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AGRICULTURAL PRODUCTION IN THE STATE OF RIO GRANDE DO SUL / BRAZIL: AN ANALYSIS FROM THE ESTIMATION OF THE COBB DOUGLAS PRODUCTION FUNCTION

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ABSTRACT

Agribusiness plays a very significant role in the economy of the Brazilian state of Rio Grande do Sul because it generates jobs and income in rural and urban areas. The aim of this study was to evaluate the relationship between factors of production and gross output value in farms. Such analysis can underpin policies for maximization of the economic result of agricultural output. Thus, data from the Brazilian Agricultural Census (2006) were used for an estimation of the Cobb-Douglas production function. Among the findings, it is noteworthy that the existing capital within the rural establishments is the variable that accounts for most of the Gross Output Value of Agricultural Production. It was also observed that the returns to scale are decreasing and that the average productivity of factors is not homogeneous across microregions. As a result, this paper underlined the need for further research and public policies that can contribute to the modernization and increased agricultural productivity.

INTRODUCTION

The economy of the state of Rio Grande do Sul, as compared to the economic activity of other Brazilian states, stands out for production in three sectors: primary, secondary and tertiary. Productive activities ensure much of the domestic market supply and make it one of the largest Brazilian exporters. With a Gross Domestic Product (GDP) estimated at BRL 215.86 billion in 2009, Rio Grande do Sul ranked fourth among the highest GDPs in Brazil. The GDP per capita, equivalent to BRL 19,778.39, is greater than the average GDP per capita of Brazil, BRL 16,917.66 (Brasil, 2011). In the 496 towns and cities in the state, 441,467 farms, predominantly small and mid-sized ones, produce food and fiber in an area of approximately 18.9 million hectares and generate employment for 1.07 million rural workers (Brasil, 2009). Investments on the technology used in the production processes of rural establishments were estimated from the cost spent on modern inputs: BRL 1.93 billion on fertilizers, BRL 1.26 billion on soil amendments, BRL 268.27 million on seeds and seedlings, BRL 1.11 billion on pesticides and BRL 893.54 million on salt and feeds, among others (Brasil, 2009). The structure of production and marketing is comprised of 166 agricultural cooperatives joined by approximately 272,882 associates (2010), with sales of BRL 14.94 billion and 30,275 formal jobs (Ocergs, 2012). Agriculture, forestry and silviculture correspond to 68.7% of gross value added of agriculture, while livestock and fisheries account for 31.3%. The economic output of the agricultural sector in Rio Grande do Sul represents 9.9% of total amount in the state, while industrial activity accounts for 29.2% and services, 60.9% (Brazil, 2011). The importance of agricultural production for socioeconomics in the state of Rio Grande do Sul justifies the formulation of public policies to stimulate this sector, but the planning of agricultural policy necessarily depends on solid knowledge of the structure and situation of the productive sector. In this context, the study of factors that influence production can be another tool for planning policies for agribusiness in Rio Grande do Sul. Aligned with these principles, this paper is aimed at estimating the function of

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agricultural production in Rio Grande do Sul and quantifying how much land, work and capital, as factors of production, contribute to generating wealth in the state. The paper is organized as follows: Section 2 shows the materials and methods used. Section 3 presents the results and discussions, including the analysis of elasticities, returns to scale, average productivity of factors and marginal rate of substitution. Finally, Section 4 brings the conclusions.

MATERIALS AND METHODS

Based on the model proposed by Solow (1956), Barbosa (1985), Soares, Silva and Lima (2007), Silva (1996), Gujarati (2006) and Saens, Lobos and Rivera (2008), a Cobb-Douglas production function was adapted (Equation 1) to represent how the factors of production are combined to generate the value of agricultural production of farms in the state of Rio Grande do Sul. After such estimation, economic indicators were developed to support decision-making in the field of economic policy for the rural sector.

$$Y = \alpha_0 X_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} \dots X_k^{\beta_k} \varepsilon \qquad (1)$$

where:

Y = Gross output value of agriculture on farms;
$X_1, X_2, \dots X_k$ = factors of production;
$\alpha_0, \beta_1, \beta_2, \dots \beta_k$ = parameters to be estimated, and;
ε = random error term

For Barbosa (1985), the function under analysis is supposed to present an increasing relationship between amounts and factors of production, be almost concave and have continuous second-order derivatives. Considering these assumptions, the production function for agriculture in Rio Grande do Sul was specified by equation 2, linearized in logarithmic form and estimated by equation 3.

