs and inputs (*netputs*), z_k represents the quasi-fixed inputs, and ε_π represents the random error. We only included a quadratic term, among the quasi-fixed inputs, for the cooperative membership. It was also the only quasi-fixed input that interacts with prices[10]. The restricted profit function was modeled using corn, soybean, sugarcane and milk as variable outputs, labor and fuel as variable inputs, and cooperative membership, family labor and irrigated area as quasi-fixed inputs. Using Hotteling lemma we can find commodity supply and input demand as

$$\begin{aligned} \frac{\partial \pi}{\partial p_i} &= y_i^* = \alpha_i + \sum_{j=1}^{n+m} \beta_{ij} \, p_j + \phi_{ik} z_k + \varepsilon_{y_i} \\ -\frac{\partial \pi}{\partial p_j} &= y_j^* = \alpha_j + \sum_{i=1}^{n+m} \beta_{ji} \, p_i + \phi_{ik} z_k + \varepsilon_{y_j} \end{aligned} \tag{6}$$

where the first equation represents supply and the second demand, and ε_{y_i} and ε_{y_j} represent random errors for these equations.

A system of equations considering equation (5) and five (4 outputs and one input – corn, milk, soybean and sugarcane as output and fuel as variable input) equations represented in equations (6) were estimated using an *Iterated Three Stage Least Square* (I3SLS). The hired labor was used as a normalizer price on the estimation and its demand can be recover using the homogeneity property represented by equation (2) on the theoretical framework

$$y_0^* = \alpha_0 + \sum_{k=1}^{K} \gamma_k \, z_k - \frac{1}{2} \sum_{i=1}^{n+m} \sum_{j=1}^{n+m} \beta_{ij} \, p_i p_j + \frac{1}{2} \gamma_{kl} z_k z_l \tag{7}$$

[10] We have opted for not including all quadratic terms due to potential multicollinearity issues.

Symmetry and homogeneity were imposed on the estimation but monotonicity was checked after. The own-price elasticity can be estimated as

$$\epsilon_{pi} = \frac{\partial ln y_i}{\partial ln p_i} = \frac{\partial y_i^*}{\partial p_i}\frac{p_i}{y_i^*} = \beta_{ii} \cdot \frac{p_i}{y_i^*} \tag{8}$$

where for outputs have to be positive reflecting the positive slope of a supply curve, and for an input it has to be negative reflecting the negative slope of a demand. Cross-price elasticity can be found as

$$\epsilon_{yipj} = \frac{\partial ln y_i}{\partial ln p_j} = \frac{\partial y_i^*}{\partial p_j} \cdot \frac{p_j}{y_i^*} = \beta_{ij} \cdot \frac{p_j}{y_i^*} \tag{9}$$

where theoretically we do not expected[11] a specific sign.

To identify the impact of cooperative membership on profit we take the first derivative of the restricted profit function with respect to this variable[12]

$$\lambda_k = \frac{\partial \pi}{\partial z_k} = \gamma_k + \gamma_{kl} z_k + \sum_{i=1}^{n+m} \phi_{ik}\, p_i, \qquad k = 1, \dots, K \tag{10}$$

where λ_k represent the monetary gain/loss occurred by a marginal change on the quasi-fixed input, which it translates to a monetary return of cooperative membership ***proportion*** for each municipality. The supply/demand elasticity with respect to a quasi-fixed input can be found as

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[11] These elasticities can also be calculated for the normalized input demand, respectively as

$$\epsilon_{00} = \frac{\partial ln y_0^*}{\partial ln p_0} = \frac{\partial y_0^*}{\partial p_0} \cdot \frac{p_0}{y_0^*} = \left[\sum_{i=1}^{n+m}\sum_{j=1}^{n+m} \beta_{ij}\frac{p_i p_j}{p_0^2}\right] \cdot \frac{p_0}{y_0^*} = \left[\sum_{i=1}^{n+m}\sum_{j=1}^{n+m} \beta_{ij} p_i p_j\right] \cdot \frac{1}{y_0^*} \tag{1a}$$

$$\epsilon_{i0} = \frac{\partial ln y_i^*}{\partial ln p_0} = \frac{\partial y_i^*}{\partial p_0} \cdot \frac{p_0}{y_i^*} = \left[-\sum_{i=1}^{n+m} \beta_{ij}\frac{p_j}{p_0^2}\right] \cdot \frac{p_0}{y_i^*} = -\frac{1}{y_i^*}\sum_{i=1}^{n+m} \beta_{ij}\, p_j \tag{2a}$$

$$\epsilon_{0j} = \frac{\partial ln y_0^*}{\partial ln p_j} = \frac{\partial y_0^*}{\partial p_j} \cdot \frac{p_j}{y_0^*} = \left[-\sum_{j=1}^{n+m} \beta_{ij} p_i\right] \cdot \frac{p_j}{y_0^*} \tag{3a}$$

where equation (1a) represents own-price elasticity, equation (2a) and (3a) the cross-price elasticity between non-normalized output and normalized output. As previously assigned, we expect a negative sign of the own-price elasticity since it is an input demand.

