CAPITAL INCREASE IN BRAZILIAN AGRICULTURE SECTOR: A VISION BASED ON COMPUTABLE GENERAL EQUILIBRIUM MODEL

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Abstract

In the last decade, the Brazilian agriculture has undergone several chances. One of them is the increase of grains production such as soybeans and corn beans which raises Brazil as one of top producer and exporter for these grains. To reach this position, was necessary to increase the planted area, by doing this the grain production expanded for unexplored areas that creates a new agricultural frontier. At the same time, consolidated grains planting areas were. The need for more areas of plantation caused an increase in the value of land, which caused an increase in the capital employed (invested capital). Therefore, all Brazilian agriculture and livestock were affected by this increase in land values. In this scenario, this paper aims to quantify the influences in import, export, international prices and value of production by the increase in invested capital, due to increase in land prices. The methodology used was modeling in computable general equilibrium and the main data input in the model is an Input-Output Table structured to represent the five macro-regions of Brazil and those interactions around the globe. The computable general equilibrium model chosen was the General Equilibrium Analysis Project for the Brazilian Economy (PAEG). Using this model, the results indicated that there was positive influence in importations, exportations and international commodity prices. However, the value of production had a drop down. Thus, this paper deals with a current and important theme for the Brazilian agriculture, that can help making efforts and decision by measure the impacts in increasing the planted area in the medium and long term.

Key words: Computable General Equilibrium, PAEG, Land market, Land values, Agriculture.

1. Introduction

In the last decade, the Brazilian agriculture has undergone several chances and raised the agribusiness sector to one of the most important in Brazil. According with the Federation of Industries of the State of São Paulo (Fiesp), Brazil has the second largest soybean production in the world with more than 104 million tons for the 2016/2017 crop, only behind the United States of America. Regarding the exportation of soybeans, Brazil is the main exporting country with around 59 million tons for the 2016/2017 crop.

All this increase of grain production and export reflects in Brazilian economy in positive ways. The agribusiness sector, which includes the livestock and agriculture, is responsible for more than 21% of the total Gross Domestic Product (GPD) in 2017 and about 79% in national value added (CENTER FOR ADVANCED STUDIES ON APPLIED ECONOMICS, 2017). The export of agricultural commodities is responsible for keeping the trade balance in surplus, and the employment in the countryside are important to maintain a stable employment level and ensure food security for the country. The Figure 1 illustrates the growth of agribusiness sector participation in Brazilian GDP over 10 years.

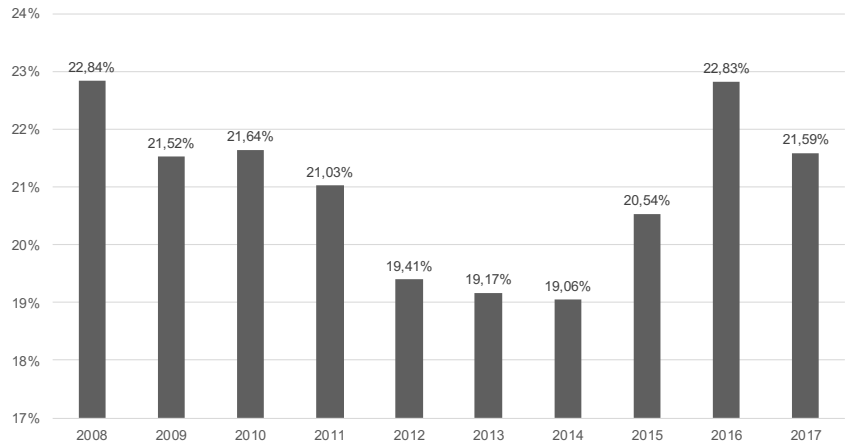

Figure 1. Agribusiness GPD participation in Brazilian GPD.
Source: Research data.
Note: Center for Advanced Studies on Applied Economics, 2017.