$$Q_i = \alpha L^{\beta_1} W^{\beta_2} K^{\beta_3} \varepsilon_i \qquad (2)$$

$$logQ_i = \alpha_0 + \beta_1 logL_i + \beta_2 logW_i + \beta_3 logK_i + \varepsilon_i \qquad (3)$$

Where:

log Q_i is the logarithm of the Gross Output Value (GOV) of farms in Rio Grande do Sul, in BRL 1,000.00, per microregion;

log L_i is the logarithm of the area used for agricultural production (ha^{-1}) in the microregions of Rio Grande do Sul;

log W_i is the logarithm of the number of employees working on farms in Rio Grande do Sul;

log K_i is the logarithm of the value of the premises, buildings and improvements within farmsin Rio Grande do Sul;

α is the value of the general intercept of the equation;
β_j are the parameters to be estimated.
ε_i is the stochastic error term of the equation.

Estimation of equation 3 allows the analysis of "the technical relationship that assigns to each allocation of factors of production the maximum amount of product obtained from the use of such factors"[our translation] (Barbosa, 1985. P. 219). The following indicators were also calculated: average productivity (AP), marginal productivity (MP), output elasticity (ε_{xi}), returns to scale and marginal rate of substitution of work over capital (MRS), because these indicators are important and should be considered when sectorial policies are planned.$AP$is expressed by the ratio between Gross Output Value and amount of factors Land, Work and Capital. It was measured by Equation 4, given by the ratio of product (*Y*) by factor (*X*), which represents land, work and capital.

$$AP_{xi} = \frac{Y}{X} = \frac{AX_1^{\beta_1} X_2^{\beta_2} \dots X_n^{\beta_n}}{X_i} = AX_1^{\beta_1} X_2^{\beta_2} \dots X_i^{\beta_k - 1} \dots X_n^{\beta_n} > 0 \qquad (4)$$

The marginal physical product, also defined as the ratio between the amount of output (Y) and amount of factor (X) used in production, reflects the variation in Q (Gross Output Value), given a change in the factors Lor W or K. Thus, $MP$is equivalent to the derivative of the production function in relation to each production factor used (Varian, 2006), and it can be measured by the equation 5.

$$MP_{xi} = \beta_i AX_1^{\beta_1} X_2^{\beta_2} \dots X_i^{\beta - 1} \dots X_k^{\beta_k} = \beta_i \left(\frac{Y}{X_i}\right) > 0 \qquad (5)$$

In contrast, output elasticity reflects the percentage change in the gross output value, given a percentage change in the factors Land or Work or Capital, *ceteris paribus*. Based on this ratio, expressed by equation 6, it is possible to quantify the effect that the change of each factor separately causes on GOV. Soares, Silva and Lima (2007) and Varian (2006) state that ouput elasticity is given by:

$$\varepsilon_{xi} = \left[\beta_i \left(\frac{Y}{X_i}\right)\right] * \left[\frac{X_i}{Y}\right] = \beta_i \quad (i = 1, 2, \dots, k) \qquad (6)$$

The analysis of returns to scale was based on the sum of the estimated parameters β_i. Barbosa (1985) and Gujarati (2006) showed that for every:

$\sum_{i=1}^{k} \beta_i > 1$ returns to scale are increasing;

$\sum_{i=1}^{k} \beta_i = 1$ the returns to scale are constant, and;

$\sum_{i=1}^{k} \beta_i < 1$ returns to scale are decreasing.

Equation 7 was used to estimate the marginal rate of substitution of work over capital (MRS), which expresses the amount of capital that is reduced by the increase in the amount of work, while the amount produced remains unchanged. Mathematically, MRS is found by dividing the marginal product of the work (MR_{Work}) factor by the marginal product of the capital ($MR_{Capital}$) factor (Equation 7).