[12] See Lau (1976), McKay *et al.* (1983) and Huffman and Evenson (1989) for quasi-fixed input effect on profit.

$$\epsilon_{yizk} = \frac{\partial ln y_i^*}{\partial ln z_k} = \frac{\partial y_i^*}{\partial z_k} \cdot \frac{z_k}{y_i^*} = \phi_{ik} \cdot \frac{z_k}{y_i^*} \quad (11)$$

All procedures were done using Stata 14 with the code *reg3*. The elasticities and the cooperative membership effect on profit were obtained using *predictnl* and *nlcom* commands while the standard errors are obtained using the Delta method.

RESULTS AND DISCUSSION

A system of equation was estimated using I3SLS where the quadratic restricted profit function [equation (5)], the supply of corn, milk, sugarcane and soybean, and the demand of fuel [equations (6)] were in the system. Hired labor price was used as normalizer price and did not have an equation to be estimated[13]. Overall[14], the estimation presents a good fit. Most of the coefficients were statistical significant (around 70% of the coefficients were significant at 10%); monotonicity[15] was satisfied in at least 90% of the observations within outputs/inputs directly estimated in the system of equation.

On the average, own-price elasticities have shown the correct sign[16]. Elasticities were estimated using equation (8) and (9). Table 3 displays the results. Own price elasticity of soybean, milk, and hired labor are statistical significant at 1%. An increase of 10% on soybean price would lead to an increase of its supply by 1.7%. Castro (2008) estimates a profit function for Brazil (not per municipality, which is more aggregated) and finds a significant own-price

[13] For system estimation results, see Table A1.
[14] Breusch-Pagan test indicated 3SLS estimation over separately Ordinary Least Square (OLS) equations estimation.
[15] Monotonicity property was satisfied in 93% of the observations for soybean (positive output supply), 99% of the observations for milk, 99% of the observations for sugarcane, 100% of the observations for corn, and 100% of the observations for fuel demand (negative demand). For the numeraire, hired labor demand, this result was lower, only 33% of the observations satisfied it.
[16] We present them as the average of the observations that satisfied monotonicity.

elasticity for soybean of 0.57, three times higher than our estimate. Figueiredo (2002) does not find statistical significant and positive elasticity.

[Table 3]

For this hired labor, an increase of 10% on wage would lead to a decrease on its demand of 4.8%. Labor was used as the normalized price and we also use family labor as a quasi-fixed input. On the literature, there is no consensus on the estimative of this elasticity. Figueiredo (2002), Disch (1983) and Castro (2008) find -0.34, -0.42 and -2.96, respectively. The sign of cross-price elasticity corroborates the estimates on the literature. Soybean and corn are complements, as in Castro (2008).

As expected, inputs prices lead to a decrease on soybean supply; i.e. an increase of 10% on fuel prices would lead to a reduction of 6% on soybean supply. Our soybean elasticity with respect to labor price estimate, of -1.07, is similar to Figueiredo (2002), of -1.59. Castro (2008) and Disch (1983) also found a negative effect but lower. A similar result is obtained for most of the output supplies with respect to labor and fuel.

Our results suggest that corn, milk, and sugarcane are complements. Figueiredo (2002) also found complementarity between milk and corn. Elasticities estimates indicates a decrease on fuel demand due to increase on corn, milk and labor prices, which means that labor and fuel are complements.

Cooperative membership effects

To evaluate the impact of cooperative membership on profit and commodities supply we have used equations (10) and (11). We observed a greater effect on soybean, elasticity of 0.98 while corn, milk and sugarcane displayed an elasticity of 0.05, 0.34, 0.27, respectively. For example, an increase of 10% on average cooperative membership variable, equivalent to 0.024 or an increase of 2.4% on the proportion of members, would generate an increase of 3.4% on milk supply. Sugarcane elasticity with respect to cooperative membership was not significant. A positive elasticity was also found for the inputs, suggesting that as the number of farms that are members increase more inputs are used in the municipality.

The effect of cooperative membership on profit was obtained using equation (10), evaluated at the overall mean of the variables. It is the first derivative of the normalized restricted profit with respect to the cooperative membership variable. Our estimate indicates a positive effect of cooperative membership on profits. Figure 3 displays the histogram[17] of the marginal effect estimated for each region. On average, this effect was of around US$ 1,918.27[18]. It is statistically significant at 1%, which corroborates our hypothesis that cooperative membership affects positively the profits, at least for these two regions. On average, the South region have shown a smaller effect, of US$ 1,677.07, while for the Southeast was US$ 1,991.31 for the Southeast, both statistically significant at 1%. Average prices have played an important role on this effects estimate. Figure 4[19] displays the geographic distribution of this effect. Our results suggest that cooperative membership affects agricultural profit not only in municipalities with high number of members.

[Figure 3]

[Figure 4]

[17] The histogram is obtained using observed data on prices and cooperative membership for each municipality instead of evaluated at the mean.

