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EFFECTS OF GOVERNMENT INTERVENTION VIA RURAL CREDIT SUBSIDY ON ECONOMIC GROWTH AND WELFARE OF BRAZILIAN REGIONS

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ABSTRACT

The objective of this paper is to evaluate the impact of the Rural Credit Interest Rates Equalization Policy (IRE) on the economic and welfare growth of five Brazilian regions. The simulations are performed using the model, database and software from the General Equilibrium Analysis Project of the Brazilian Economy (PAEG). The results suggest IRE provides economic growth greater than the cost of the policy in the Midwest, Northeast and South regions. Moreover, in the North and East regions there is a decrease in GDP. For Brazil, the policy is cost-effective and offers 34% rate of return in terms of economic growth generation. Furthermore, all regions present welfare gain. The main conclusion is that IRE promotes economic and welfare growth and contributes to reduce regional disparities.

Keywords: Government intervention, rural credit subsidy, economic and welfare growth, Brazilian regions, PAEG.

1. INTRODUCTION

State intervention is a controversial and complex subject and divides the economists into opposing currents. However, despite all the criticisms on intervention, some believe that policymakers may envision positive results in terms of economic and welfare growth with the application of subsidies. In this sense, one may question the impact of subsidies applied to the Brazilian agriculture through the interest rate equalization policy.

In Brazil, Rural Credit Interest Rate Equalization Policy (IRE)[1] is an important subsidy to agriculture, which has contributed, firstly, to a higher demand for agricultural inputs, and, secondly, to expand production. Formally, the IRE is an action intended to cover the differential rate between the cost of fund raising by financial institutions, plus administrative costs and tax, and the charges levied on farmers borrowing credit (MINISTRY OF FINANCE, 2003). With the IRE, the federal government wants to expand the

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participation of private banks in financing the rural sector as a form of expanding credit application without burdening the Treasury[2] (GONÇALVES NETO, 1997, p.161).

According to Castro and Teixeira (2004), the IRE policy subsidizes about 30% of the total funds invested in agriculture through rural credit. However, credit is concentrated only in some regions. According to Bittencourt (2003), the regional distribution of rural credit in Brazil is not homogeneous, since it is closer to the participation of Gross Agriculture Production Value (VBP) in each region than to the number of farms. In 2009, the Northeastern region had the highest number of farms, but only 11% of rural credit resources were allocated to the Northeastern and Northern regions (BCB, 2010). Thus, it should be noted that any analysis that takes into account the effects of various types of rural finance in Brazil should be conducted regionally.

Providing rural credit at lower interest rates than those prevailing in the market is an agricultural subsidy. This subject is very controversial, insofar as the theory postulates that the agricultural subsidies lead to allocative and distributive inefficiency, as well as to social costs. However, concomitantly, the most developed countries, especially the U.S. and the EU countries insist on maintaining this type of grant. Two questions arise: are the social benefits the real reason for the subsidies? Or does the subsidy exist because the policy promotes economic growth greater than its cost? Such questions may have different answers depending on the country concerned. In this study, given that Brazilian agriculture is subsidized through the IRE policy, it is examined the effect of subsidy on economic growth and welfare in the country's regions.

Regarding the effects of rural credit subsidy on the Brazilian economy, Castro and Teixeira (2004) estimated the impact of the IRE policy on GDP growth using the input-output matrix. These authors concluded that the benefits to the economy in terms of economic growth are higher than the cost to government with the policy. However, the effects measured took into account only the backward linkages of the agricultural sector, i.e., the demand. The effects of subsidy on economic growth is that it generates growth by increasing input demand (backward linkages), and also by increasing product supply into the economy (forward

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[2] To illustrate the mechanism of interest rates equalization on rural credit, it is presented a numerical example. It should be noted that this is an abstraction, because the values defined here are fictitious. In a given year, the Ministry of Finance releases an amount of money to be spent with rural credit equalization, i.e. to subsidize rural credit. Let's assume $1.00 billion. The Worker Support Fund (FAT), which is a major source of subsidized credit, keeps its fund invested in the market at 12% per year rate. Without equalization, the producer would pay 12% interest rate to borrow money. The government recognizes the need to offer lower interest rate to farmers to enable production. Thus, credit is offered to farmers at 4% yearly interest rate. The difference between the two rates, 8% is the equalization rate. Thus, the $ 1.00 billion subsidy provides $12.5 billion ($1.00 / 0.08) in rural credit.

linkages). Thus, the total effect of rural credit on economic growth is evaluated using a general equilibrium analysis.

Besides the direct cost, an alternative rate of return is associated with this policy since the capital could be applied to another sector, probably able to generate greater benefits for the economy.

The transport sector has strong interdependence with the agricultural sector given the significant share of its cost to the farmers' production structure. According to Stülp and Plá (1992), the transportation sector strongly affects the efficiency of various other sectors in the economy. According to Castro (2002), the expansion and improvement of transport services generate significant externalities and multiplier effects on the economy, introducing positive discontinuities in the growth potential of several sectors. Also according to this author, in agriculture, the significant dependence on random internal and external factors, such as equipment availability, weather, input and output prices, makes this sector more vulnerable to the transportation service.

If the resources spent on the IRE were applied to the transportation sector, besides benefiting the agricultural sector by reducing costs to the producer, other economic activities would also be favored. Is the rural credit IRE the most efficient way to apply the public resources to encourage economic sectors? The question is how high the alternative rate of return is related to IRE.

Accordingly, the purpose of this study is to determine the efficiency of rural credit spending in relation to its ability to generate economic growth and welfare in the five Brazilian regions and to assess whether the policy benefits are greater than its cost. This paper innovates in that it analyses the effects of the IRE at the regional level rather than looking at the country as a whole. Besides, despite studies that use partial equilibrium approaches and input-output matrices, this study uses an Applied General Equilibrium Model, specifically the model from the General Equilibrium Analysis Project of the Brazilian Economy (PAEG), which presents the contribution to model the regions of Brazil and the relationship of these regions with the rest of the world. Another important contribution of this study is that it proposes to measure the alternative rate of return of subsidized agricultural credit in relation to its application in the transportation sector.

The analysis is performed by two analytical scenarios. The PAEG model is used to estimate the effect of the rural credit subsidy via interest rate equalization on the economic growth and welfare of the five regions. Applying the same analytical tools, the alternative rate of return the rural credit subsidy applied to the transportation sector is also measured.

This paper is divided into four sections, with this introduction being the first. The second section includes the theoretical framework, where the effects of subsidies within a context of general equilibrium are briefly studied. The PAEG model, data source and analytical scenarios are also introduced in this section. In the third section, the results are discussed, and in the fourth, the main conclusions are presented.