$$MRS = \frac{MR_{Work}}{MR_{Capital}} \qquad (7)$$

ESTIMATION METHOD

Because the parameters are a function without simultaneity bias, they were estimated by the method of Least Squares (LS), which results in best linear unbiased estimators (BLUE). However, the analysis of economic phenomena as well as orientation of policies and decision-making, based on the classical linear regression model (CLR), does not require the acceptance of classical hypotheses (Santana, 2003; Hoffman, 2006), including:

a) The parameters are linear;
b) The average of the error term is zero, $E(\varepsilon_i) = 0$;
c) The variance of the error term is constant, $E(\varepsilon_i^2) = \sigma^2$, that is, data are homoscedastic;
d) There is no autocorrelation among the errors,$cov(\varepsilon_i, \varepsilon_h) = 0, \forall(i \neq h)$;
e) The observations of the explanatory variables $X_i$are fixed and uncorrelated with the error term (ε_i);
f) Errors have normal distribution, $\varepsilon_i \sim N(0, \sigma^2)$ e;
g) There is no exact linear combination of explanatory variables, namely, there are no collinear variables.

Therefore, to confirm the non-violation of classical hypotheses of the CLR model, residual analysis was performed. Considering that autocorrelation is more common in time series and the data used were obtained cross-sectionally, the Durbin-Wantson d-statistic was not analyzed. Alternatively, the presence of multicollinearity and heteroskedasticity was investigated. The degree of multicollinearity was measured by the variance inflation factor (VIF), defined by Hoffman (2006) by equation 8, where R_i^2 is the determination coefficient of the explanatory variable i, returned against all other explanatory variables:

$$VIF_i = \frac{1}{1 - R_i^2} \tag{8}$$

According to Santana (2003) and Hoffman (2006), VIF≤ 1 indicates no linear combination of explanatory variables, 1 ≤VIF ≤ 5 indicating low multicollinearity (does not compromise the results of the model) and VIF ≥ 5 indicates the presence of multicollinearity.VIF values greater than 10 indicate serious multicollinearity problems. Heteroscedasticity, a situation where the variance of the error term of the explanatory variables is not constant and affects the parameters β associated with the variables X_i, was analyzed by the test proposed by White (1980). Therefore, all explanatory variables were considered as cross-correlations, as can be seen in equation 9.

$$\begin{aligned}\varepsilon_i^2 = \quad & \sigma_0 + \sigma_1 \log(L_i) + \sigma_2 \log(L_i)^2 + \sigma_3 \log(L_i) * \log(W_i) \\ & + \sigma_4 \log(L_i) * \log(K_i) \\ & + \sigma_5 \log(W_i) + \sigma_6 \log(W_i)^2 \\ & + \sigma_7 \log(W_i) * \log(K_i) \\ & + \sigma_8 \log(K_i) + \sigma_9 \log(K_i)^2 + \nu_i\end{aligned} \tag{9}$$

Where :ε_i^2 is the squared stochastic error term of the regression of equation 3,σ_i are the regression parameters (i = 1, 2, 3,.., 9), ν_i is the random error term. The null hypothesis for White's test for heteroscedasticity is expressed by Equation 10, where:

$$H_0: \sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = \sigma_5 = \cdots \sigma_9 = 0 \tag{10}$$

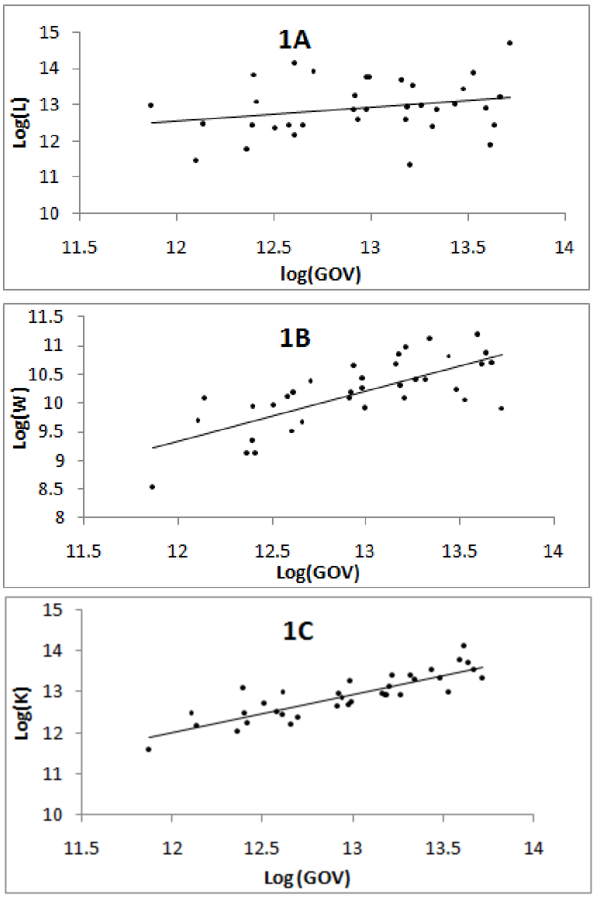
Santana (2003) and Gujarati (2006) demonstrated the possibility of using the LM-statistic and the F-statistic. Also known as the Breusch-Pagan test for heteroscedasticity, the LM statistic is given by multiplying the number of observations by the coefficient of determination R^2, i.e., $LM = n * R^2 \overset{a}{\rightarrow} x_k^2$. In this context, if these statistics are not statistically different from zero at the 5% level, the null hypothesis is accepted, confirming that the residuals are homoscedastic. Otherwise, data analysis must be performed carefully.