[18] This value was obtained using the average of normalized prices and cooperative membership. In R$, for the normalized price y_1 the average was 0.072, for y_3 was 0.91, y_4 was 0.042, y_5 was 0.43, y_6 was 0.066. For the cooperative membership, the average was 0.24. After evaluating Equation (10) at these values we divide by 2.17 to obtain this value in US$.

[19] As Figure 3, these values were obtained using observed data for the variables instead of evaluating at the mean.

Using the average supplies and prices displayed in Table 2 we can estimate an average profit per municipality (multiplying quantity by prices, then subtracting the revenue from the cost) of around US$ 3,23 million. Although statistically significant, the cooperative membership proportion was responsible for less than 1% of this profit. Assuming that this average effect represents all municipalities, we find a total effect of almost US$ 4.1 million (= US$ 1,918.27 x 2130)[20] for the South and Southeast region. This is a yearly gain given we have data only on 2006.

Effectively, RECOOP[21] has implemented almost US$ 370 million from 1998 to 2002[22] for the entire Brazil. This investment was also directed to agricultural cooperatives instead of their members while our estimative, of US$ 20.5 million (= US$ 4.1 million x 5 year), is an indirect effect of this policy (at current level of cooperatives). It is important to consider that RECOOP's main focus was the financial restructuration of agricultural cooperatives. The impact on profit shows that the recovery provided by this policy also contributed to the increase in economic performance of its members.

The effect of cooperative membership on profit varies according to the characteristics of the agricultural activities of each municipality and region. As shown in Figure A1 (in the appendix), milk production is concentrated in the state of Minas Gerais and in the northwest of the South region of Brazil. On the other hand, soybean is mainly produced in the South. Sugarcane production is concentrated in São Paulo, where large cooperatives operate directly linked to industrial plants that produce anhydrous alcohol. Most of sugarcane production is allocated to

[20] If we sum all municipality's profit instead of looking at the average, we find a profit of almost US$ 8,8 billion and a gain from cooperative (evaluated at the observed cooperative membership variable) of US$ 3,5 million.
[21] We do not analyze PROCAP-AGRO effects because it was created only in in 2009, after 2006 Census.
[22] This information can be found at "https://www.milkpoint.com.br/cadeia-do-leite/giro-lacteo/cooperativas-querem-continuidade-do-recoop-14954n.aspx".

own-capital firms, which may explain why the effect of cooperative membership on sugarcane was not significant. The effect of cooperative membership is greater in the South region where corn and soybean are predominantly produced. In the Southeast, greater effects are observed where milk and sugarcane production are larger. See Figure 4 and Figure A1.

CONCLUSION

This paper provides some preliminary empirical evidence about the cooperatives membership effect in the Brazilian South and Southeast regions. To evaluate this effect we estimate a restricted profit function, commoditiy supplies for corn, soybean, milk and sugarcane, and input demand for labor and fuel at municipality scale using the Agricultural Census of 2006 for these regions. This system was estimated using *Iterated Three Stage Least Square* (I3SLS).

Our results suggest that cooperative membership affects both commodity supplies and input demands. A greater proportion of farms that are members of a cooperative would lead to an increase in the supplies of soybean, corn, and milk, in addition to an increase on input demands for labor and fuel. It also indicates that the current level of cooperative membership leads to an increase on profit of US$ 1,918.27. We estimate a yearly monetary gain from cooperative membership of US$ 4.1 million using this average effect for all municipalities in the South and Southeast region.

These findings can be of use to evaluate the effect of cooperatives on agricultural production when designing public policies toward these institutions. It is an ongoing research. In the next step, we are evaluating this issue in a farm scale data using the Ag. Census of 2006.

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Figures and Tables

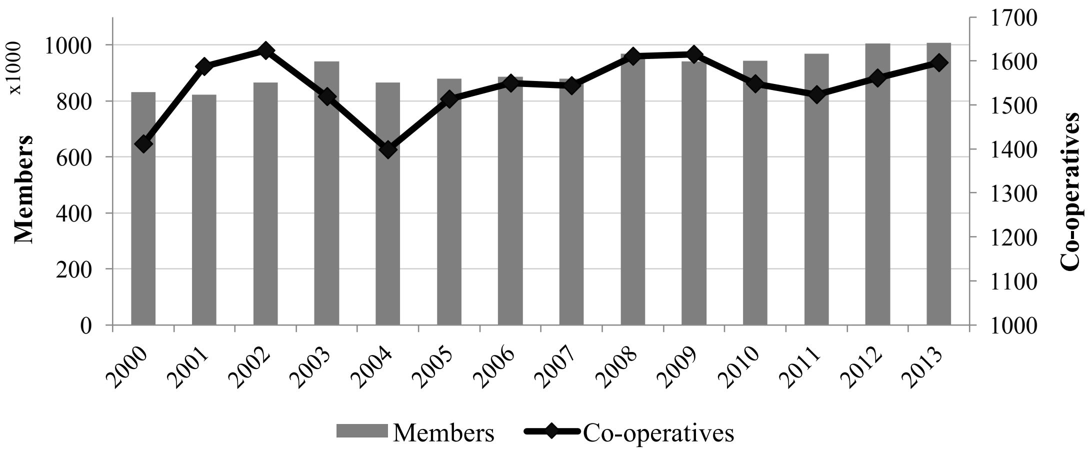


Figure 1. Number of OCB affiliated cooperatives and of cooperatives members, Brazilian agricultural sector, 2000 to 2013
Source: OCB (2011) and OCB (2014).