2.   METHODOLOGY

According to Jensen et al. (2010), general equilibrium models are more appropriate for measuring the effects of trade and interventionist policies, since they are able to capture the total effect (direct and indirect) the policy provides. An adaptation of the model by Harberger (1962) is used for the theoretical framework to illustrate the effects of subsidies on agricultural production within a context of general equilibrium. PAEG is the model applied since it is capable of representing the economies of large regions and partner countries, analyzing trade flows and trade protection, as well the implementation of changes in policy variables in the regions. The following subsections describe the theoretical and analytical approach and present the data source and proposed scenarios.

2.1. Production subsidies and allocative and distributive distortions

Under perfect competition ideal conditions, the economy is operating at maximum efficiency and it is Pareto optimal. However, in certain situations, the market does not work properly and fails to deliver efficient outcomes, so their correction requires government intervention. Government intervention by means of a subsidy is justified in the presence of externalities, in the case of public goods, in the case of natural monopolies, when markets are incomplete, when there is information failure and in situations of macroeconomic imbalance, namely when there is market failure. Market failure drives the economy away from Pareto optimal, so government intervention is needed to bring the economy to its efficient functioning.

The high interest rate of the Brazilian economy sets up a market failure, i.e., in Brazil, the basic interest rate ("Selic") is not defined by the market, but rather by the Monetary Policy Committee (COPOM) from the Central Bank (CB), and aims to meet inflation control objectives. Since the "Plano Real", the basic interest rate of the economy is maintained by the Central Bank at high levels[3] to control inflation, and, therefore, it is not

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[3] Although this rate has decreased in recent years, Brazil still has an interest rate higher than the global economy.

determined in the monetary market. Very high interest rates represent a market failure because they encourage financial applications but discourage productive investments. Thus, some sectors facing this market failure need to be encouraged by sector policies, since they would be unfeasible at the high interest rates fixed for the entire economy, which is the case of agriculture. Government uses the financial system[4] to implement a subsidy policy to the agricultural sector through a program of rural credit with interest rates below that prevailing in the market. Paying lower interest rate, farmers borrow from the bank and invest in production, creating effects in the agricultural sector and the entire economy.

The model by Harberger (1962) provides the theoretical basis for this study. It has the following simplifying assumptions, which are: the existence of only two goods, two factors of production supplied in a fixed amount, the markets are competitive, and in the absence of interventions, resources are allocated so that the economy is Pareto efficient. It is further assumed that all the subsidy policy spending will be equal to the income transfer from one sector to another, so that the total expenditure with agricultural and industrial products remains constant. Thus, the theoretical model used in this study has two sectors, Agriculture (A) and Industry (I), and two factors of production, capital (K) and Labor (L), which initially are in equilibrium.

Targeted subsidies for agricultural production increase the net return of capital in agriculture relative to the industry, thus increasing the demand for capital in agriculture. In other words, they reduce the marginal cost of capital in agriculture relative to industry. Thus, with no restrictions on capital mobility, it moves from industry to agriculture due to increased attractiveness brought about by higher returns. This subsidized capital movement in agriculture lasts until the return is equal in the two sectors. The basic effect of a subsidy policy on a given sector is to raise the income for the capital owners in the subsidized sector. The reduction in the cost of capital in agriculture, due to the credit subsidy, alters the relationship between capital and labor. Because of the greater amount of capital, agricultural production increases, while industrial production decreases, since capital is relatively more expensive for this sector. Considering that the agricultural product price is lower after the incorporation of agricultural subsidies, an increase will occur in consumption by workers and capital owners. In the manufacturing sector, workers will respond negatively to higher prices; however, agricultural capital owners will increase their industrial consumption once their

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[4] Banks are encouraged to provide loans to farmers, since the government equalizes the interest rate differential. Moreover, according to Castro and Teixeira (2004) financial institutions charge a very high spread to the Government to participate in the program IRE, which sets great incentive to lend to farmers.

income increases more than proportionally to increase in industrial prices. Thus, it seems that subsidy increases the real income of capitalists who invest in agriculture, since they consume more of both goods, agricultural and industrial products.

The change in relative prices provides a new balance; however, it is not Pareto efficient. The decrease in efficiency represents the welfare loss or the social cost that subsidies bring for transferring resources from one sector to another; in this case, from the manufacturing sector to agriculture. However, as industrial prices increase and agricultural prices fall, the real income of the economy can vary significantly, depending on the weight of each sector in the economy. The difference between the current product (after the subsidy) and the product at the initial equilibrium may be evidence of change in real income, that is, of change in GDP through subsidies to the agricultural sector.

2.2. The PAEG Model

The PAEG model is static, multiregional, and multi-sectorial. It is built to analyze the Brazilian economy regionally. It represents the production and distribution of goods and services in the global economy, where each region is represented by a structure of final demand and optimizing agents, maximizing their welfare subject to a budget constraint. The investment and production in the public sector are fixed. The productive sectors combine intermediate inputs and primary production factors to minimize costs, given the technology.

The PAEG is based on the Global Trade Analysis Project (GTAP) model and database (Hertel, 1997; GTAP, 2001). However, it adopts the basic structure of the model GTAP in GAMS (Rutherford; Paltsev, 2000; Rutherford, 2005) that uses the syntax of Modeling Programming System for General Equilibrium (MPSGE), and the development of a nonlinear complementarity problem in GAMS.

The PAEG data base is compatible with the GTAP data base 7.0. However, in the case of the PAEG, instead of considering the country as a whole, it considers the five major regions of Brazil with compatible data for the year 2004. Thus, the data for Brazil obtained from an aggregation of the GTAP data base 7.0 must be replaced by the data obtained from the Brazilian regions' input-output matrix. In this replacement, the data for trade flows between Brazil and other regions of the world are kept intact. The first step is to disaggregate GTAP data and the data from the Brazilian regional matrices in the regions and sectors of interest to the research. Subsequently, both data are fed into a single file and the data from the Brazilian regional matrices are rescheduled, so that the Brazilian GDP, obtained by the sum of regional GDP from inter regional input-output matrices, is consistent in magnitude with

the Brazil's GDP in the GTAP database. Data for Brazilian imports are distributed among regions, using the regional matrices to define the relative share of imports from each region in total Brazilian imports.

This same procedure is used to distribute the Brazilian exports regionally as these data come from the GTAP database for the entire country. However, the accounts of supply and demand for the Brazilian regional matrices lose balance, since the original data on exports and imports have been replaced by data from Brazil in the GTAP database. In order to restore the balance, the sectorial investment and capital flow values are adjusted in the Brazilian regions. This procedure avoids the inconvenience of changing the input-output coefficients in the sectors in disequilibrium. Finally, the elasticities for Brazil contained in the GTAP database are allocated to the Brazilian regions, and the data for Brazil are removed, leaving only the data of the regional Brazilian matrices and those of the other GTAP regions.