DATA SOURCE

The data used were compiled from the last Brazilian Agricultural Census conducted in 2006, and the sample corresponds to the statistics of the 35 microregions of the State of Rio Grande do Sul. The data were extracted from the census tables 4.4.7 (GOV), 4.2.13 (Land), 4.3.3 (Work) and 4.4.5 (Capital).

RESULTS AND DISCUSSION

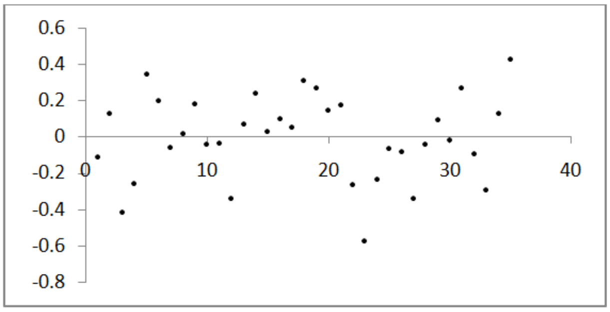
The dispersion analysis of the data confirms the theoretical assumption that the relationship between product (Q) and factors (L, W, K) is not decreasing. In this case, the relationship is positive and direct, as can be seen in Figures 1A, 1B and 1C.



Source: Research data. Based on IBGE (2010).

Figure 1. Ratio between number of factors and amount of output in agriculture in Rio Grande do Sul.

It is thus observed that the rural properties that have the greatest area, employ more work and have greater capital, such as silos, barns, piggeries, poultry sheds and milking parlors, among others, generate higher output volume. The importance of each factor for production was analyzed based on econometric estimation. The results (Table 1) show that the parameters associated with the variables L, W and K were statistically significant at the 5%, 10% and 1% levels, respectively, and the sign of the coefficients associated with the variables indicates that they both have positive influence on agricultural productivity. Altogether, 76% of the variations of the Gross Output Value of Agriculture (Q) were explained by variations in Land (L), Work (W) and Capital (K).



Research data. Based on IBGE (2010).

Figure 2. Regression residuals estimated by equation 3

Table 1. Estimation of the Cobb-Douglas production function

Variável dependente: LOG(Q)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.56939	1.167529	1.344195	0.1886
LOG(L) (land)	0.11677	0.055310	2.111124	0.0429
LOG(W) (work)	0.18978	0.109274	1.736773	0.0924
LOG(K) (capital)	0.61637	0.119998	5.136531	0.0000
R-squared	0.78334	Mean dependent var		12.96156
Adjusted R-squared	0.76237	S.D. dependent var		0.499829
S.E. of regression	0.24365	Akaike info criterion		0.121070
Sum squared resid	1.84038	Schwarz criterion		0.298824
Log likelihood	1.88127	Hannan-Quinn criter.		0.182431
F-statistic	37.3597	Durbin-Watson stat		1.347807
Prob(F-statistic)	0.00000			

Source: Data of this study.