Table 1 - Percentages of farms, farms associated to cooperatives and Gross Value of Production (GVP), Brazilian regions, 2006

	North	Northeast	Southest	South	Midwest	Brazil
Farms[1]	9	47	18	19	7	**100**
Gross Value of Production[1]	6	17	32	27	18	**100**
Associated to Cooperatives[2]	3.8	4.3	18	31.9	12	**14.4**

Notes: [1] Percentages obtained considering the participation of each region in the total.
[2] Percentage obtained considering the proportion of associated farms in each region and in Brazil.
Source: IBGE (2012).

Table 2 - Overall descriptive statistics of outputs and inputs for municipalities in South and Southeast of Brazil in 2006

Variables	**Mean**	**St. Devi.**	**Minimum**	**Maximum**
Quantities[1]				
Soybean (y1)	8,048.00	42,437.61	0	90,283.00
Labor (y2)	297.02	486.24	0	10,234.00
Milk (y3)	113.47	140.82	0	1,134.60
Sugarcane (y4)	51,733.94	317,397.9	0	7,329,973.00
Fuel (y5)	502.69	1,022.1	0	22,345.30
Corn (y6)	7,280.83	25,619.37	0	583,490.00
Prices[2]				
Soybean (p1)	48.18	91.76	0.00	557.18
Labor (p2)	4,207.31	30,667.65	0.00	1,765,418.43
Milk (p3)	211.74	152.27	0.00	887.80
Sugarcane (p4)	68.66	147.93	0.00	1,376.96
Fuel (p5)	924.53	1,283.13	0.00	7,533.64
Corn (p6)	158.78	97.80	0.00	1,585.06
Fixed Factors				
Irrigated Area (z2)[3]	646.85	3,172.76	0	59,457.30
Cooperative membership rate (z4)	0.24	0.22	0	1.00
Family Labor (z6)[4]	1,479.17	1,608.66	0	24,278.00
Nº Observations		**2,130**		

Notes: [1]Value in Tons for y1, y3, y4, y5 and y6. Value in number of workers, weighted by age and gender of workers for y2. [2]Value in US$; average exchange rate in 2006, R$ 2.17 / US$. [3]In Hectares (ha), 1 ha = 2.47 Acres. [4]Number of workers, weighted by age and gender of workers.
Source: Own elaboration.

