SPILLOVER EFFECTS OF RURAL CREDIT: A CGE APPLICATION FOR BRAZILIAN REGIONS

Talita Priscila Pinto[1]
Cicero Zanetti de Lima[2]
Angelo Costa Gurgel[3]
Erly Cardoso Teixeira[4]

ABSTRACT

This research aims to determine the spillover effects of rural credit promoted by the interest rate equalization policy (ETJ) on the Brazilian regions. This study uses the General Equilibrium Analysis Project for the Brazilian Economy (PAEG) to perform the analytical simulations. The results suggest that food, chemical, plastic and rubber, textile, and wood and furniture industries are indirectly positively affected by ETJ policy in Southern, Southeastern and Midwestern Brazil. The effects on service industry is small for all regions. For poor regions like the Northearn and Northeastearn, the results suggest a better public policy planning to maximize the direct and indirect effects.

Key words: rural credit, sectorial *spillover*, general equilibrium.

JEL code: C68, Q14, Q18.

[1] PhD candidate in Applied Economics at Federal University of Vicosa, Brazil. E-mail: talita01@hotmail.com
[2] Visiting PhD student at MIT Joint Program on the Science & Policy of Global Change and student in Applied Economics at Federal University of Vicosa, Brazil. E-mail: czlima@mit.edu
[3] Professor, Sao Paulo School of Economics, Brazil. E-mail: angelo.gurgel@fgv.br
[4] Voluntary Professor, Agricultural Economics Department at Federal University of Vicosa, Brazil. E-mail: teixeira@ufv.br

1. INTRODUCTION

This research aimed to determine the spillover effects of rural credit promoted by the interest rate equalization policy (ETJ) on the agricultural sectors in Brazilian regions. ETJ is a policy to cover the rate differential among the cost of obtaining the funds by official financial institutions and the charges for the farmer. We use the General Equilibrium Analysis Project for the Brazilian Economy (PAEG) (Teixeira *et al.*, 2013).

Among other numerical methods, the CGE models are widely employed by various national and international organizations (IMF, World Bank, IDB, OECD, ECLAC, etc.). CGE models use the general equilibrium theory and combine behavioral assumptions on rational economic agents with the analysis of equilibrium conditions. These models have studied policy both qualitatively and quantitatively. Alternative quantitative techniques have been used for public policy analyses (Piermartini and Teh, 2005).

There are several studies in the literature that use CGE models to measure the effects of several trade and sectorial policies. For example, Harrison et al. (1997) and Teixeira (1998) investigate the possible reducing effects in trade barriers and tariffs on agribusiness products in the Uruguay Round. Harrison et al. (2003), Cline (2003), Rae and Strutt (2003), Cypriano et al. (2003), Conforti and Salvatici (2004), Buetre et al. (2004) and Gurgel (2006), among others, have investigated the expected effects of the Millennium Round and full trade liberalization of agricultural markets worldwide.

As for the national literature, Ferreira Filho (1999), Gurgel and Campos (2003) and Gurgel *et al*. (2009) addressed the impact of trade policies on the agricultural industry. There are recent studies by Gonçalves *et al*. (2014), de Lima *et al*. (2014), Pinto *et al*. (2014) on trade policy that investigate how different trade policies for the Mercosur, total liberalization of trade between the United States and the European Union, and Free Trade Areas, affect Brazilian agribusiness.

Gurgel (2014) analyzes a series of trade and industry policies through a CGE model. Regarding sectorial policies, the author points out that the agricultural policy to support production is essential for the for sustained production of food, fiber and bioenergy in the country.

According to Cardoso *et al*. (2014), the ETJ policy is an important subsidy for agriculture that increases both production and the demand for agricultural inputs. Formally, the ETJ is an action intended to cover the rate differential between the cost of obtaining the funds from official financial institutions, plus the administrative and tax costs of these

institutions, and the charges that credit borrower have to pay. With the ETJ policy, the Federal Government sought to expand compulsory participation of private banks in financing the rural sector as a way to expand – without burdening the Brazilian National Treasury – the volume of resources available to the sector (Gonçalves Neto, 1997).

The current ETJ policy ensures about 30% of the total resources applied to agricultural sectors in Brazil. However, Bittencourt (2003) indicates that the regional distribution of rural financing in Brazil is not homogeneous. The distribution amount is close to the gross value of agricultural production in each region. Moreover, Cardoso *et al*. (2014) corroborate this regional inequality and claim that any analysis of the Brazilian rural areas must take into account such differences.

As for the sectorial policies that directly affect Brazilian agribusiness, Rodrigues *et al*. (2007) investigate the effects of income stabilization policy on family farms. Santos and Ferreira Filho (2007) address the tax policy impact on the consumption of food and agriculture. In the scope of this work, Castro and Teixeira (2004, 2012) investigate the interest rate equalization policy. The authors estimate the impact of ETJ policy on GDP growth using input-output matrices. The results indicate that the effects generated by ETJ policy on economic growth outweigh the costs of implementation thereof. This type of modeling, although very useful, is unable to fully specify agents' behavior as well as the primary factors representation in production markets and their restrictions.

In order to analyze these limitations, Cardoso and Teixeira (2013) investigated the effect of ETJ policy on agribusiness development in different regions of Brazil. The authors approach the problem using a CGE model calibrated for 2004 aiming to capture the effect of the policy considering that the entire amount of credit made available via ETJ is intended for the purchase of intermediate inputs. The authors conclude that the ETJ policy favors the whole chain of agribusiness and has sectorial impacts on the chemical, food and transport industries.

However, Pinto (2015) introduces a new methodological approach for assessing ETJ policy. Considering the effects of different degrees of mobility of production factors, the author points out that the results are sensitive to the different mobilities and may be overestimated when considering the full mobility of the primary factors, which is observed in the works by Cardoso and Teixeira (2013). The results indicate that despite the social costs, the policy generates economic growth for Brazil. However, the Brazilian regions present different patterns. In terms of welfare, the results show a positive change for all Brazilian

regions under the different mobilities analyzed, except when considering the partial mobility of the primary factors in the North.

Thus, it is used a computable general equilibrium model that takes into account, through the input-output matrices database, the structure of interdependence between sectors and Brazilian regions. Moreover, Pinto (2015) claims that there is an interest in determining the rural credit spillover effects on other sectors of Brazilian economy. The ETJ policy is known for generating welfare gains and economic growth when compared to spending in intermediate consumption of the agricultural sectors.