Table 2. White's Test for Heteroscedasticity

F-Statistic	2.214710	Prob. F(9,25)		0.0564
Statistic LM: Obs*R²	15.52630	Prob. Chi-Square (9)		0.0775
Scaled explained SS	10.30223	Prob. Chi-Square (9)		0.3266
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.840572	8.597001	-0.330414	0.7438
LOG(L)	-0.603345	0.525667	-1.147771	0.2619
(LOG(L))^2	-0.013534	0.020787	-0.651077	0.5209
(LOG(L))*(LOG(W))	0.064510	0.047273	1.364632	0.1845
(LOG(L))*(LOG(K))	0.022619	0.039662	0.570294	0.5736
LOG(W)	0.011781	0.852295	0.013823	0.9891
(LOG(W))^2	0.152452	0.097550	1.562814	0.1307
(LOG(W))*(LOG(K))	-0.316401	0.177031	-1.787258	0.0860
LOG(K)	1.032036	1.367819	0.754512	0.4576
(LOG(K))^2	0.078233	0.085160	0.918660	0.3671
R - squared	0.443609	Mean dependente var		0.052582
Adjusted R - squared	0.243308	S.D. dependet var		0.069388
S.E. of regression	0.060360	Akaike info criterion		-2.542039
Sum squared resid	0.091082	Schwarz criterion		-2.097654
Log-likelihood	54.48569	Hannan-Quinn criterion		-2.388638
F-statistic	2.214710	Durbin-Watson stat		1.744515
Prob (F-statistic)	0.056373			

Source: Research data.

RESIDUAL ANALYSIS

Residual analysis revealed that the stochastic error term has a normal distribution, zero mean, $E(\varepsilon_i) = 0$, and constant variance (Figure 2), which eliminates the possibility of heteroscedasticity. The absence of heteroscedasticity was confirmed by White's test for heteroscedasticity, in which it was observed that all the parameters of the equation were statistically equal to zero at the 5% level of probability (Table 2). The probability of the LM and F statistics, at levels of 5.64% and 7.75%, allows the acceptance of the null hypothesis, that there is no heteroscedasticity in the data, confirming that the residuals are homoscedastic.

Autocorrelation problems are absent, since this violation occurs mainly in historical series. Also, no exact linear combinations were identified between the variables. For all these reasons, it is assumed that the regression results are free from bias and robust enough to support the subsequent economic analyses.

ELASTICITIES

This indicator shows the importance of infrastructure in farms; otherwise much of the agricultural output would not be generated. In this context, for every 10% increase in capital, an increase of 6.16% was expected in agricultural productivity, *ceteris paribus*. The opposite is also reciprocal.

Considering that the capital stock of large farms determines a great part of their production, policies to stimulate investment through credit are essential to promote the advancement of agricultural production in Rio Grande do Sul. Output elasticity of the land factor was 0.1167. This indicates that for every 10% increase in the area used for agriculture, an increase of 1.16% is expected in the Gross Output Value (GOV) of agriculture. This result shows that, in the current agricultural structure, mere area expansion without capital investment and technology does not usually generate a significant amount of product, especially in Rio Grande do Sul, where production is made possible from a capital intensive model and management practices aimed at maximizing production per unit area.

The elasticity of the work factor of 0.1898 indicates that for each increase of 10% in skilled work, an increase of 1.89% is expected in agricultural GOV, *ceteris paribus*. This result shows the need for new investments in farms, because the mere incorporation of work without improvements and expansion of the existing infrastructure of farms does not usually result in a significant increase in production. Therefore, if the mere incorporation of areas and expansion of work is not enough to result in significant growth of production, Rio Grande do Sul has to consider policies that encourage investment in the infrastructure of farms, either by exemption in the segment of capital goods or by access to more affordable credit, as has been largely the case already. In this perspective, the growth of agricultural production in Rio Grande do Sul is subject to the adoption of practices and capital intensive technology, whether in beef cattle and milk production, grain production or breeding of other animals for slaughter.

RETURNS TO SCALE

The returns to scale are obtained by adding the parameters β when there is a Cobb-Douglas function (Barbosa, 1985; Gujarati, 2006). The sum of the parameters β corresponding to the elasticities of the variables L, W and K indicated decreasing returns, as can be seen in Table 3.

Table 3. Parameters estimated by logarithmic multiple regression

Variable	Coefficient (***β***)
LOG(L) (land)	0.11677
LOG(W) (work)	0.18978
LOG(K) (capital)	0.61637
Total	0.92292

Source: Research data. Based on IBGE (2010).

This result shows that the average production costs tend to increase as producers intensify the use of factors. In this perspective, the results show that new investments resulting in an intensified use of the factors should be planned based on a detailed economic feasibility study. It should be noted that there is the need for specific microeconomic studies that consider the specificities of each production system, whether developed on properties of micro, small, medium or large size, dealing with livestock or agriculture. It is also imperative to develop and disseminate management practices and technologies that enable higher average productivity. Otherwise, there may be producers' indebtedness and economic infeasibility of activities.