The database includes bilateral trade flows between countries and regions as well as transportation costs, import tariffs and export subsidies or taxes. Table 1 describes the data set represented in the model.

Table 1: Database Contents

Index	Description
i, j	Sectors and goods
r, s	Countries and regions
f $\in$ m	Production factors with free mobility within a given region: skilled labor, unskilled labor and capital
f $\in$ s	Fixed factors of production: land and other natural resources

Source: Gurgel *et al.*(2009).

The operation of the PAEG model can be demonstrated by macroeconomic accounting identities, represented by the social accounting matrix. Equation (1) shows that domestic production (vom_{ir}) is distributed among exports ($vxmd_{irs}$), international transport services (vst_{ir}), intermediate demand ($vdfm_{ijr}$), private consumption ($vdpm_{ir}$), investment ($vdim_{ir}$) and government consumption ($vdgm_{ir}$). Equation (2) denotes that imported goods, represented by vim_{ir} are distributed among intermediate consumption ($vifmj_{ir}$), private consumption ($vipm_{ir}$) and government consumption ($vigm_{ir}$).

$$vom_{ir} = \sum_{s} vxmd_{irs} + vst_{ir} + \sum vdfm_{ijr} + vdpm_{ir} + vdgm_{ir} + vdim_{ir} \qquad (1)$$

$$vim_{ir} = \sum_{j} vifm_{ijr} + vipm_{ir} + vigm_{ir} \qquad (2)$$

In the production of good j (Yir), intermediate inputs (domestic and imported) and mobile and specific production factors (vfm_{fir}, f $\in$ m) are used. The production factor service

income is distributed to the representative agent. Equilibrium in factor markets is given by an identity that relates the amount of the factor services payment with their income, as in equation (3).

$$\sum_i vfm_{fir} = evom_{fr} \tag{3}$$

The balance between supply and demand requires exports to be equal to imports (equation 4).

$$vxm_{ir} = \sum_s vxmd_{irs} \tag{4}$$

where vxm$_{ir}$ represents exports of good i by region r and vxmd$_{irs}$, imports of same good by trading partners.

Similarly, the aggregate supply of transport services j is equal to the value of transportation services in exports (equation 5).

$$vt_j = \sum_r vst_{jr} \tag{5}$$

The balance between supply and demand in the market of transport services makes the supply of such services equal to the sum of bilateral flows of purchased transport services in imports of goods, as in (6).

$$vt_j = \sum_r vtwr_{jisr} \tag{6}$$

Government income (vgm$_r$) is the sum of taxes and transfers. Thus, government budget constraint can be represented by equation (7).

$$vgm_r = \sum_i R_{ir}^Y + R_r^C + R_r^G + \sum_i R_{ir}^M + R_r^{HH} + vb_r \tag{7}$$

where R_{ir}^Y, R_r^C, R_r^G, R_{ir}^M are indirect taxes on production and exports, consumption, government demand and imports, respectively. R_r^{HH} stands for indirect taxes for the representative agent, and vb_r are transfers from abroad.

The budget constraint of the representative agent relates income from production factors $evom_{fr}$, minus the tax payments R_r^{HH}, with consumer spending vpm_r and private investment vim_r (equation 8).

$$\sum_f evom_{fr} - R_r^{HH} = vpm_r + vim_r \tag{8}$$

Thus, based on the equations presented, two conditions are considered: supply equal to demand in equilibrium, and balance of income, i.e., net income equal to net expenditure. In PAEG, as in GTAP, the economy is considered to operate in perfect competition and, thus, classical assumptions are valid: Constant returns of scale, production cost equal to the value of production, and, thus, economic profit equal zero. These conditions apply to each of the productive sectors and activities, according to equations (9) to (14).

$$Y_{ir}: \sum_f vfm_{fir} + \sum_j (vifm_{jir} + vifm_{jir}) + R_{ir}^Y = vom_{ir} \tag{9}$$

$$M_{ir}: \sum_s \left(vxmd_{isr} + \sum_j vtwr_{jisr} \right) + R^M_{ir} = vim_{ir} \tag{10}$$

$$C_r: \sum_i vdpm_{ir} + vipm_{ir}) + R^C_{ir} = vpm_r \tag{11}$$

$$I_r: \sum_i vdim_{ir} = vim_r \tag{12}$$

$$FT_{fr}: evom_{fr} = \sum_i vfm_{fir} \quad f \in s ; e \tag{13}$$

$$YT_j: \sum_r vst_{jr} = vt_j = \sum_{irs} vtwr_{jirs} \tag{14}$$

Firms behavior[5] are represented in production blocks as an optimization problem and it is defined by production functions (Rutherford, 1999). The firm supply is obtained by unit costs minimization through a combination of primary factors and intermediate inputs. The basket of intermediate inputs consists of domestic and imported goods. The substitution between the components of value added is represented by Constant Elasticity of Substitution (CES) since the primary and intermediate inputs are combined from a Leontief function. Each intermediate input in this Leontief function is a combination of domestic and imported inputs. Regarding the demand for imported inputs, each imported good demanded by a region is an aggregate of goods imported from different regions. The choice between imports from different trading partners is based on the Armington assumption.

The behavior of consumer agents is also optimized. It is represented by blocks of demand. The final demand in the model is characterized by a Cobb-Douglas function of composite goods, formed by the aggregation of domestic and imported goods. The consumption of public administration is represented in the model by a Leontief aggregation, consisting of domestic and imported goods. Land and natural resources are considered specific factors of production, offered by a function of constant elasticity of transformation (CET).

The closure in the PAEG model considers that the total supply of each primary factor is fixed; however, these factors are mobile among sectors within a region. Among Brazilian regions, free mobility for capital and labor is assumed. It must be noted that among countries such mobility does not occur. The land factor is specific to the agricultural sectors, while natural resources are specific to certain sectors (for extraction of mineral resources and energy). Unemployment is not considered in the model; thus, factor prices are flexible. On the demand side, investment and capital flows are fixed, as well as the results of the balance of payments. Thus, changes in real exchange rate must occur to accommodate changes in the trade flow after the shocks. Government consumption will change with changes in goods prices, and revenue from taxes will be subject to changes in activity level and consumption.

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[5] This description is complete in Rutherford (2005).

2.3. Source and data processing

In preparing the PAEG database for the Brazilian regions, the 1995 interregional input-output matrix, obtained by Parré (2000), is broken down into five geographical regions. The inter-regional matrix, however, has been updated for the year 2004, and the agricultural sector was disaggregated into eight sectors. International data in the PAEG data base comes from the GTAP 7.0 database that reflects the economic environment for the year 2004 and includes information to the international and domestic trade[6]. Table 2 presents the sectors and regional composition of PAEG.