This work, according to Pinto (2015), differs from Cardoso and Teixeira (2013) in some aspects, such as: (*i*) it use of the GTAP8.1 database updated for 2007 as well as the rural credit data for the same year; (*ii*) distinct methodological approach for the implementation of rural credit in the model; (*iii*) the results are decomposed in different simulated scenarios; and (*iv*) sensitivity analysis of the results of the model.

The text is divided into two further sections besides this brief introduction. The methodology, model and initial calibration data are presented in the next section. The results are presented in the third section, followed by the references and appendix.

2. METHODOLOGY

Applied General Equilibrium models follow a Walrasian theoretical basis where the economy is competitive and has two main actors, producers and consumers. The agents produce, consume and sell services and products. Consumers, with their budget constraints and preference baskets, demand goods and maximize their utility function. Preferences are hypothetically continuous and convex, and their resulting continuous demand functions are zero degree homogeneous with regard to prices, i.e., only relative prices can be determined.

For production, technology is described by a production function with constant returns to scale, which means that, in equilibrium, the profit of firms is zero. Firms are assumed to have a specific technology of production and demand factors to minimize their costs. These models allow analysis of direct and indirect effects arising from changes in public policies, such as tariff shocks, tax rates and endowments (Teixeira, Pereira, Gurgel, 2013, p.14).

2.1. PAEG Model

PAEG is a static, multi-regional and multi-sector model elaborated according to GTAPinGAMS (Rutherford and Paltsev, 2000; Rutherford, 2005) which, in turn, stems from the GTAP (Hertel, 1997; GTAP, 2001). Additionally, PAEG database for the Brazilian economy was disaggregated to represent its five main regions — Midwest, North, Northeast, South, and Southeast — keeping the GTAP aggregation for the other regions of the world, i.e., PAEG is capable to represent the trade among Brazilian regions and the rest of the world. (Teixeira, *et al.*, 2013).

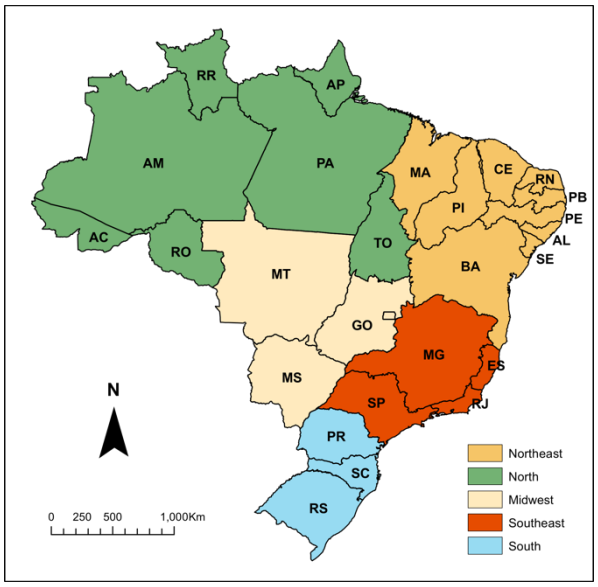

Figure 1. Map of Brazilian Regions in the PAEG model.

The regions are represented by a final demand structure and agents present an optimizer behavior. They maximize their well-being subject to budget constraint and consider investment rate and production in the public sector as fixed. The productive sectors minimize costs with a combination of intermediate inputs and primary factors given technology. Bilateral trade flows among regions, transport costs, taxes and/or subsidies are also present in the database (Gurgel *et al.*, 2011).

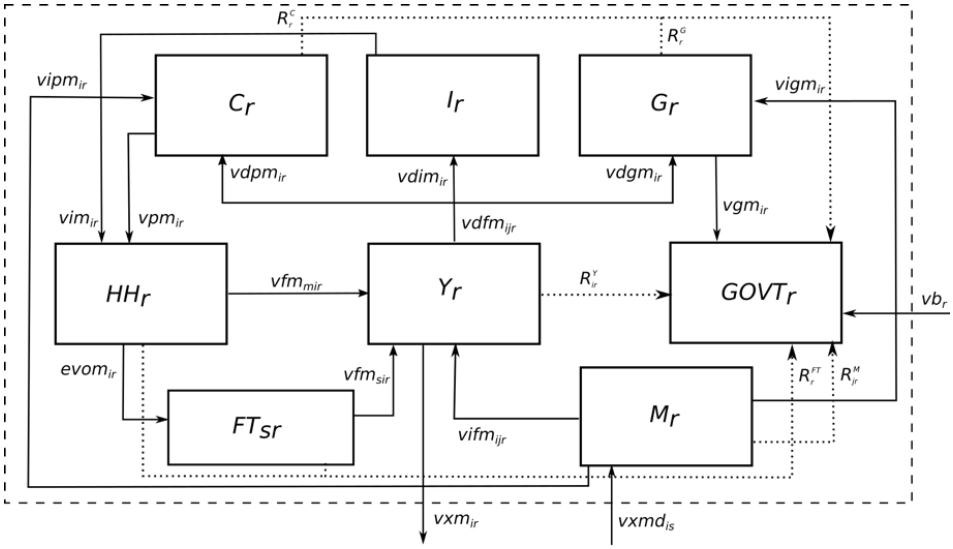

Figure 2. Regional economic structure of the PAEG model.

The economic structure underlying the PAEG dataset and model is illustrated in Figure 2. In a region *r* marked by dashed line the symbols in the flows chart correspond to variables in the economic model, and small letters are the parameters associated to the them. Solid arrows represent the flows of each variable. Y_{ir} is the production of good *i* in region *r*, C_r, I_r, and G_r is private consumption, investment, and public demand, respectively. Tax revenues and transfers are indicated by dotted lines. R_{ir}^Y, R_r^C, R_r^G, R_r^{FT}, R_{jr}^M are the tax flows defined by indirect taxes on production, consumption, public demand, factors of production, and imports, respectively.

2.2. Model aggregation and calibration

This research uses the same database as GTAP8.1. It is consolidated in 134 regions and 57 commodities for 2007. The database has been adapted to obtain thirteen regions in the model. Brazil is disaggregated into five main regions and there is also the United States, European Union, China, Rest of NAFTA, Rest of America, Rest of Mercosur, Venezuela, and Rest of the World. The commodities were aggregated into 19 sectors presented in Table 1. The agricultural sector showed the greatest disaggregation.

Table 1: Aggregation of Sectors, Regions, and Factors of Production in PAEG.