Therefore, if this path is not changed and if new investments are not grounded on technical criteria, the competitive advantage of agriculture in Rio Grande do Sul will tend to be reduced.

AVERAGE PRODUCTIVITY OF FACTORS

The results of the calculation of average productivity show a gross output value of BRL 1,047.46 for each hectare used for agricultural activities. Similarly, the average production for each worker was BRL 16,108.95 and each unit of capital produced the equivalent to BRL 1.06 per year (Table 4).

Table 4. Average productivity (in BRL) of factors over GOV

Factor of Production	AP/year*	Minimum Productivity	Maximum Productivity
L (land)	1,047.46	214.84	6,444.65
W (work)	16,108.95	7,772.00	44,806.86
K (capital)	1.0627	0.5028	1.7382

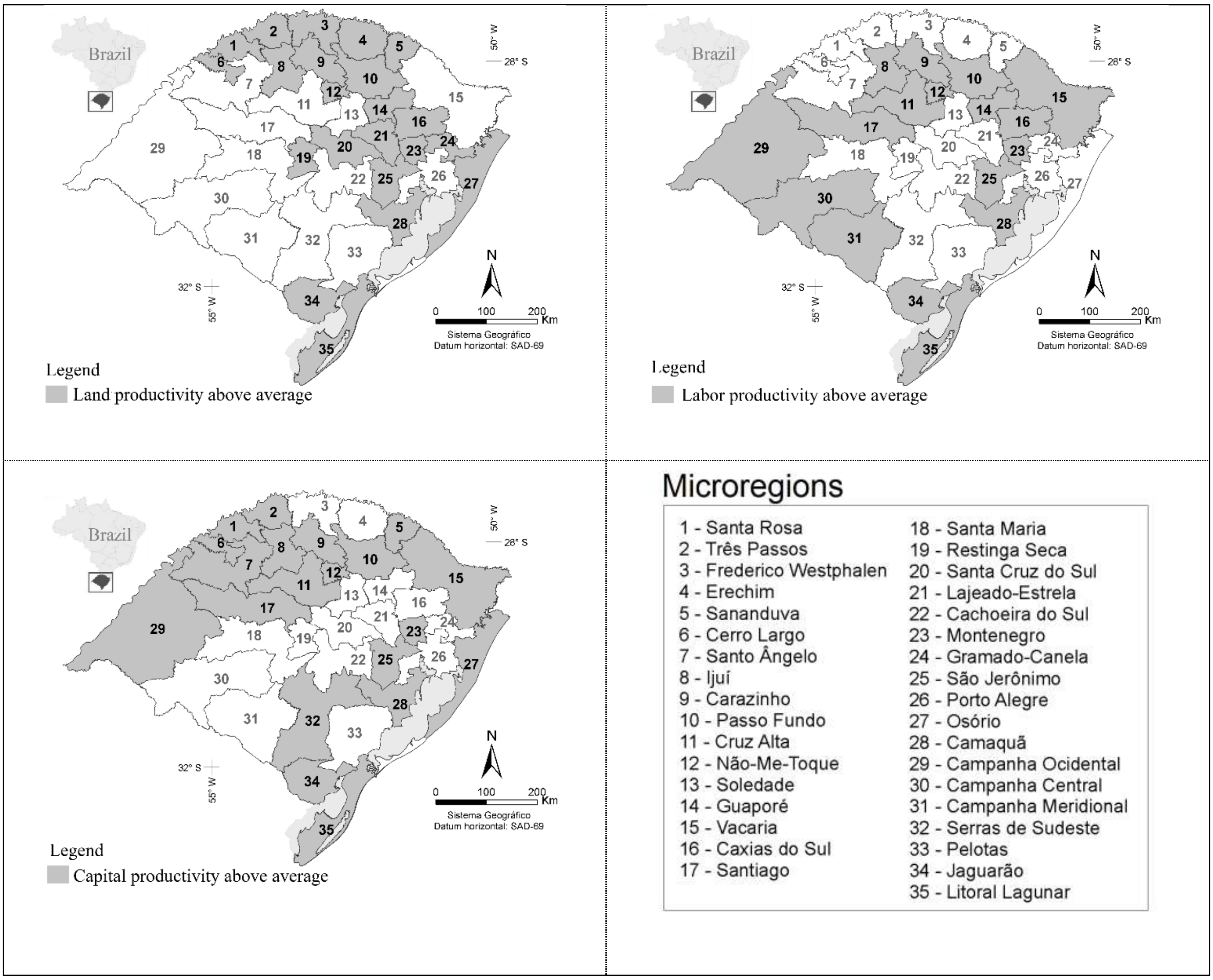
* Geometric mean. Source: Research data. Based on IBGE (2010).