The expenditure data on the Interest Rate Equalization (IRE) policy and the total rural credit were obtained from the Federal Budget Secretariat (SOF) (2010) and from the Rural Credit Statistical Yearbook (BCB, 2004), respectively. IRE data in the above publication are aggregated at the country level, but disaggregated between family and commercial agriculture. However, the total rural credit data are broken down into regions and activities, family and commercial farms. To separate government expenditure with IRE from the total subsidies paid to agriculture, proportional distribution of total rural credit to the regions was considered. Despite the fact that actual data for the IRE is not available in every activity and region, this procedure is believed to have allowed good proxies, since, according to Bittencourt (2003), IRE supplies approximately 70% of the credit directed to family farms and around 30% of those directed to commercial agriculture. Therefore, it is considered a reasonable approximation to assume the expenditure with IRE and the amount of credit provided based on their distribution according to the total rural credit. The volume of rural credit provided by the IRE to Brazil as a whole was calculated based on the work of Bittencourt (2003) and Castro (2004)[7].

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[6] For more details on the GTAP 7.0 data base, see Narayanan and Walmsley (2008).
[7] For more details, see Cardoso (2011).

Table 2: Aggregation across regions and industries for PAEG

Regions	Activities
1- Brazil-Northern region (NOR)	1- Rice (pdr)
2- Brazil-Northeastern region (NDE)	2- Corn and other cereal grains (gro)
3- Brazil-Mid-Western region (COE)	3- Soybean and other oilseeds (osd)
4- Brazil-Southeastern region (SDE)	4- Sugarcane, beet sugar., ind. sugar (c_b)
5- Brazil-Southern region (SUL)	5- Meat and live animals (oap)
6- Rest of Mercosul (MER)	6- Milk and milk products (rmk)
7- United States (USA)	7- Other agricultural products (agr)
8- Rest of Nafta (NAF)	8- Food - Other food, beverages and tobacco (foo)
9- Rest of America (ROA)	
10- European Union 25 (EUR)	9- Textiles (tex)
11- China (CHN)	
12 – Rest of world (ROW)	10- Clothing and footwear (wap)
	11- Wood and furniture (lum)
	12 - Paper, cellulose and ind. Graphics (ppp)
	13 – Chemicals, ind. rubber and plastics (crp)
	14 -Manufactured: non-metallic minerals, metallurgical, mining, and other ind. (man)
	15 - SIUP and com.(siu)
	16 – Construction (cns)
	17 – Trade (trd)
	18 – Transport (otp)
	19 - Services and public administration (ser)

Source: Pereira *et al.* (2009).

2.4.   Analytical Scenarios

This paper simulates two analytical scenarios to meet two distinct goals: to estimate the effect of government expenditure with the IRE on the economies of the five Brazilian regions and to measure the alternative rate of return of this subsidy in relation to an application in the transportation sector. However, it is worth noting that in these two scenarios it is considered that primary factors (labor and capital) to have perfect mobility among Brazilian regions[8].

In the case of the PAEG model, whose database depicts the base year of 2004, it is a representation of the Brazilian economy that captures the interrelationships between its macro-regions, and the trade flows with the rest of the world. In the economic environment simulated by PAEG it is incorporated all the actions taken by the agents represented in the model: firms, households and government. Therefore, any government policy into effect in 2004 is represented in the initial equilibrium. That is also the case of IRE. In other words, the effect of IRE on different sectors is captured in the benchmark equilibrium. Thus, to evaluate

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[8] It is recognized this assumption limitation, since common sense is that factors do not migrate freely from one region to another, given the economic costs and various subjective factors preventing their free movement. However, it is perfectly acceptable that there is a certain level of displacement in response to a difference in the primary factors service payment.

the effect of this policy on the economy it is necessary to establish a shock to eliminate it in order to compare a situation without the policy with a situation where the policy is present.

To implement this shock, it is necessary first to eliminate all government expenditure with the policy in the form of subsidy and, second, to eliminate the entire amount of credit generated by the subsidy. Thus, the shock consists in eliminating the entire portion corresponding to the IRE from the total subsidy (rto) allocated to the agricultural sector. At the same time, the expenditure with intermediate input purchase by the agricultural sector is eliminated by taking out the volume of credit provided by the subsidy[9]. This second part of the shock id done by a homogeneous shock on the intermediate consumption taxes (rtfd and rtfi) of those sectors where agriculture is directly interconnected. The goal of this simulation is to eliminate any effect provided by the credit supplied by the IRE subsidy. This is done to compare with the initial equilibrium in which the policy is in place. The increase in intermediate input tax decreases the agriculture intermediate input purchase by a value equivalent to the subsidized credit supplied by the IRE subsidy.

Since the goal of the simulation is to evaluate the effect of IRE on the economy, the results are presented with opposite sign in order to understand the effect the policy generates on the regional economies and not the effect of its withdrawal. By reversing the sign of the result, it allows to establish the effect generated by the policy on the endogenous variables of the model in a situation where the policy is implemented.

Some drawbacks from the shock on the intermediate consumption tax are worthy noting, though: a) The tax increase causes changes in relative prices and thus agriculture faces higher prices for intermediate consumption in relation to industry and services; b) it is not possible to specify the shock for each agricultural sector input consumption reduction. Thus, expenditure reduction of intermediate inputs to agriculture is simulated in each region, using the same amount of resources made available by the IRE, and c) change in government tax revenues due to increase in tax rates and indirectly via changes in economic activity. However, given the limitations to simulate straight reduction in the purchase of intermediate inputs in a general equilibrium model, the proposed simulation, despite these drawbacks, is believed to be a reasonable alternative representation for the effects of the IRE policy.

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[9] As in Castro (2004), it is considered that the farmers spend the borrowed credit in the purchase of intermediate inputs. In other paper, Castro and Teixeira (2010) measured the elasticity of demand for inputs in relation to rural credit in Brazil and found an elasticity of 0.95 for fertilizer, that is very close to 1. This result indicates that considering all funding acquired by the producer is spent on intermediate inputs is a reasonable approximation. It should be noted that to represent the total effect of eliminating the IRE, it is necessary to consider not only the withdrawal of the subsidy, but also a reduction in the volume of credit available as a result of the IRE, as illustrated in footnote 2.

The second scenario measures the effects on economic growth from the alternative use of the resource spent by the government with the IRE. Accordingly, it is considered that the IRE subsidy is transferred from the agricultural sector to the transportation sector. The objective of this simulation is to determine the alternative rate of return of the IRE subsidy in terms of changes in GDP and welfare on the regions.