Sectors	Acronym	Regions	Acronym
Rice	(pdr)	Northern Brazil	NOR
Corn and cereals	(gro)	Northeastern Brazil	NDE
Soy and other oils	(osd)	MidWestern Brazil	COE
Sugar cane, sugarbeet and sugar industry	(c_b)	Shoutheastern Brazil	SDE
Meat and livestock	(oap)	Southern Brazil	SUL
Milk and dairy products	(rmk)	Rest of Mercosur	RMS
Agribusiness products	(agr)	Venezuela	VEM
Foods	(foo)	United States	USA
Textile Industry	(tex)	Rest of Nafta	RNF
Clothes and shoes	(wap)	Rest of America	ROA
Wood and furniture	(lum)	Europe	EUR
Cellulose and grafic industry	(ppp)	China	CHN
Chemical, plastic and rubber industry	(crp)	Rest of the world	ROW
Manufactured	(man)		
Gas, electricity, and water distribution	(siu)	Factors of Production	Acronym
Building	(cns)	Capital	cap
Sales	(trd)	Labor	lab
Transport	(otp)		
Service and Public administration	(adm)		

Source: Research data.

The Brazilian National Treasury provides aggregated government expenditure on ETJ policy as well as divided among its modalities. It was necessary to determine the share of each model sector in the ETJ policy likewise the value provided in rural credit for each culture in each region.

We divided the total spent on ETJ and rural credit in two categories – Family Agriculture and Commercial Agriculture. This partition was performed to represent more accurately the sharing of the resources, given the intrinsic characteristics of each group in Brazil. The values of rural credit for distribution between groups, regions, and cultures in the model were obtained on the Statistical Yearbook for Rural Credit (Brazil's Central Bank, 2014),

An effort was made to consider the total credit provided to producers, but in the case of credit for investment only the data for specific activities were used. The credit provided for the construction of dams, warehouses, soil improvement, machinery was not used, since these resources could not be distributed among the agricultural sectors in the PAEG model.

The credit for investment considered in this research was that specifically used in perennial crops, agriculture, and animals acquisition for livestock. A high percentage of the total credit volume was considered in the survey. The lowest percentage was granted to the Northern region, approximately 72%, and the greatest to the Midwestern, around 81%.

Table 2 shows the ETJ spending distribution as well as the percentages of the regions and sectors. A total of BRL 2,894.0 million in ETJ subsidy were made available in the PAEG

model. Out of this amount, the sectors of other agricultural products (wheat, fiber, fruits, vegetables, etc), and meat and live animals received the highest subsidy volume, 29.7% and 22.4%, respectively, followed by corn and other cereals, soybeans and oil seeds with 15.2% and 12.6%, respectively. The sectors of sugarcane and sugar industry, dairy products, and rice received 8.1%, 7.6% and 4.4%, respectively.

The South benefited most and received 36.9%. Corn and cereals, and other agricultural products received almost 50% of the subsidy in the region. The Southeast, with 33.6%, better divided into sugarcane, 19.7%, meat and live animals, 16.2%, and other agricultural products 41.5%. The Midwest received BRL 416.9 million; 25.3% for soybean sector, and 37% for meat and live animals. The North and Northeast were granted, BRL 107.9 and BRL 328.2 million, respectively. The sectors meat and livestock, and other agricultural products benefit the most from these regions.

Table 2. Interest rate equalization policy (ETJ) distribution (BRL million) and its percent (%) in PAEG model sectors and regions.

Sectors/Regions	Northern		Northeastern		Midwestern		Southeastern		Southern		Brazil	
	BRL	%	BRL	%	BRL	%	BRL	%	BRL	%	BRL	%
Rice (pdr)	5.0	4.6	6.4	2.0	4.8	1.1	9.9	1.0	102.0	9.5	128.1	**4.4**
Corn and cereals (gro)	4.5	4.1	18.2	5.6	60.6	14.5	87.5	9.0	268.0	25.1	438.8	**15.2**
Soy and other oilseeds (osd)	6.2	5.8	19.2	5.8	105.4	25.3	29.4	3.0	204.9	19.2	365.2	**12.6**
Sugar cane, sugarbeet and sugar industry (c_b)	0.7	0.7	20.9	6.4	10.8	2.6	191.7	19.7	9.4	0.9	233.5	**8.1**
Meat and livestock (oap)	58.7	54.4	105.3	32.1	154.8	37.1	157.7	16.2	172.4	16.1	648.9	**22.4**
Milk and dairy products (rmk)	12.1	11.2	30.6	9.3	37.8	9.1	92.3	9.5	48.5	4.5	221.2	**7.6**
Agribusiness products (agr)	20.7	19.2	127.7	38.9	42.7	10.2	403.6	41.5	263.8	24.7	858.4	**29.7**
TOTAL	**107.9**	**3.7**	**328.2**	**11.3**	**416.9**	**14.4**	**972.0**	**33.6**	**1.068.9**	**36.9**	**2.894.0**	**100.0**

Source: research data.

The credit distribution available via ETJ policy and the percentage for regions and sectors follows the original subsidy distribution. It is noteworthy that BRL 14,021.8 million were made available in loans, in the model, for 2007. The Southern and Southeastern regions received the highest amount of resources. In the South, these resources were distributed for the sectors of corn, 24.3%; soybeans, 19%; and other agricultural products, 25%. In the Southeast, for sugarcane, 20.3%; and other agricultural products, 41.1%.

The Midwestern region received about 14.8% of the credit; for the soybean sector, 25.8%; for meat and live animals, 36.9%; and for corn, 14.6%. The Northern and

Northeastern regions were the least favored, receiving 10.8% and 3.6% of total loans via ETJ, respectively. It must be highlighted the wide use of credit for the meat and livestock sector in both regions, 31.5% and 54.5%.

The calibration process consists in determine the rates of ETJ and rural credit shock that were implemented in the model scenarios. The first part of Table 3 shows the ETJ rates, which is the ratio between the monetary amount spent on ETJ policy in each sector and its gross value of production in the region. The rates in the Northern region deserves attention for the sectors of rice, soybean, and milk and dairy products, which received large contribution from the rural credit. The corn and other cereals sector in the Midwest and South must also be highlighted, with rates of 14.3% for the former and 10.2% for the ladder.

Table 3. The ETJ tariff (%) used in the PAEG model and rural credit promoted by interest rate equalization policy (%) as percent of agriculture sectors output values.