To support this level of participation in GDP, the Brazilian agribusiness increases the planted area over time. In the past 10 years the planted area has grown about 20% and the harvested area grew about 21%. One of the main causes for this is the increase of grains production such as soybeans and corn beans which raises Brazil as one of top producer and exporter for these grains. To reach this position, was necessary to increase the planted area, by doing this the grain production expanded for unexplored areas that creates a new agricultural frontier between the States of Maranhão, Piauí, Tocantins and Bahia, all in the Brazilian northeast, region known as Mapitoba. At the same time, consolidated grains planting areas were modernized in center-west and south of Brazil.

The expansion of agricultural and livestock production goes together with an increase in increase of planted area in all Brazilian regions. This increase in the area planted leads to the need to

expand new areas of cultivation and new agricultural frontiers (Sampaio, Sampaio & Bertrand, 2012). Not only the soybeans and the corn beans had their area planted increased, but the area for agriculture was raised in all regions of Brazil. To illustrate growth of the planted area, the Figure 2 demonstrates what happened to the level of total planted area over the last 10 years.

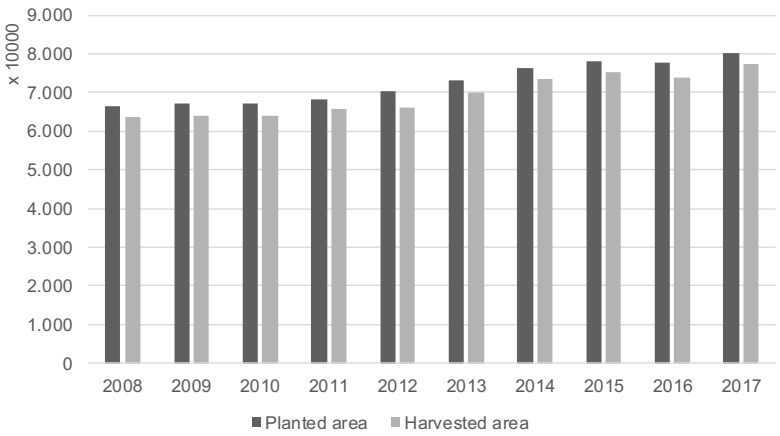

Figure 2. Planted and harvested area between 2008 and 2017.
Source: Research data.
Note: Brazilian Institute of Geography and Statistics (IBGE), 2017.

Especially for the soybean plantation, the increase of planted area was about 6% during the 2010/2011 and 2016/2017 crop affording with National Supply Company (Conab, 2017). This amount in planted areas was accompanied by the expansion of production to newer agricultural frontier areas, such Mapitoba and this factor are related to the increase of grain production. For Freitas (2011), this region stands out in the production of soybeans because of the stable climate, a balanced pluviometry and a flat topography, which is good for modernization and allow returns on investments for the producers.

Parallel to the increase in soybean production, export and planted area, there is an increase in the price of land due to the need to obtain more areas for planting. Some authors as Ferro & Castro (2013) and Asai & Piffer (2016) indicates that land has been appreciated in the last decades, both in areas of traditional soybean cultivation areas and in new agricultural frontier.

Considering the land as a production factor as Rahal (2003) said, the demand for the expansion of the planted area raises its price, in accordance to the supply and demand law. Other authors such Sayad (1977) and Gasques et. al. (2008) indicate that land prices are directly linked to two factors: those related to agricultural activities and those that are not directly linked to agricultural activity.

Among the factors resulting from the agricultural activity that affect the price of land, Oliveira & Costa (1977) indicates some of them as the prices received in agriculture for the producers and the prices paid for the inputs, as well as the technological index employed in the crops. In agreement, Rangel (2000) also cites agronomic innovations as a factor that influences the value of land.

Thus, the value of land becomes important for the cultivation of soybeans since it becomes possible to plant and gain efficiency and competitiveness of the national product against the market. Authors like Sayad (1977), Reydon & Plata (2000), Dias *et al.* (2001), Rahal (2003) and Reydon *et al*.

(2014) point out the value of land as part of the process linked to agricultural and livestock's activities, that is, the price of land is influenced by the activity linked to it.