3.   RESULTS

The rural credit IRE policy provides higher credit than government expenditure, since the subsidy is limited to the payment of the differential between market interest rates and the rates paid by farmers. Thus, to evaluate the efficiency of the IRE policy in terms of its capacity to generate GDP growth to the Brazilian regions, it is simulated the elimination of the subsidy and the subsidized credit, since this policy is already in place. The results are described as if the signs were opposite. To evaluate the alternative rate of return of the IRE, the effects of the expenditure with the IRE transfer to the transportation sector on regional GDP were measured. In a second step, the effect of the IRE policy on welfare was evaluated in the five regions, as well as the alternative rate of return for the welfare.

Table 3 shows the government spending with equalizations (1), the values of rural credit provided by this subsidy (2), the results for the variation in GDP due to the policy of IRE (3) and also the effect on GDP of every dollar spent in equalizations (3/1) in each Brazilian region. Additionally, the results for the transfer of the credit subsidy to the transport sector (4) are presented. Overall, perceptible changes are found in the regions GDP.

Table 3: Effects of the IRE expenditure and credit provided by this policy on GDP, and impacts of this subsidy transfer to the transportation sector on GDP, 2004 (R$ billion).

Brazilian regions	IRE[1] expenditure (1)	Rural credit supplied by IRE (2)	(Scenario 1)[2]	Multiplier (3/1)	(Scenario 2)[3]
NORTH	0.05	0.23	-0.64	-12.88	0.62
NORTHEAST	0.10	0.45	0.97	9.66	-0.90
MIDWEST	0.15	0.87	1.43	9.51	-1.17
SOUTHEAST	0.22	1.19	-1.47	-6.69	0.92
SOUTH	0.41	2.04	0.97	2.36	-0.28
BRAZIL	0.93	4.78	1.24	1.34	-0.81

Note: [1] IRE –Interest Rate Equalization.
Source: Search results.

Brazil spent R$ 0.93 billion in equalization, providing R$ 4.78 billion in rural credit to farmers. That is, the credit effectively applied were aproximately five times the amount spent on the equalizations. The IRE promotes an increase in GDP in the Northeastern, Midwestern, and Southern regions, and in Brazil as a whole. By contrast, it promotes a decrease in GDP in the Northern and Southeastern regions. The effect of the subsidy transfer to the transportation sector on GDP showed positive results for the Northern and Southeastern regions and negative results for the others regions.

The Midwest is a region in which agricultural subsidies provide the largest gain in GDP. In 2004, R$ 0.15 billion were spent with interest rate equalization, providing R$ 0.87 billion for rural credit, allowing an increase in GDP of around R$ 1.43 billion. Therefore, the multiplier effect on GDP is 9.51 times the amount spent with the IRE. That is, for every R$ 1.00 spent on equalization, there is an increase by R$ 9.51 in the Midwest GDP.

These results confirm the importance of those subsidies to the Midwestern region, marked by significant competitiveness of its agricultural products. This region is also a major generator of foreign currency, due to its capacity to export agricultural commodities, explaining the high rate of return for the IRE subsidy. Besides, the substantial rate of return from the IRE expenditure is associated with the commercial standard of the agricultural sector in the Midwest. That is, since the majority of the farmers are part of the Commercial Agriculture, equalization spending is lower, since commercial producers pay higher interest rates compared with family farmers, with the IRE costing less to the government. Low IRE spending, combined with the effect enhanced by a highly dynamic production, promotes a substantial rate of return in terms of GDP increase.

Regarding the alternative rate of return of the IRE in the Midwest, it is found that granting the equivalent IRE subsidy to the transportation sector from agriculture promotes a decrease of R$ 1.17 billion in the region GDP. Thus, by transferring the IRE subsidy to the transportation sector, this region would no longer earn R$ 1.43 billion but would still lose R$ 1.17 billion in GDP. Therefore, the rural credit IRE subsidy has no alternative rate of return in the Midwest, since the region gains the most by subsidizing interest rates for rural credit. This result also indicates that, although the logistics sector is the major bottleneck in the region, the subsidy granted to the rural credit in agriculture is much more cost-effective.

In the Northeast, the increase in GDP by the IRE policy is R$ 0.97 billion, compared to a subsidy expense of R$ 0.1 billion. Thus, the multiplier effect on GDP is 9.66 times the amount spent with the IRE policy, or, in other words, for every R$ 1.00 spent, there is a GDP gain of R$ 9.66 in the region. The rural credit subsidy is also associated with a significant

rate of return in the Northeast, a region that, despite the dynamism of some of its economic activities in recent years, still shows strong traces of subsistence agriculture. The economic growth observed by government spending with the IRE can boost this economy and reduce social problems, since PRONAF[10] is the credit modality that benefits the most from the IRE policy in the Northeastern region.

The IRE subsidy in the Northeast has no alternative rate of return in relation to its application to the transportation sector. By subsidizing rural credit, instead of granting the subsidy to the transportation sector, this region will not lose R$ 0.9 billion, but still earns R$ 0.97 billion in GDP. The Northeastern region gains the most with the IRE policy.

In the South, the multiplier effect on the IRE subsidy, in terms of generating economic growth, is more modest, compared to the Midwest and Northeast. This region received the largest amount of equalization funds in 2004, equivalent to R$ 0.41 billion, obtaining a gain in GDP of about R$ 0.97 billion, which provides a multiplier effect of 2.36 times the expenditure with the IRE. Thus, every R$ 1.00 spent on interest rates equalization generates an increase of R$ 2.36 in the Southern region GDP. Although the gains in economic growth in the South and in the Northeast were of the same magnitude, the IRE policy costs more in the South, and the subsidy is more cost-effective in the Northeast.

Regarding the alternative rate of return in the South, subsidy transfer to the transportation sector causes a reduction in GDP of R$ 0.28 billion. Thus, the IRE policy is not associated with alternative rate of return in the region, either.

The North and the Southeast are among the regions that do not benefit in terms of economic growth from the current IRE policy, with the latter being the most penalized.

The Southeastern region presents a GDP reduction of R$ 1.47 billion, while spending R$ 0.22 billion in equalization which provided R$ 1.19 billion in rural credit. Thus, the multiplier effect on GDP is negative, that is, every R$ 1.00 spent on IRE policy promotes a reduction of R$ 6.69 in economic activity in that region. The Southeastern region, in relative terms, has a comparative advantage in industrial production. The subsidy to agricultural production represents a stimulus to this sector, which provides a disincentive to the industrial activity. This implies that the IRE distorts production, shifting production factors from the industrial sector to the agricultural sector in the region and in other regions where this sector has the greatest comparative advantages. However, in this region, the economic activity gain

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[10] PRONAF -National Program of Family Farming.

in the agricultural sector is proportionally smaller than the loss of activity in the industrial sector, promoting a reduction in GDP.