ETJ tariff in the model (%)					
Sectors/Regions	**Northern**	**Northeastern**	**Midwestern**	**Southeastern**	**Southern**
Rice (pdr)	10.3	1.0	0.4	0.8	4.2
Corn and cereals (gro)	1.9	1.8	14.3	4.1	10.2
Soy and other oils (osd)	13.9	1.9	2.6	1.0	3.9
Sugar cane, sugarbeet and sugar industry (c_b)	0.9	0.5	2.1	8.2	0.5
Meat and livestock (oap)	7.0	3.4	2.0	2.2	2.3
Milk and dary products (rmk)	11.2	8.9	7.0	3.5	3.2
Agribusiness products (agr)	0.5	1.9	1.1	1.7	1.5
Rural credit by ETJ policy as percent of output value (%)					
Rice (pdr)	50.3	4.3	2.1	4.3	21.0
Corn and cereals (gro)	9.0	8.7	71.7	20.0	47.3
Soy and other oils (osd)	70.3	9.6	13.3	5.3	18.6
Sugar cane, sugarbeet and sugar industry (c_b)	4.7	2.5	10.7	41.7	2.7
Meat and livestock (oap)	32.9	15.4	10.1	11.0	11.1
Milk and dary products (rmk)	53.6	39.4	33.3	16.7	15.3
Agribusiness products (agr)	2.1	8.5	5.5	8.5	7.2

Source: research data.

The second part of Table 3 shows the rural credit share of in the gross value of production in each sector and region for 2007. The sectors of dairy products stand out with high percentage of credit in all regions, and corn and other cereals in the Midwest, Southeast, and South, 71.7%, 20%, and 47.3%, respectively. Credit for the sugarcane and sugar industry in the Southeast reached 41.7%; for rice sector in the North, 50.3%. These data show the spatial credit distribution and the main sectors that were granted the resources in the

calibration year. These data will support the analysis and interpretation of results as wel as the spillovers effects in each sector and region.

2.3. Strategic scenarios

The research analyzed two scenarios to verify the impacts of ETJ policy and rural credit on agricultural sectors, as well as the spillover effects on the economy. The scenarios were chosen to represent the decomposition of the economic policy effects under discussion. The strategic scenarios consider partial mobility of production factors — capital and labor — among Brazilian regions. This caveat is important because the PAEG model does not allow the move of production factors in other regions. There is an exception precisely for the five major Brazilian regions.

The following scenarios were simulated:

i. Removal of the ETJ subsidy (*cred_off*): only government spending with the ETJ policy in the agricultural sectors is eliminated from the economy.

ii. Removal of the ETJ subsidy and rural credit (*cred_on*): government spending with ETJ policy as well as all rural credit generated by the policy are eliminated. It allows this credit to circulate freely and be fully captured, given the attractiveness, by each sector of the model.

The challenge here is how to represent the removal of ETJ subsidy and credit in a CGE framework. The approach needs to be consist with the benchmark equilibrium and database as well as ensure that the credit available through the ETJ policy from agricultural sectors is now available in the economic system. It was created a scheme in the modeling to reallocate the credit in the economy, i.e., the volume will be available and according to the attractiveness of the sectors the model returns to the equilibrium condition.

The Figure 3 shows the technologic structure underlying a given sector *j*. To produce some amount of commodity *j* is required a fixed combination of intermediate inputs – domestic and imported – and primary factors capital and labor. The intermediate inputs are a combination of domestic and imported under elasticity of substitution *esubd* (for each commodity *i*). The primary factors are combined under elasticity of substitution *esubva* specific for *j* sector. A new fixed production factor (artificial) is added to the sectors benefited by the ETJ. To avoid distortions in the sector accounting, the new fixed factor should be considered as a perfect complement to the aggregate of other inputs and production factors. To enable the shock, i.e., the rural credit removal, the factor supply is reduced in the

same proportion as the ETJ rural credit granted to the sector. The new fixed factor *ETJ Policy* is specific for each commodity *i* and enters in the same level of the intermediate inputs and the aggregate primary factors, i.e., the model combines all the inputs in a Leontief technology.

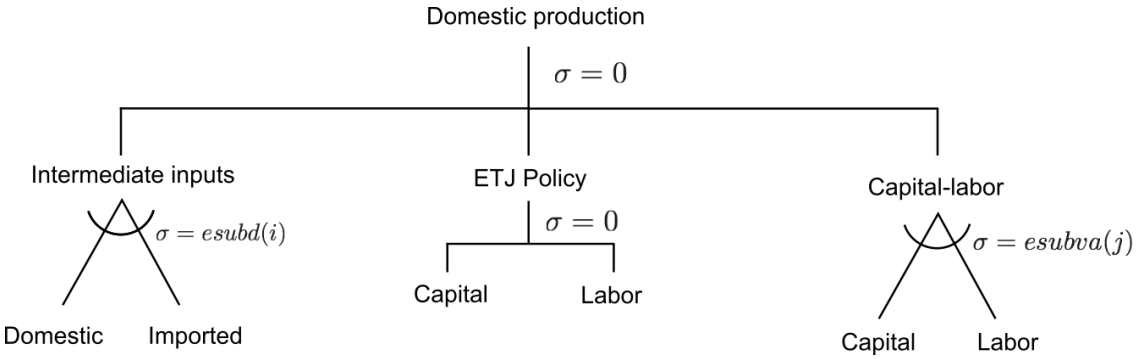

Figure 3. Production function with artificial fixed factor to represent ETJ policy.

In order to ensure that the agricultural sectors receiving ETJ can also be recipients of this credit – if they are competitive enough – the fixed factor is produced from a function that combines capital and labor. The proportions of capital and labor to produce *ETJ Policy* are the same of those factors in the total stock in the region.

The *ETJ policy* enters in the simulation through the changes in the tax flows (R_{ir}^{Y}). The ETJ policy – a subsidy for agricultural sectors – implies a greater supply and a decrease in the relative price of commodity. A greater supply increases the demand for intermediate inputs from other sectors, domestic or imported, i.e., stimulates the increase in production or importation of these inputs. The new supply means higher demand for regional primary factors, such as capital and labor, which increases the factors prices and the family's income in each region. This is one of the transmission mechanism implemented in the PAEG model.

By the other side a lower relative price of commodity stimulates an increase in consumption both for families, intermediate demand as well as exportation. If the commodity that receives the ETJ subsidy represents a reasonable share in family's consumption the lower relative price increases their welfare. The same dynamic is applied to other sector's output. The lower relative price of commodity stimulates the sectors to increase the demand as intermediate inputs and increase their output. If the commodity's share in total exports is higher the new exports are beneficial for other regions that buy the commodity.