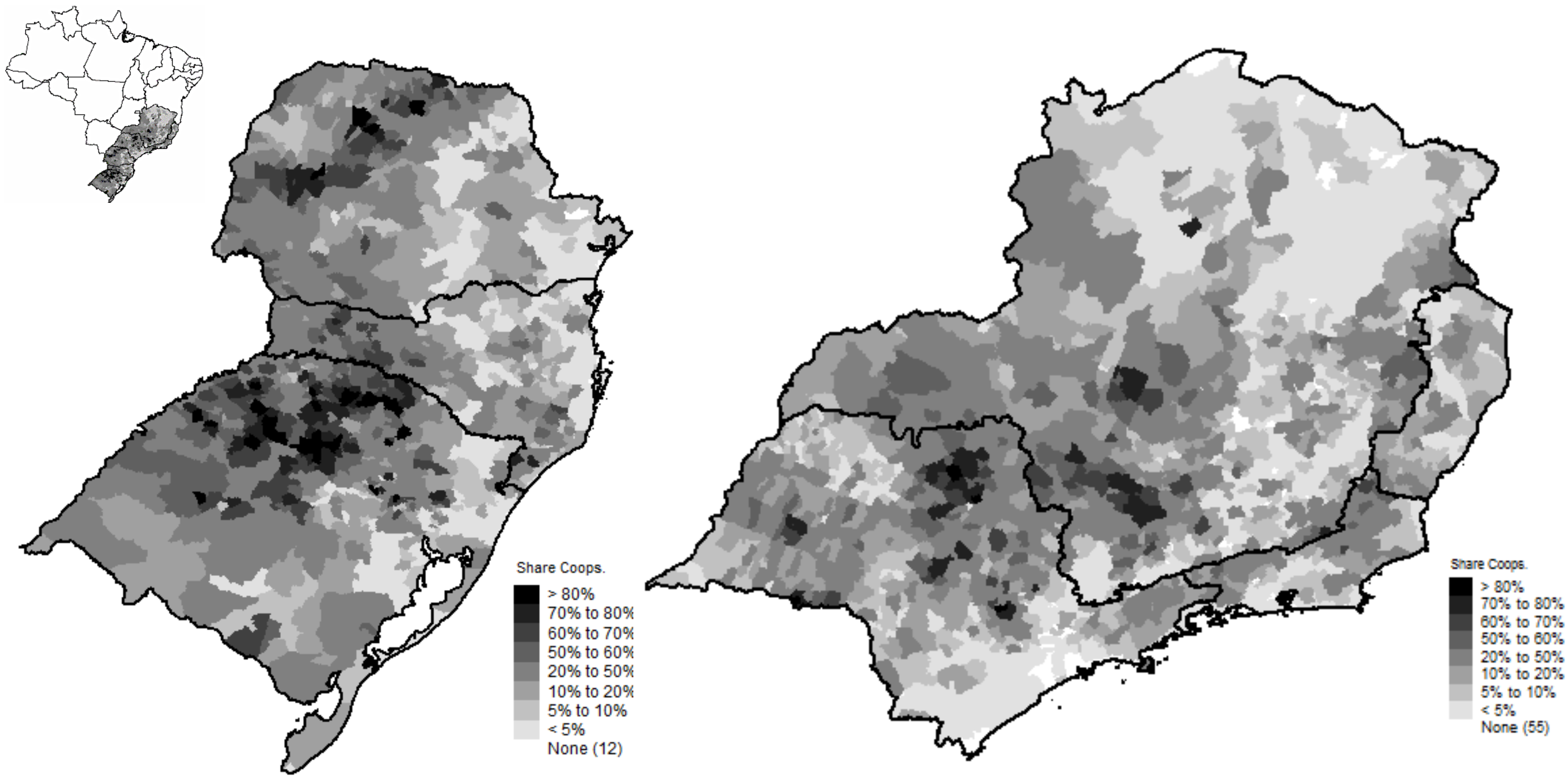


Figure 2 - Cooperatives share of members per municipality in regions South and Southeast, Brazil, 2006.
Source: own elaboration from IBGE (2009)

Table 3 - Own and cross price elasticity of demand and supply for selected product of the South and Southeast region of Brazil in 2006

		Prices					
		Soybean	**Milk**	**Sugarcane**	**Corn**	**Fuel**	**Labor**
Quantity	**Soybean**	**0.1708** **(0.017)**	0.0276 (0.002)	-0.1778 (0.110)	1.668 (0.258)	-0.617 (0.097)	-1.071 (0.311)
	Milk	0.132 (0.011)	**0.430** **(0.03)**	0.025 (0.119)	0.175 (0.149)	-0.283 (0.041)	-0.470 (0.076)
	Sugarcane	-0.151 (0.094)	0.003 (0.001)	**0.033** **(0.037)**	0.378 (0.419)	0.040 (0.064)	-0.446 (0.1972)
	Corn	0.087 (0.013)	0.002 (0.0001)	0.038 (0.018)	**0.032** **(0.098)**	-0.103 (0.027)	-0.056 (0.104)
	Fuel	0.045 (0.007)	-0.036 (0.003)	0.177 (0.11)	-1.905 (0.295)	**-0.005** **(0.006)**	-0.126 (0.029)
	Labor	1.037 (0.102)	0.112 (0.012)	0.518 (0.233)	9.811 (5.049)	-1.577 (0.443)	**-4.881** **(1.111)**

Note: All elasticities were estimated as the average of only observations that satisfied monotonicity. Standard errors are presented between brackets.
Source: own elaboration.