The IRE policy in the Southeast is associated with alternative return. If the subsidy was transferred to the transportation sector, the region would not lose R$ 1.47 billion and would still earn R$ 0.92 billion in GDP. Therefore, an alternative rate of return of R$ 2.4 billion is estimated. This result is much more associated with the elimination of distortions caused by subsidies to agriculture in the region rather than to their imposition on the transportation sector[11]. The elimination of agricultural IRE promotes the redistribution of production factors, stimulating industrial production in the Southeast. The same analysis can be extended to the North.

The Northern region also has a comparative advantage in manufacturing production, as a result of the Manaus Free Zone. The IRE policy provided a negative multiplier effect on GDP of greater magnitude (12.88) in this region, since very little was spent with the policy in this region (R$ 0.05 billion) but the negative effect on GDP was of great magnitude (R$ 0.64 billion). Thus, it appears that every R$ 1.00 spent on equalization causes a decrease of R$ 12.88 in the region GDP.

In the North, as well as in the Southeast, IRE policy presents a positive alternative rate of return. If the subsidy was transferred to the transportation sector, the region's economy would cease to lose R$ 0.64 billion in GDP and still earn R$ 0.62 billion. Therefore, the alternative return for the IRE policy is R$ 1.26 billion.

 For Brazil, the aggregate result shows economic growth gains of around R$ 1.2 billion, compared to an IRE expenditure of R$ 0.93 billion. Thus, the multiplier effect on GDP is 1.34 times what it is spent on equalization, or, in other words, each R$ 1.00 spent on IRE promotes an increase of R$ 1.34 in GDP. That is, the rate of return of the IRE subsidy in terms of promoting GDP growth is 34.0%. It is clear that, for the country, the effects of IRE policy are positive, in terms of promoting economic growth. Moreover, the spending with the policy has no alternative rate of return. Thus, in terms of economic activity, rural credit IRE expenditure offers the highest gain when applied to agriculture. A positive effect of spending on IRE on Brazilian economic growth was also observed by Castro and Teixeira (2004).

The results can be explained by the relative importance of sectors in the economies of different regions of Brazil, given the mobility of factors (labor and capital) that is assumed in this study. In this sense, Table 4 shows the share of economic sectors in the Brazilian regions

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[11] In the simulation in which only the subsidy and subsidized credit are eliminated without granting subsidy to the transportation sector, the Southeastern region shows gain in GDP of around R $ 1.47 billion. By transferring the subsidy to the transportation sector, the gain in GDP is much smaller, R $ 0.92 billion.

GDP. The service sector has the greatest participation in all regions GDP. The industry GDP share are larger than the agriculture share in the northern and southeastern regions.

Table 4: Sectors Participation in the Brazilian regions GDP, 2004 (%)

	North	Northeast	Midwest	Southeast	South
Agriculture	11,35	15,16	21,39	10,77	22,01
Manufacture	32,23	19,59	10,61	38,04	28,66
Services	56,42	65,25	68,00	51,19	49,33

Source: IBGE (2009).

The key to understanding regional results is the possibility of mobility allowed by the model for the production factors labor and capital. One must remember that the movement of factors is an alternative to trade in goods and services. By the assumption of free factors mobility, allocation should occur in the same direction of the trade based on comparative advantage. That is, regions relatively more abundant in a productive factor are potential exporters of goods intensive in that factor and tend to see movement of this factor to other regions[12]. To support the discussion presented, the results for the mobility of capital (K) and labor (L) are shown in Figure 1, which presents the percentage change in the capital rate of return and wages paid in each region by IRE policy.

According to Figure 1, the Midwestern, Northeastern and Southern regions show increases in the return to capital and wages paid. In contrast, the Southeastern region show a reduction in both factors, and the Northern region, despite having experienced an increase in wages paid, show a more important reduction in the return to capital.

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[12] This factor movement does not occur as freely as represented by the model; thus, this interpretation must be met with caution.
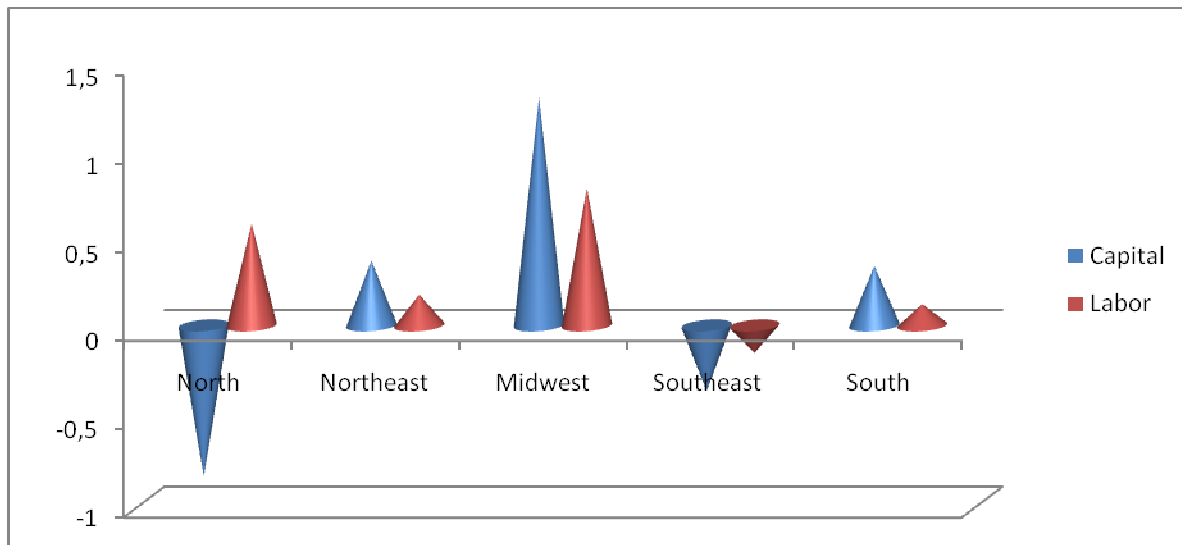
Figure 1: Percentage change in the capital rate of return and wages paid in the regions of Brazil as a result of IRE subsidy.

The subsidies distort sectorial production. The disincentive (relative) caused by the stimulus (relative) to the agricultural sector via credit subsidy in areas where the manufacturing sector has a much higher share than agriculture in the economy (North and Southeast) will lead to a reallocation of primary production factors to regions where agriculture accounts for larger participation in the economy. These regions will absorb the migrant factors, particularly in the agricultural sector, which is the activity stimulated by the incentive, and thus increase their activity level.