The microregions with the best land productivity are Montenegro, Caxias do Sul, Lajeado-Estrela and Guaporé, with the two latter producing an amount equal or equivalent to BRL 2,500.00 / ha, while the microregions Campanha Ocidental, Jaguarão, Serras de Sudeste, Campanha Meridional and Campanha Central have the lowest productivity indicators, below BRL 390.00/ha. The measurement of work productivity showed a high standard deviation. The mostprominent microregions, with average work productivity above BRL 26,900.00/worker, are Campanha Ocidental, Vacaria, Jaguarão and Litoral Lagunar. In contrast, average work productivity in the microregions of Santa Rosa, Pelotas, Frederico Westphalen and Soledade was below BRL 10,000.00 in the year analyzed (Figure 2).

The capital factor of production also showed a high standard deviation. The farms of the microregions Vacaria, São Jerônimo, Campanha Ocidental and Ijuí had the best indicators, with average productivity above BRL 1.40.In contrast, in the microregions Campanha Central, Gramado-Canela, Caxias do Sul and Porto Alegre, theaverage productivity of capital was below BRL 0.70. With above-average productivity for the three factors, the most productive microregions are Carazinho, Camaquã, Ijuí, Montenegro, Não-Me-Toque, Passo fundo and São Jerônimo. Ranking second, with above-average productivity for two factors, are the microregions, Campanha Ocidental, Caxias do Sul, Cerro Largo, Cruz Alta, Guaporé, Jaguarão, Lajeado-Estrela, Litoral Lagunar, Osório, Sananduva, Santa Rosa, Santiago, Três Passos and Vacaria. In contrast, the microregions Cachoeira do Sul, Pelotas, Porto Alegre, Santa Maria and Soledadehad the lowest productivity for the three factors (Figure 3).

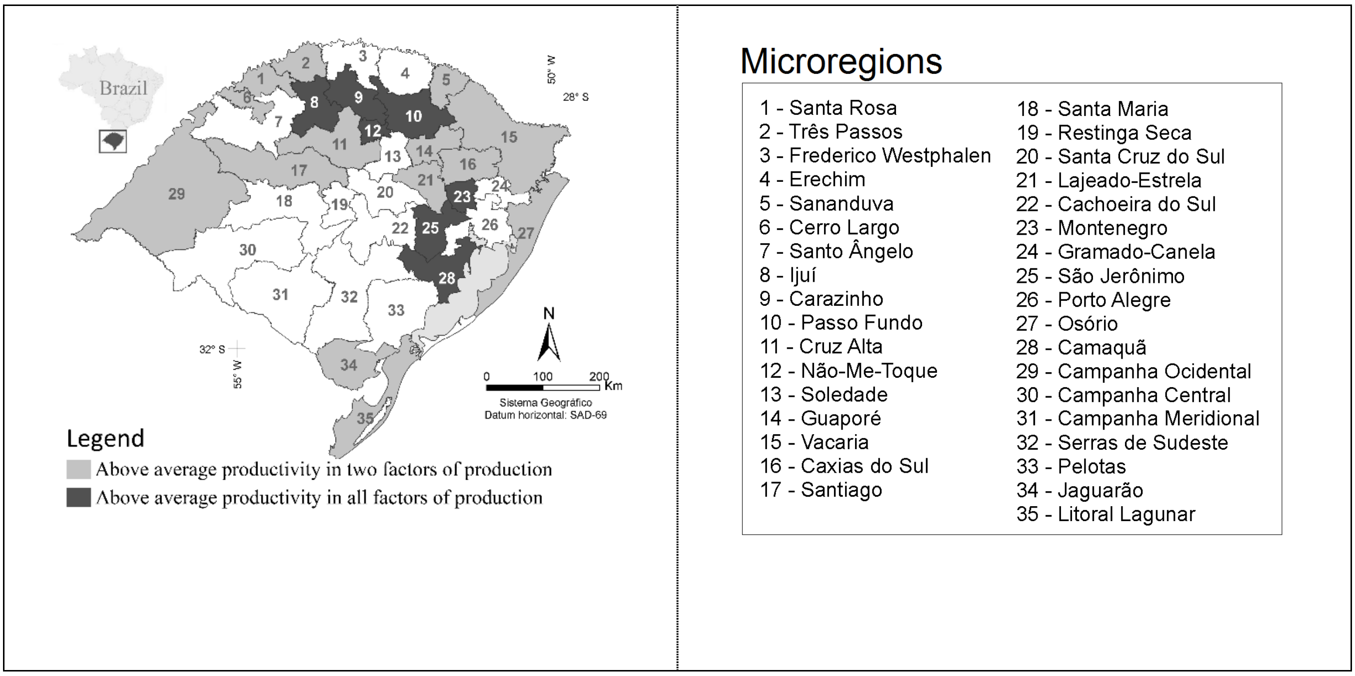
MARGINAL PRODUCTIVITY AND USE OF RESOURCES