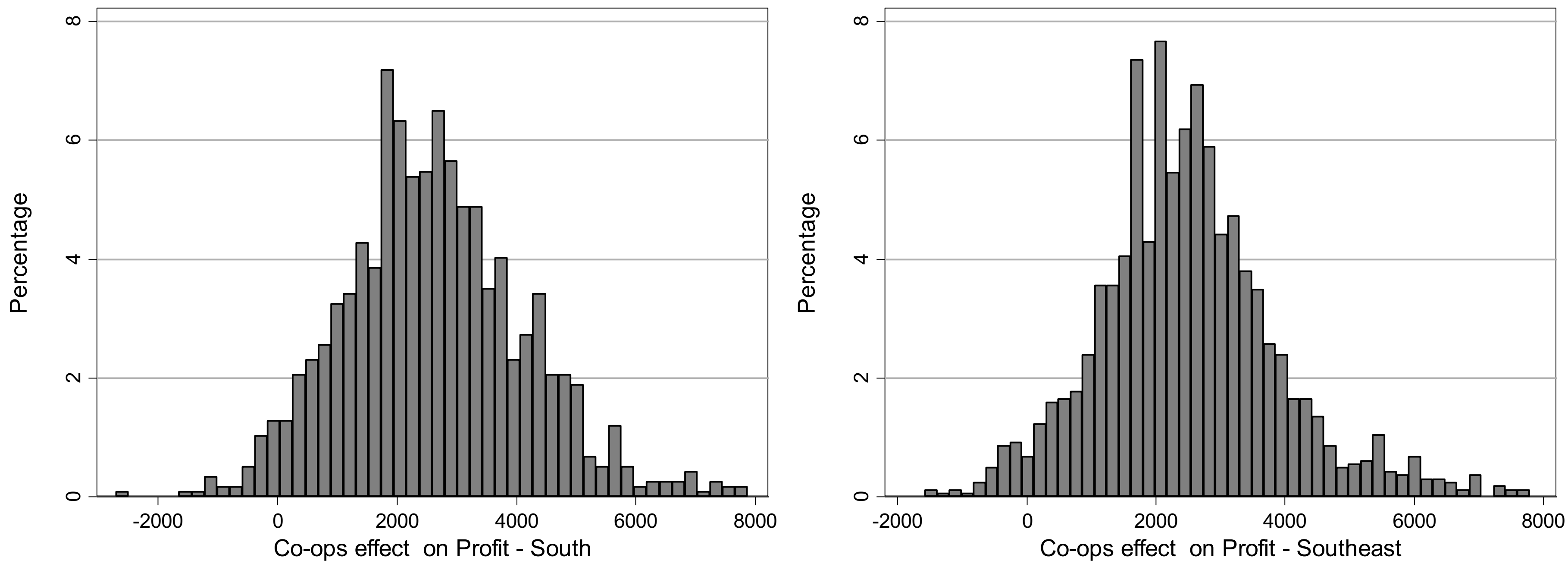
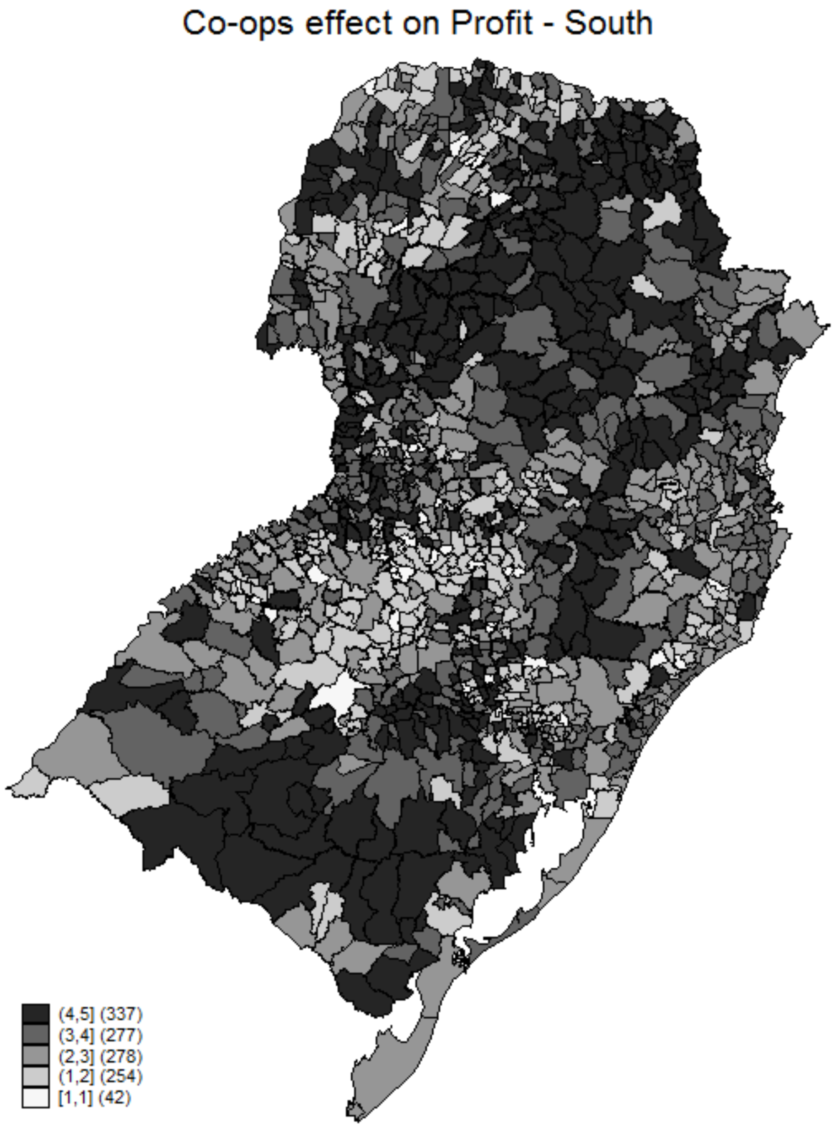


Figure 3 – Histogram of the cooperative membership effect on profit in the South (left) and Southeast (right) of Brazil in 2006.
Source: own elaboration