The transmission mechanism has both backward and forward effects. The former is driven by increase in supply and increase in intermediate demand as well as primary factors

(positive effect). This effect stimulates domestic sectors (and sectors from other regions) that produce these inputs, which in turn are in competition for capital and labor with the sectors that received the ETJ subsidy (negative effect). The latter is driven by the lower relative commodity price that received the ETJ subsidy. The new favorable price both favors domestic and interregional production chains (positive effect). The increase in the factor prices is transmitted in a higher family's income and consumption (positive effect), which in turn change the composition in family's basket, i.e., decrease the demand for other goods (negative effect).

The spillover effects appear in a second-round through the changes in the cost structure in each sector, i.e., the new demand pattern determines the new values for intermediate and final demands as showed in Figure 3. The net effect is determined by the relative strength of each force, backward or forward. Also the final result is dependent of elasticities, and the shares of production, consumption, intermediate demand, both domestic and imported. Figure 4 summarizes the transmission mechanism associated with major first-order effects in the adjustment process underlying the model's structure.

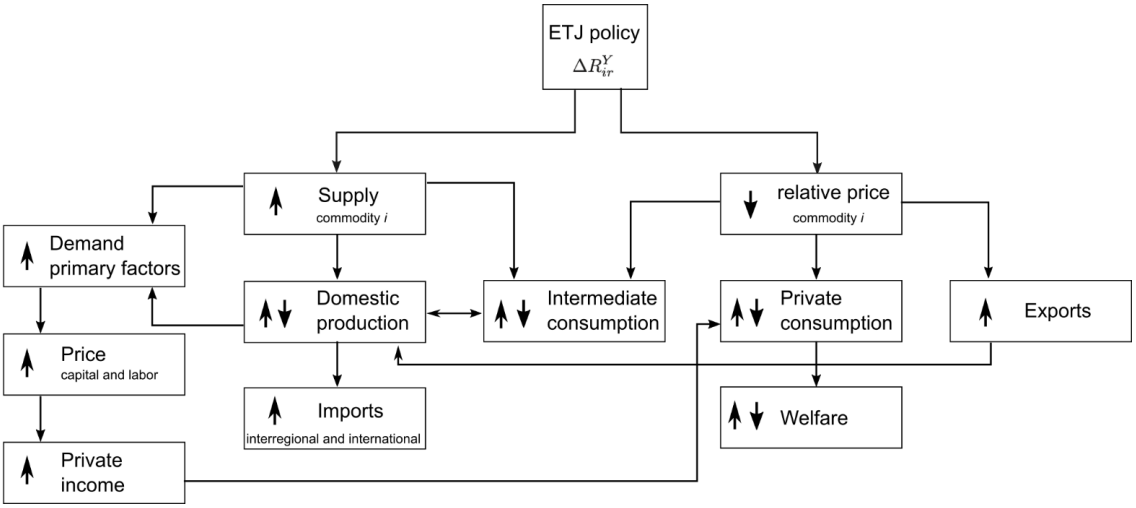

Figure 4. Causal relationship in the simulation.

2.4. Solution and Equilibrium conditions

The model is formulated and solved as a mixed complementarity problem (Mathiesen, 1985; Rutherford, 1995). Three inequalities should be satisfied: the zero profit, market clearance, and income balance conditions. Thus, a set of three non-negative variables is involved: prices, quantities, and income levels.

The zero profit condition

The zero profit condition requires that any activity operated at a positive intensity must earn zero profit. The inputs value must be equal or greater than outputs value. Under constant returns to scale activity levels y is the variable associated with this condition. If $y > 0$ then profit is zero, or the profit is negative and $y = 0$. For every sector in economy:

$$profit \geq 0, y \geq 0, output^T(-profit) = 0$$

The market clearance condition

The market clearance condition requires a balance between supply and demand for any good with positive price. Any good in excess of supply must have a zero price. The price vector p is the associated variable as well as includes prices of final goods, intermediate goods and factors of production. The following condition must be satisfied for every good and every factor of production:

$$supply - demand \geq 0, p \geq 0, p^T(supply - demand) = 0$$

The income balance condition

The income balance condition requires that, for each agent, including government, the value of income must be equal to the value of factor endowment and tax revenue:

$$income = endowment + taxrevenue$$

The model closure considers that the total supply of each factor of production does not change, but such factors are mobile between sectors within a region. The land factor is specific to the agricultural sectors, while natural resources are specific to certain sectors – mineral and energy resource extraction. There is no unemployment in the model. Therefore, factor prices are flexible. Investment and capital flows, and the balance of payment are kept constant at the initial equilibrium. Thus, changes in the real exchange rate must occur to accommodate changes in the flows of exports and imports after shocks. Government consumption can change as the prices of goods changes, and the net revenue from taxes will be subject to changes in activity level and consumption.

3. RESULTS AND DISCUSSION

The signs of all results will be reversed in order to facilitate the understanding. The scenarios simulate the removal of ETJ policy and rural credit, but their results (with inverted

signs) evaluate the impact of ETJ policy. Such an approach is justified in the fact that the policy is already present in the database for benchmark year.

Table 4 shows the results for welfare in each region. The results in welfare are calculated by Hicksian equivalent variation, i.e., changes in regional consumption from changes in income and prices of goods.

Table 4. Effects of the interest rate equalization policy (ETJ) on the welfare of Brazilian regions.

Scenarios/Regions	Northern	Northeastern	Midwestern	Southeastern	Southern
Subsidy effect (*cred_off*)	0.033	0.050	0.093	0.351	0.193
Total effect (*cred_on*)	-0.028	0.045	0.021	0.642	0.255
Credit effect	-0.061	-0.005	-0.072	0.291	0.062

Source: research results.

The welfare results are in agreement with the results of Pinto (2015). It is observed that there are welfare gains in all regions when considering only the ETJ subsidy. The largest welfare gain is in the Southeast, 0.351%, followed by the South, 0.193%. The two regions are the most benefited by the policy, 33.6% and 36.9% of the total subsidy, respectively. The other regions have small increase in welfare, i.e., the consumption also increases in these regions, but to a lesser degree compared to the other regions aforementioned.