The results of the analysis of the marginal product of the factors *L*, *W* and *K* used in the productive activities of farms show that for each additional worker: a) an increase of BRL 3,057.16 is expected for GOV/year; b) for each hectare of additional area, the amount of BRL 102.36 is expected for



Source: Research data. Based on IBGE (2010).

Figure 3. Higher average productivity of factors of production used in farms, by microregion: Rio Grande do Sul – 2006



Source: Research data. Based on IBGE (2010).

Figure 4. Microregions above-average factor productivity: Rio Grande do Sul - 2006

GOV and c) the marginal productivity of capital confirms the increase of BRL 0.66 in Q for every BRL 1.00 invested in the infrastructure of farms (Table 5).

Table 5. Marginal productivity of factors (MP) over GOV

Factor of Production	MP*
L (land)	122.31
W (work)	3,057.16
K (capital)	0.6550

*It is the derivative of output over factor, equivalent to: * MP = AP * β_i
Source: Research data. Based on IBGE (2010).

MARGINAL RATE OF SUBSTITUTION (MRS)

Considering that the MRS of work over capital is equivalent to the ratio between the MP of work and the MP of capital, the replacement of one unit of skilled work requires the investment of BRL 4,667.49, (equation 11).

$$MRS = \frac{MR_{Work}}{MR_{Capital}} = \frac{3.057,16}{0,6550} = 4.667,49 \qquad (11)$$

Given these results, it is concluded that credit policies and exemptions that favor investment in farms is an alternative to expand production in the medium and long term. However, the decreasing returns to scale point to the need for policies that raise the competitiveness of the agricultural production in the Rio Grande do Sul. In this perspective, investments in infrastructure for irrigation; grain storage within the properties or in agricultural cooperatives, stables, milking parlors, milk coolers; construction of aviaries and piggeries, among others, tend to contribute to the diversification of production and increased income for farms in Rio Grande do Sul

Conclusions

The socioeconomic importance of agricultural production in Rio Grande do Sul has motivated this research. These activities not only generate jobs and income for many towns and cities, but also typically represent the state. However, due to adverse conditions arising from market issues and successive water stress episodes, they should be observed and stimulated carefully. Planning public policies should be preceded by structural and cyclical analyses. The production function was estimated in this context. The main results show that the ratios between product (Q) and factors (L,W, K) are increasing and that, overall, the properties that either have the largest area, are more work-intensive or have greater capital generate higher amount of product. Likewise, it was observed that the mere expansion of the area without investment in capital and technology does not usually result in significant growth of production. Conversely, stimulating investment and modernization can be a key element to promote the advancement of agricultural production and improve competitiveness indices, as long as guided by assessments of the economic viability of farms. Thus, further microeconomic studies should consider the specific characteristics of each production system, and the use of econometric modeling to estimate the Cobb-Douglas function is one of the methodological alternatives for analysis. The validity of the results of this study can also be credited to census data. They not only accurately describe production, but were also a good fit to the model, because all parameters corroborated the economic theory and were statistically different from zero. Finally, if production is to be maximized, and the competitiveness of agricultural production of Rio Grande do Sul is to be maintained and increased, the government should adopt policies to stimulate investment, exempt the capital goods industry and strongly encourage the professionalization of farmers through rural extension activities and specific policies to address the bottlenecks of each activity.

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