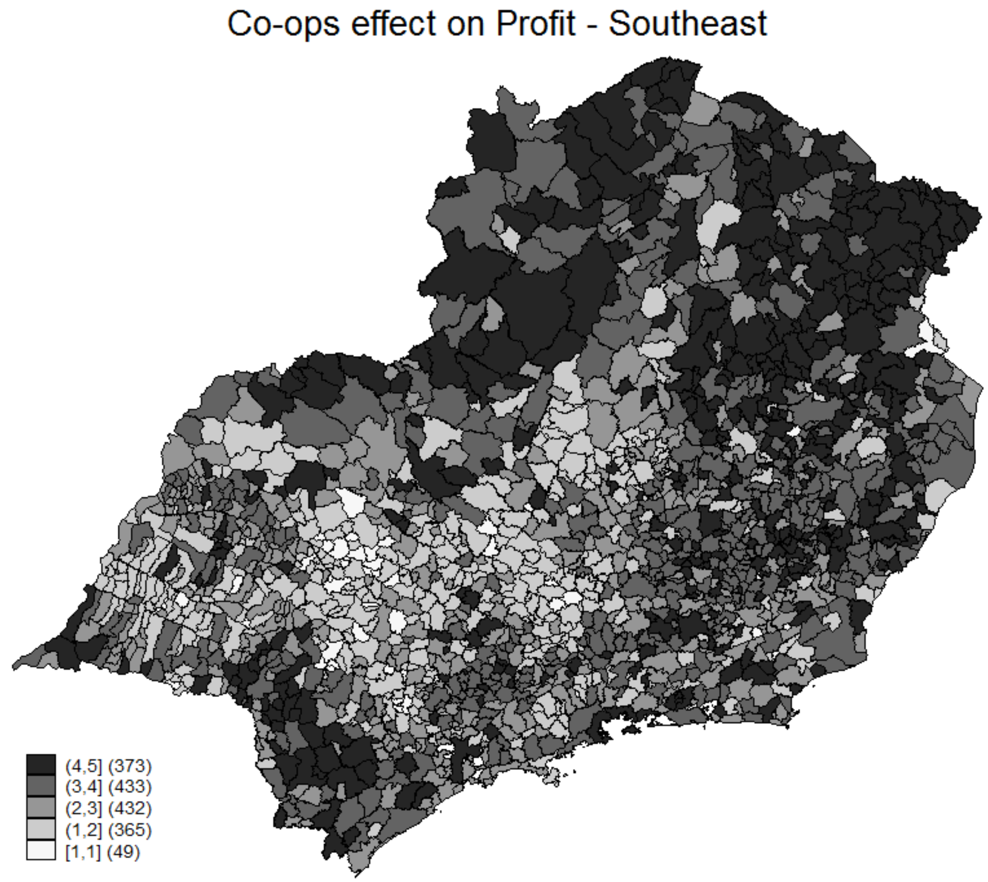


Figure 4 – Estimated normalized shadow price of cooperative membership on profit in the South (left) and Southeast (right) of Brazil in 2006.
Source: own elaboration