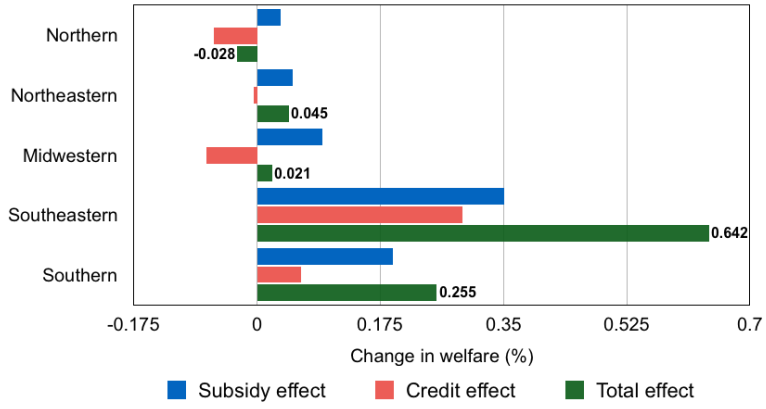

Figure 5. Effects of the interest rate equalization policy (ETJ) on the welfare of Brazilian regions.

However, when considering the decomposition of the shock in the rural credit scenario, the results are more intense for the Southeast and South. As for the other regions, according to Pinto (2015), there is a decline in welfare. The Midwest (-0.072%) and North (-0.061%) are the most affected. Cardoso *et al*. (2014) reports different results for the Northern

region, which confirmed that the results for welfare are sensitive to the mobility of production factors, as recommended in Pinto (2015).

The results are also sensitive to the determination of shock in the model. The greatest loss in welfare was observed in the Midwest, where the credit effect – difference among the scenarios – indicates the region's dependence on resource supply via rural credit. The result for welfare is US$ 3.47 billion in monetary and aggregate terms for Brazil as shown in Table A2. This result is also determined in Gurgel (2014) when loans to agricultural activities are considered.

The results indicate when the rural credit is removed from agricultural sectors it migrates to more economically attractive regions, given by regional sectorial technologies as well as the stock of primary factors before and after the shock. However, the migration of resources between regions is modeled to take into account some friction in the movement of the primary production factors, to prevent the occurrence of extreme cases, such as total or absent mobility.

Welfare analysis, given the free movement of rural credit, indicates that consumption increases due to the initial effect of the subsidy on the prices of agricultural goods. The Northern and Midwestern regions are among the most sensitive regions, and are dependent on the inflow of funds from rural credit in the agricultural sectors. It can be argued that these regions would be in better conditions without free credit circulation, i.e., the situation resulting from the current use of subsidized resources, in which welfare would be maximized.

The presentation of the results per sector will make them easy to understand. The results of sectorial percentage change in the model regions for the two simulated scenarios are given below. As expected, the agricultural sectors are the most affected by subsidies and rural credit.

Table 5. Percentage variation in sectorial production in each region of the model for simulated scenarios.

	Regions	**Northern**		**Northeastern**		**Midwestern**		**Southeastern**		**Southern**	
	Sectors	*cred_on*	*cred_off*	*cred_on*	*cred_off*	*cred_on*	*cred_off*	*cred_on*	*cred_off*	*cred_on*	*cred_off*
Agricultural	**pdr**	-0.98	-1.11	-3.08	-3.64	-5.11	-6.05	-0.60	-1.68	8.41	7.43
	gro	4.28	2.74	0.34	-0.92	3.91	2.53	6.38	4.77	5.38	3.99
	osd	-3.30	-4.16	-0.65	-2.57	7.51	5.84	4.44	2.15	7.66	5.99
	c_b	0.15	-0.04	0.11	-0.64	2.98	2.42	2.14	1.83	2.37	1.33
	oap	4.22	3.32	-1.02	-1.36	3.32	2.13	2.88	2.01	2.87	2.05
	rmk	0.67	0.17	-3.16	-3.18	3.29	1.72	3.29	2.49	3.97	3.04
	agr	-0.43	-1.43	0.21	-1.03	2.11	0.88	5.23	3.69	5.27	3.61
Industrial	**foo**	0.13	0.06	-0.50	-0.41	1.40	0.98	0.81	0.57	1.71	1.22

	tex	-0.42	-0.25	1.36	0.00	-0.46	-0.19	0.09	0.13	-0.53	-0.30
	wap	-0.01	0.06	-0.01	0.22	-1.18	-0.62	-0.88	-0.53	-0.56	-0.40
	lum	0.49	0.06	0.56	0.48	-0.69	-0.37	0.20	0.24	-0.23	-0.14
	ppp	-0.15	-0.07	0.09	0.04	-0.73	-0.39	-0.19	-0.07	-0.25	-0.17
	crp	0.65	0.06	0.00	-0.08	0.33	0.25	0.09	0.14	0.86	0.58
	man	-0.80	-0.26	-0.38	-0.07	-1.09	-0.49	-1.20	-0.61	-1.42	-0.81
Services	**siu**	-0.15	-0.12	-0.09	-0.05	-0.41	-0.28	-0.14	-0.12	-0.28	-0.24
	cns	-0.26	-0.15	-0.13	0.00	-0.71	-0.55	-0.03	-0.13	-0.52	-0.50
	trd	-0.10	-0.19	0.10	0.03	-0.03	-0.03	-0.02	-0.06	0.14	0.05
	otp	-0.10	-0.11	-0.11	-0.05	-0.01	0.01	-0.11	-0.08	0.11	0.06
	ser	-0.23	-0.16	-0.10	-0.01	-0.36	-0.29	-0.04	-0.09	-0.34	-0.30

Source: research data.
Note: The sectors are: **pdr –** rice; **gro –** corn and cereals; **osd –** soy and other oils; **c_b –** sugar cane, sugarbeet and sugar industry; **oap –** meat and livestock; **rmk –** milk and dairy products; **agr –** agribusiness products; **foo –** foods; **tex –** textile industry; **wap –** clothes and shoes; **lum –** wood and furniture; **ppp –** cellulose and graphic industry; **crp –** chemical, plastic and rubber industry; **man –** manufactured; **siu –** gas, electricity, and water distribution; **cns –** building; **trd –** sales; **otp –** transport; **adm –** service and public service.

In the *cred_on* scenario, where the impacts of the subsidy and rural credit are present, the positive effects on all agricultural sectors of the South can be highlighted. The sectors of rice, soybeans, and other agricultural products present total production variation of 8.41%, 7.66% and 5.27%, respectively. The same is true in the Southeast, except for the rice industry. Corn and cereals sector and other agricultural products present variation of 6.38% and 5.23% in the region. In the Midwest, soybean and oilseeds present variation of 7.51% in the total production value.