It was concluded that the IRE policy promotes economic growth in the regions whose productive pattern favors agriculture (the Midwest, Northeast and South), while in regions relatively more competitive in the manufacturing sector, (the North and Southeast), subsidy distorts production and does not present the same results. Thus, government spending with equalizations is cost-effective (in terms of economic growth) in the Midwest, Northeast and South, while providing no return on economic growth in the North and Southeast.

The results for the effect of the IRE on the regions' GDP, ultimately, suggest that policies play an important role in reducing economic inequalities since they transfer resources from the richest region, namely the Southeast, to disadvantaged region in terms of GDP, such as the Northeast. This may be a regional policy goal which has been met with success, since by redistributing productive factors can raise the economically disadvantaged regions to higher levels of economic growth and development. However, it is worthy noting that the Northern region, which can be considered economically poor, is penalized by the policy.

Another analysis concerns the effect of IRE policy on regional welfare. As subsidies interfere with the income of the economy, it exerts a direct impact on consumption, and therefore, in the welfare of agents. The changes in welfare resulting from variations in the utility of agents, measured in terms of increased income, are measured by equivalent variation. Figure 2 shows the welfare gains, measured by equivalent variation, in response to government spending on IRE policy (scenario 1). Also, Figure 2 shows the effects on welfare of a transfer of the credit subsidy to transport activities (Scenario 2).
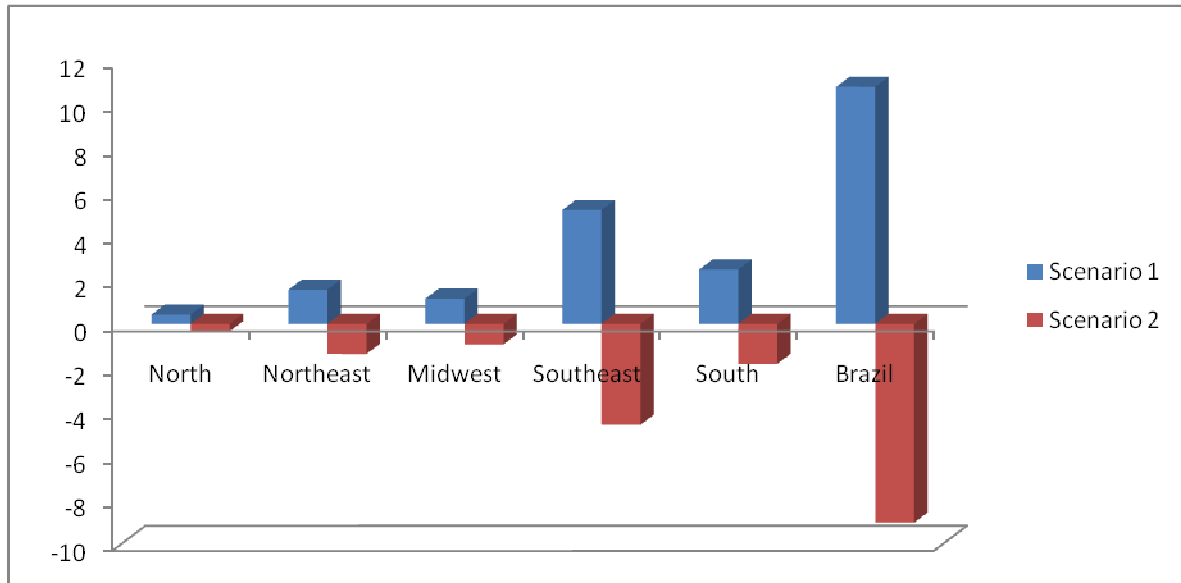

Figure 2: Comparison between changes in welfare in response to IRE policy (scenario 1) and to an alternative policy of subsidy transfer to the transportation sector (scenario 2), 2004 (in R$ billion).

The results indicate that government subsidy via IRE policy brings welfare gains to all regions (scenario 1), even in the North and South whose total effect on GDP was negative. Welfare is higher in the presence of the IRE because subsidies on agricultural products encourage increased production and consumption by reducing the price thereof. Brazil's earnings of R$ 10.8 billion were estimated in terms of welfare in 2004. Among regions, the southeast is the region where welfare increased the most, surpassing R$ 5.18 billion.

This effect is interesting because even though the South region has received the greatest amount of subsidy and the Midwest's GDP has increased the most, the Southeastern region has presented the largest gain in utility, even though it presented a decrease in GDP. The equivalent variation can be thought by the change in utility multiplied by the per capita regional income, i.e., by the size of the economy at the initial equilibrium. Thus, since the Southeast has more than 50% of national income, even a small variation in per capita utility

generates a great effect on the equivalent variation. It can be concluded that, in terms of welfare, the policy is cost-effective in all the regions.

It is noteworthy that when considering the results on the GDP, it should be borne in mind that the closure assumptions of the general equilibrium model directly influence the outcome. In the measurement of GDP, we consider changes in household consumption (C), government spending (G), investment (I) and the change in trade balance (X-M), i.e., the components of final demand. However, the closure assumptions dictate that investments and trade balance are exogenous and are kept fixed in their initial equilibrium levels, i.e., the observed changes in these components result only from changes in the prices of these aggregates and not at the cash flows. On the other hand, the welfare measure considers the change in household consumption, resulting from changes in goods and factors relative prices and in the income thereof, under the concept of hickisian equivalent variation. Thus, the welfare index is not directly affected by the closure of the model (hypothesis of exogeneity of investment and trade balance). Therefore, by construction, the measure of welfare is more accurate and realistic than the GDP measure.

Finally, Figure 2 also shows that, in terms of welfare, there is no alternative rate of return associated to government spending with IRE policy in the Brazilian regions, and thus, in the country as a whole. While the rural credit interest rates equalization policy promotes gain in welfare in all regions, the transfer of resource spent on this policy to the transportation sector (scenario 2) promotes a significant loss of welfare. However, it is important to note that the decrease in the agents welfare in this scenario (scenario 2) is due to the negative effects on consumption caused by the removal of the IRE subsidy. The effect of agriculture credit removal outweighs the positive effects granted by the subsidy transfer to the transportation sector.

It must be pointed out that the efficiency of IRE, in terms of economic growth or welfare, is mainly related to the mechanism of subsidizing rural credit interest rate, which provides a lot more credit than the amount the government spends on the policy. Also, the importance of strong agricultural inter-sectorial linkages should be taken into account, as it certainly contributes to policy efficiency.

4. CONCLUSION

The objective of this paper is to contribute to the debate on state intervention in the economy. Specifically, it aimed to measure the effects of the Rural Credit Interest Rates Equalization Policy (IRE) on economic growth and welfare of the Brazilian regions.

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Additionally, it aimed to measure the alternative rate of return of this subsidy when applied to the transportation sector. The model, database and software from the PAEG package were used.