APPENDIX

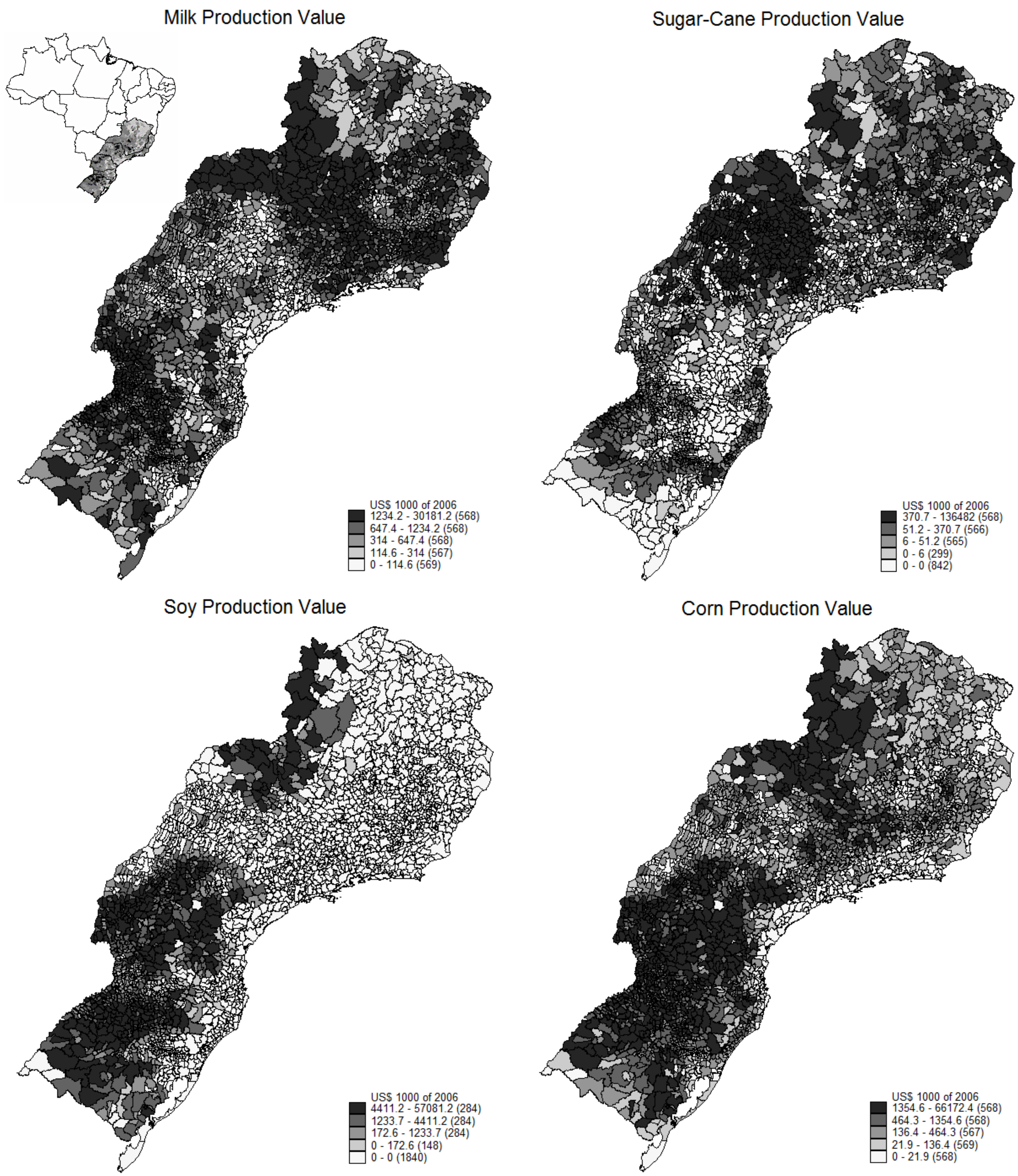


Figure A1 - Production Value of milk, sugarcane, soybean and corn for the South and Southeast of Brazil in 2006 (US$ 1000 of 2006)
Source: IBGE (2009).

Table A1 – Iterated 3SLS parameter estimates for quadratic restricted profit function, four supply and one demand function

	Coefficient	Std. Error		Coefficient	Std. Error
Normalized Restricted Profit			***Corn supply***		
p1n	-1,357.538*	725.425	*p3n*	419.813***	140.931
p3n	41.663***	5.988	*p1n*	68,824.710***	10,658.640
p4n	878.387	1,417.397	*p4n*	21,593.100**	10,271.250
p5n	-235.905***	46.774	*p5n*	-3,155.457***	821.412
p6n	6,234.122***	934.675	*p6n*	6,532.886	20,472.520
p1n2	108,988.300***	11,062.750	*z4*	17,673.390***	2,192.157
p3n2	761.893***	51.796	*Cons*	6,234.122***	934.675
p4n2	4,074.695	4,633.249	***Milk supply***		
p5n2	24.666	32.337	*p3n*	761.893***	51.796
p6n2	6,532.886	20,472.520	*p1n*	862.268***	74.398
p1np3n	862.268***	74.398	*p4n*	121.321**	53.820
p1np4n	-12,771.050	7,900.475	*p5n*	-64.666***	9.523
p1np5n	-3,559.165***	564.373	*p6n*	419.813***	140.931
p1np6n	68,824.710***	10,658.640	*z4*	21.250*	11.741
p3np4n	121.321**	53.820	*Cons*	41.663***	5.988
p3np5n	-64.666***	9.523	***Soybean supply***		
p3np6n	419.813***	140.931	*p3n*	862.268***	74.398
p4np5n	287.390	461.158	*p1n*	108,988.300***	11,062.750
p4np6n	21,593.100**	10,271.250	*p4n*	-12,771.050	7,900.475
p5np6n	-3,155.457***	821.412	*p5n*	-3,559.165***	564.373
z4	2,014.561***	429.751	*p6n*	68,824.710***	10,658.640
z42	-4,013.673***	1,138.009	*z4*	27,358.430***	1,826.999
z2	-0.035***	-0.010	*Cons*	-1,357.538*	725.425
z6	-0.020	-0.020	***Sugarcane supply***		
p1nz4	27,358.430***	1,826.999	*p3n*	121.321**	53.820
p3nz4	21.250*	11.741	*p1n*	-12,771.050	7,900.475
p4nz4	4,581.997*	2,753.221	*p4n*	4,074.695	4,633.249
p5nz4	-490.926***	100.453	*p5n*	287.390	461.158
p6nz4	17,673.390***	2,192.157	*p6n*	21,593.100**	10,271.250
Cons	40.980	72.253	*z4*	4,581.997*	2,753.221
			Cons	878.387	1,417.397
			(negative) Fuel demand		
			p3n	-64.666***	9.523
			p1n	-3,559.165***	564.373
			p4n	287.390	461.158
			p5n	24.666	32.337
			p6n	-3,155.457***	821.412
			z4	-490.926***	100.453
			Cons	-235.905***	46.774

Note: p1 - soybean price; p3 – milk price; p4 – sugarcane price; p5 – fuel price; p6 – corn price; z2 – irrigated area; z4 – proportion of cooperative members; z6 – family labor. Numeraire: p2 - labor price.
Significance levels: *** - 1%; ** - 5%; * - 10%.
Source: Own elaboration.