In the Northern region is a positive response from the sectors of corn and cereals, and meat and live animals, 4.28% and 4.22%, respectively. However, for the Northeastern region, only three sectors, corn and cereals, sugarcane, and other agricultural products have positive variation in production. The other sectors showed reduced production. This result can be explained by the initial allocations of the primary factors in the region, which, after the shock of the scenarios considered, cannot hold the same attractiveness for the other regions of the model. Another important feature is the fact that the regional agricultural sectors are highly dependent on the rural credit from the ETJ policy.

The volume of available credit leads all activities to compete for resources. Of course, since the resources are removed from the agricultural sectors, these are the most affected. Therefore, the application of credit for agricultural investment, according to Gurgel (2014) and Cardoso and Teixeira (2013), reveals the degree of importance of directing resources to purchase supplies or services for agriculture. When rural credit is provided across the board,

without the discrimination of specific sectors, even with competition among Brazilian regions, the agricultural system as a whole is more benefited.

Regarding the rural credit spillover effects via ETJ policy, the industrial sector of processed foods (foo) in the Midwest, Southeast, and South benefits from production increase by 1.40%, 0.81% and 1.71%, respectively. This result is justified by the degree of binding between the agricultural and food sectors in these regions, as highlighted by Castro and Teixeira (2004, 2012). The chemical, rubber industry and plastics (crp) also show positive growth in total output in these regions and in the North. Despite minor variations, 0.86% in the South, 0.33% in the Midwest, 0.09% in the Southeast, and 0.65% in the North, the sector holds an extensive share in the total regional "industry", as shown in Table A1. For the Southeast alone, for example, the sector accounts for 10.34% of the total regional production.

The results show interdependence between these sectors, either as demanders of agricultural products, which is the case of the food, wood and furniture industries, or as suppliers of agricultural inputs, such as the chemical, rubber and plastics industries. The resources allow the purchase of larger amount of upstream inputs, and increased supply of the product, which enhances the level of the downstream activity of the sectors. According to Castro and Teixeira (2004, 2012), Cardoso and Teixeira (2013) and Gurgel (2014), the results show the effects of inter-sectorial linkages in the economy, since the the shock is applied to the agricultural sectors and affects other sectors.

The Northern region also presents a positive response from the wood and furniture industry (lum) of 0.49%. The Northeastern region shows positive response from the textile (tex) and wood and furniture sectors, 1.36% and 0.56%, respectively. For Campos (2006), the textile industry has shown outstanding growth in the Northeast in recent years. Finally, the large sector of services, in spite of its high participation in regional total output, presents low connection with the agricultural sectors and insignificant and mostly negative response to the ETJ policy. The ETJ sectorial policy and rural credit are not able to generate significant spillover effects in these sectors.

Figure 6 shows the results for changes in prices' sectors in the regions of the model. As expected, the interest rate equalization policy reduces domestic prices by subsidizing agricultural production and slightly increases the prices of other industrial and service activities.

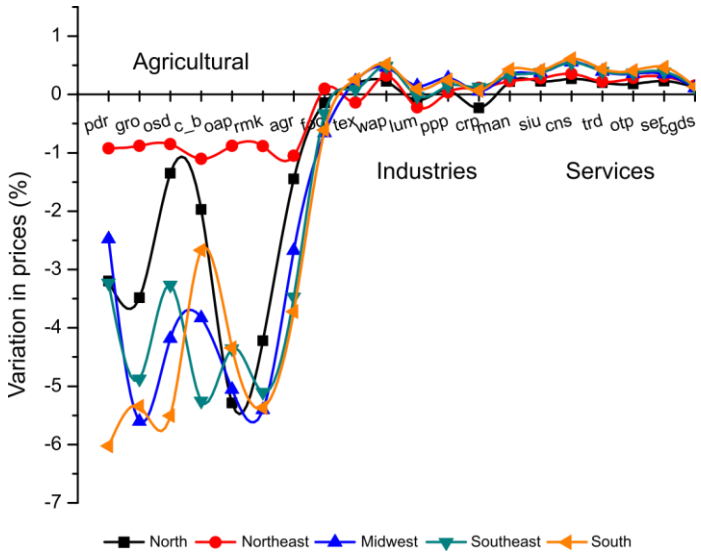

Figure 6. Variation in sectorial prices in each region of the PAEG model considering *cred_on* scenario for ETJ policy.

In short, there are very close variations in agricultural prices in the regions of the model. For example, the case of meat and livestock (oap), the variation in regional prices ranges between -4.5% and -5.5% for the regions. The same is observed for the milk and derivatives sector (rmk). In some regions, including the South, the price of rice sector (pdr) is more sensitive to the ETJ policy. The same is true for corn and other grains (gro) and soybean oil (osd) in the Southeast and Midwest. Agricultural prices in the North region are less sensitive to the ETJ policy.

3.1. Sensitivity analysis

In economic simulations implemented in CGE models, the assumptions related to some model parameters may affect the results. The sensitivity analysis carried out in the present work aims to assess how variation in these parameters affect the endogenous results of the model. Thus, this type of analysis is indispensable and corroborates the results. It is an important tool for the analysis and confirmation of the results obtained by the CGE model (Burfisher, 2011).

Table 6 shows the results of the sensitivity tests. The computational exercise was carried out only for *cred_on* scenario, which considers the effect of the subsidy and rural credit via ETJ policy. The last column in Table 6 shows the results of the simulated scenario and the other columns show the results for different elasticity values. The analysis used the *esubva* and *esubd* parameters, which the former is the elasticity of substitution between primary factors of production and the latter is the elasticity of substitution of domestic and

imported intermediate goods. The selection of parameters is explained by the disaggregation of the Brazilian regions in the model and the methodology proposed, which reallocates rural credit in the economy.

No sign change was observed in the results when considering welfare changes aiming at changes in *esubva* and *esubd*. Amplitude change was small for all values of the test in relation to the value of the original simulation, which it takes into account the initial values of *esubva*. These values show the robustness of the results.

The sensitivity test for GDP follows the same pattern. The amplitude change was small for all tested values, but when the parameter *esubd* takes 50% of its original value, against the *cred_on* scenario, for the Midwest, the GDP result changes from 0.007% to -0.010%, which changes its sign, comparing to the original one.

The major restriction to replacing intermediate inputs in the region reduces the possibility of growth through rural credit implemented in the model. However, these results represent an oscillation of around BRL 6.78 million in the region, which is extremely small, compared to the values of sectorial productions. The sensitivity analysis indicates that the values assigned to the parameters in the model calibration do not affect the results significantly, except when the replacement is restricted to intermediate inputs in the Midwestern region, with changed signal for the result in GDP.