The results suggest that regional issues in the intervention analysis deserve attention. The subsidy to the rural credit promotes higher economic growth than the cost of policy in the Midwestern, Southern and Northeastern regions. However, it leads to a decline in economic activity in the Northern and Southeastern regions. For Brazil as a whole, every R$ 1.00 spent on IRE policy provides a GDP growth of 1.34 times the amount spent with the policy; that is, the rate of return of the IRE subsidy is 34%. In relation to welfare, the IRE policy promotes welfare gain in all the regions of Brazil, being the aggregate gain to Brazil of R$ 10.8 billion. Thus, the gain in economic growth and welfare exceeds the monetary cost of the policy.

The IRE policy has no alternative rate of return in terms of economic growth in the Midwestern, Southern, and Northern regions. However, for the Northern and Southeastern regions the IRE policy is associated with alternative rate return. In terms of welfare, however, spending on IRE policy has no alternative rate return in all regions. In general, for Brazil, there is no alternative rate return associated with the IRE policy expenditure, by granting the equivalent IRE subsidy to the transport sector, in terms of economic growth, or even of welfare. Thus, the country is at its best opportunity gain subsidizing the rural credit interest rate.

Thus, the IRE policy proves to be effective, since it promotes economic benefits that outweigh its cost. This result allows two conclusions: the first suggests that some policies, i.e., governmental intervention in the economy, can generate higher gains in economic growth and welfare than the cost of the policy; the second finding suggests that the emphasis of policy-makers in maintaining agricultural subsidies for agricultural production in developed countries may be linked to social and economic rationality.

In regional terms, the policy contributes to a reduction in economic disparities, since it allows regions, such as the Northeast and Midwest, to achieve income growth, while the richer Southeastern region presents decrease in income growth. Thus, despite the fact that some regions did not benefit in terms of economic growth, the IRE policy must be maintained, especially if the goal is to reduce economic disparities among regions.

5. REFERENCES

BANCO CENTRAL DO BRASIL - BCB. **Anuário estatístico do crédito rural - 2004.** (www.bcb.gov.br). Acesso em: 18/05/2010.

BANCO CENTRAL DO BRASIL - BCB. **Anuário estatístico do crédito rural - 2010.** (www.bcb.gov.br). Acesso em: 15/04/2010.

BITTENCOURT, G.A. **Abrindo a caixa preta - o financiamento da agricultura familiar no Brasil**. Campinas: UNICAMP, 2003. 213 p. Dissertação (Mestrado em Desenvolvimento Econômico, Espaço e Meio Ambiente) - Universidade Estadual de Campinas, 2003.

CARDOSO, D. F. **Efeitos da política de equalização das taxas de juros do crédito rural nas regiões brasileiras**. UFV: 2011. 179 p. Dissertação (mestrado em Economia Aplicada) – Universidade Federal de Viçosa, 2011.

CASTRO, E. R. **Efeitos dos gastos com a equalização das taxas de juros do crédito rural na economia brasileira**. UFV: 2004. 82 p. Dissertação (mestrado em Economia Aplicada) – Universidade Federal de Viçosa, 2004.

CASTRO, E. R.; TEIXEIRA, E. C. Retorno dos gastos com a equalização das taxas de juros do crédito rural na economia brasileira. **Revista de Política Agrícola**. Ano 3, n. 3, Jul./Ago./Set. 2004. p. 52 a 57.

CASTRO, E. R. ; TEIXEIRA, E. C. Crédito Rural e Oferta Agrícola no Brasil. **Revista de Política Agrícola**, v. XIX, p. 9-16, 2010.

CASTRO, N. Custos de transporte e produção agrícola no Brasil, 1970-1996. **Revista Agric. São Paulo**, SP, 49(2): 87-109, 2002.

GLOBAL TRADE ANALYSIS PROJECT – GTAP, 2001. (http://www.agecon.purdue.edu/gtap/). Hertel, T. W. (ed.) **Global trade analysis: modeling and applications.** Cambridge University Press, Cambridge and New York, 1997.

GONÇALVES NETO, W. **Estado e agricultura no Brasil: Política agrícola e modernização econômica brasileira 1960-1980**. São Paulo: Hucitec, 1997.

GURGEL, A.C.; PEREIRA, M.W.G.; TEIXEIRA, E.C. **A estrutura do PAEG.** PAEG. Technical Paper No.1. Viçosa: DER/UFV. (2009). 14 p.

HARBERGER, A. C. The incidence of the corporation income tax. **Journal of Political Economy**, v. 70, n. 3, p. 215-240, June 1962.

HERTEL, T. W. (ed.) **Global trade analysis: modeling and applications.** Cambridge University Press, Cambridge and New York, 1997.

JENSEN, H. T.; ROBINSON, S.; TARP, F. Measuring agricultural policy bias: General equilibrium analysis of fifteen developing countries. **American Journal of Agricultural Economics**, 2010, vol. 92, issue 4, p. 1136-1148.

MINISTÉRIO DA FAZENDA. Disponível em: www.fazenda.gov.br. 2003.

NARAYANAN, B.; WALMSLEY, T. L. (Eds.). (2008). **Global trade, assistance, and production: The GTAP 7 data base, center for global trade analysis**. Purdue University. Disponível em: https://www.gtap.agecon.purdue.edu/databases/v7/default.asp. Acesso em: 01/12/2009.

PARRÉ, J.L**. O agronegócio nas macrorregiões brasileiras: 1985 a 1995.** Piracicaba, 2000. 191 p. Tese (doutorado) – Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo.

PEREIRA, M.W.G.; TEIXEIRA, E.C. **Construção da 2ª. base de dados do PAEG.** PAEG Technical Paper N.3. Viçosa: DER/UFV.2009. 8 p.

RUTHERFORD, T. F., PALTSEV, S. V. *GTAPinGAMS and GTAP-EG***: global datasets for economic research and illustrative models**. Working Paper, Department of Economics, University of Colorado, 64 p., 2000. (http://nash.colorado.edu/gtap/ gtapgams.html).

RUTHERFORD, T. F. (2005). **GTAP6inGAMS: The Dataset and Static Model**. Prepared for the Workshop: "Applied General Equilibrium Modeling for Trade Policy Analysis in Russia and the CIS" The World Bank Resident Mission, Moscow. December 1-9, 42p.

SECRETARIA DO ORÇAMENTO FEDERAL (SOF). **Estatísticas Fiscais**. Disponível em: www.portalsof.planejamento.gov.br. Acesso em: 15/08/2010.

STÜLP, V.J.; PLÁ, J.A. **Estudo do setor agroindustrial da soja**. Universidade Federal do Rio Grande do Sul, Porto Alegre, 1992. 168p.