Table 6. Percent change in welfare and GDP for different values of elasticity of substitution in value added (*esubva*) and elasticity of substitution in intermediate demand (*esubd*).

Regions	Welfare				
	***esubva**0.5**	***esubd**0.5**	***esubva**1.5**	***esubd**1.5**	***cred_on***
Northern	-0.017	-0.033	-0.031	-0.023	-0.028
Northeastern	0.053	0.030	0.042	0.057	0.045
Midwestern	0.029	0.018	0.017	0.023	0.021
Southeastern	0.653	0.654	0.638	0.632	0.642
Southern	0.268	0.252	0.250	0.257	0.255
			GDP		
Northern	-0.257	-0.264	-0.238	-0.226	-0.243
Northeastern	-0.098	-0.099	-0.098	-0.097	-0.097
Midwestern	0.004	-0.010	0.008	0.021	0.007
Southeastern	0.045	0.050	0.042	0.038	0.043
Southern	0.077	0.066	0.073	0.080	0.074

Source: research data.

* The values 0.5 and 1.5 account for 50% for less or plus, respectively, to the original value of elasticities.

4. FINAL REMARKS

The present study aimed to discuss the intervention of the state in the economy. It analyzes the effect of the interest rate equalization policy and rural credit on agricultural industries benefited as well as the spillover effects on the other Brazilian sectors.

The study was developed using the General Equilibrium Analysis Project for the Brazilian Economy (PAEG). The simulated scenarios eliminate the ETJ credit subsidy and all the rural credit generated by the policy from the agricultural sectors. Subsequently, this subsidized credit is reallocated to all sectors in the economy (including agriculture), according to their attractiveness.

Nowadays, the Brazilian macroeconomic scenario presents increase in the interest rate (*Selic rate*) and all other rates related to the agricultural industry, including TJLP (*Long run interest rate*). Thus, the government policy for investment and defrayal, such as interest rate equalization policy, becomes extremely attractive for these sectors. Increased rural credit access and better consulting plans allow these industries maintaining liquidity, even with low economic growth, since the rates paid are lower than the opportunity cost of investing resources.

Therefore, considering the aggregated results, increased welfare is observed in the Southern, Southeastern and Midwestern regions. The ETJ policy is efficient for improving the consumption by effect prices on agricultural goods. The effects on GDP are small in these regions, but represent a small economic growth.

Additionally, all agricultural industries in the Southern, Southeastern, and Midwestern regions, except for the rice industry in the latter region, increased their production value given the subsidized credit. However, the Northern and Northeastern regions suffered losses in agricultural industries, which indicates that the financial resources allocated to them are insufficient to generate regional economic growth. Increased support in production, with better consulting for projects and agricultural technicians to manage production and resources could be an alternative for maximizing the performance of these regions. The spillover effects are linked directly to agricultural industries. The food, chemicals, rubber and plastics, textile and wood, and furniture industries are indirectly affected by the ETJ policy. It is concluded that this type of government policy is effective increasing the value of industrial production and welfare, and generating spillover effects between the productive industries and regions.

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5. APPENDIX

Table A1. Percentage share of each industry and investment on total regional production in the PAEG model.

	Northern	Northeastern	Midwestern	Southeastern	Southern
Agricultural	**7.31**	**8.2**	**13.17**	**4.24**	**10.27**
1. Rice	0.06	0.3	0.8	0.12	0.62
2. Corn and cereals	0.32	0.52	0.32	0.24	0.72
3. Soy and other oils	0.07	0.59	2.99	0.33	1.45
4. Sugar cane, sugarbeet and sugar industry	0.10	2.02	0.38	0.24	0.46
5. Meat and livestock	1.04	1.43	5.53	0.71	1.96
6. Milk and dairy products	0.13	0.16	0.39	0.26	0.41
7. Agribusiness products	5.59	3.18	2.76	2.34	4.65

Industries	**32.9**	**25.15**	**13.66**	**41.93**	**35.13**
8. Foods	3.18	5.24	4.55	5.73	9.6
9. Textile Industry	1.58	1.64	0.77	1.47	3.58
10. Clothes and shoes	0.22	1.01	0.52	0.8	5.05
11. Wood and furniture	1.96	0.48	0.63	0.59	2.11
12. Cellulose and grafic industry	1.48	0.49	0.81	2.04	1.68
13. Chemical, plastic and rubber industry	3.88	9.96	3.86	10.34	4.07
14. Manufactured	20.6	6.33	2.52	20.96	9.04
Services	**50.28**	**58.99**	**64.06**	**46.15**	**47.35**
15. Gas, electricity, and waterdistribution	3.81	3.92	2.16	3.26	4.69
16. Building	16.42	13.8	12.98	3.01	6.29
17. Sales	5.98	9.4	5.37	5.71	6.68
18. Transport	1.54	2.66	2.31	4.25	4.25
19. Service and Public service	22.53	29.21	41.24	29.92	25.44
Investment	**9.51**	**7.67**	**9.12**	**7.67**	**7.26**

Source: research data.

Table A2. Welfare impacts in Brazilian regions in USD (billion).

	Regions					
	Northern	**Northeastern**	**Midwestern**	**Southeastern**	**Southern**	**Northern**
Welfare	-0.013	0.054	0.016	2.958	0.455	3.47

Source: research data.

Table A3. Values of Elasticity of substitution in intermediate demand (*esubd*), Elasticity of substitution in value added (*esubva*), and Elasticity of substitution among imported goods from different regions (*esubm*) in the PAEG model.

Sectors	**esubd**	**esubm**	**esubva**
Rice	5.050	10.100	0.250
Corn and cereals	1.300	2.600	0.250
Soy and other oils	2.450	4.900	0.250
Sugar cane, sugarbeet and sugar industry	2.700	5.400	0.250
Meat and livestock	1.576	3.038	0.250
Milk and dairy products	3.650	7.300	0.250
Agribusiness products	2.818	5.508	0.250
Foods	2.520	5.076	1.120
Textile Industry	3.750	7.500	1.260
Clothes and shoes	3.861	7.645	1.260
Wood and furniture	3.400	6.800	1.260
Cellulose and grafic industry	2.950	5.900	1.260
Chemical, plastic and rubber industry	3.300	6.600	1.260
Manufactured	3.715	8.021	0.951
Gas, electricity, and water distribution	2.800	5.600	1.260
Building	1.900	3.800	1.400

Sales	1.900	3.800	1.680
Transport	1.900	3.800	1.680
Service and Public administration	1.900	3.800	1.260

Source: research data.