Therefore, all Brazilian agriculture and livestock were affected by this increase in land values. In this scenario, what are the economic impacts (prices of the grains, production value and quantity exported) that the increase in the land value causes in Brazilian agriculture sector? To answer this question, the present paper will use a Computable General Equilibrium (CGE) model and the main data input in the model is an Input-Output Table structured to represent the five macro-regions of Brazil and those interactions around the globe.

The CGE chosen ins this paper is the General Equilibrium Analysis Project for the Brazilian Economy (PAEG) develop to represents a Brazilian economy in 19 sectors and 12 regions (five macro-regions of Brazil and seven other regions). Using this model, the main objective of the paper is to quantify the gains in production by the increase in invested capital, represented by the increase in land prices, that is, the needed for greater investment for the acquisition of new agricultural land.

Hence, this paper deals with a current and important theme for the Brazilian agriculture, that can help making efforts and decision by measure the impacts in increasing the planted area in the medium and long term.

The paper is structured in four main chapter include this one of introduction. The second one is to introduce de CGE model which will be used to capture the influences in Brazilian agriculture sector because the land appreciations. The third part is dedicated to present the results of the CGE model and describe the impacts caused in agriculture. To the end, the fourth chapter is the final considerations of the paper.

2. Methodology

The Computable General Equilibrium Model as the ability to represent the economy of a country and your commercial relationships with others inside a set of algebraic equations or accounting identities. To Sadoulet & De Janvry (1995) and Partridge & Rickman (1998), CGE models can capture the relationships among economic agents through the macroeconomic and microeconomic aspects present in the Input-Output Table.

The basic concept of a CGE model is describe by Wing (2004) as a circular flow of commodities in a closed economy, whose main variables are households, because they are the final consumer and own the factors of production. Additionally, the CGE characteristic is a zero-profit condition and the market equilibrium, managed by the Walrasian equilibrium that supply equals demand. Following the Walrasian proposition, economy is competitive and has two main actors: the producers and the consumers. The producer, consumes and sell services and products, while the consumers, demand goods and maximize their utility function governed by their budget constraints. Another assumption for CGE model is the constant returns to scale which implies that the profit of the firms in equilibrium is zero.

Among the most usual and updated CGE models found in the literature, there is a few such as: (i) Global Trade Analysis Project (GTAP) by Hertel (1997); (ii) Emissions Prediction and Policy Analysis (EPPA) used by Choumert *et al*. (2006) and Paltsev *et al*. (2005); and (iii) U.S. General Equilibrium (USAGE), used by Dixon & Rimmer (2004) and Dixon *et al*. (2007).

To fulfill the objective of this paper the CGE model chosen was the PAEG which uses part of GTAP model and its database. The next session will introduce a brief description of the PAEG model.

2.1. General Equilibrium Analysis Project for the Brazilian Economy – PAEG

In this paper the methodology used to investigate and quantify the impact of land appreciation on Brazilian agriculture is based on a quantitative descriptive and the research is focused on scenario analysis through CGE modeling.

The General Equilibrium Analysis Project for the Brazilian Economy is a static, multi-regional and multi-sector model, structured for represent the Brazilian economy and its interactions with other economies around the globe. According to Gurgel *et al.* (2011) each region presents in the model is represented by a final demand structure and each players, producer and consumer, act to maximize their welfare subject to their budget constraint, considering fixed investment, capital flow and public-sector production.

PAEG's structure is based on the *GTAPinGAMS* (Rutherford & Paltsev, 2000; Rutherford, 2005), adopting a nonlinear complementarity problem in the General Algebraic Modeling System (GAMS) developed by Brooke *et al*. (1998). For the programming language, PAEG uses a Modeling Programming System for General Equilibrium syntax (MPSGE) to solve non-linear complementarity problem in GAMS programming language develop by Rutherford (1999). All the PAEG structure, as well as their accounting identities present in the model, is described in Gurgel, *et al.* (2011).

The database used by the Global Trade Analysis Project (GTAP) was disaggregated by Teixeira *et al.* (2013), to portray the Brazilian economy in its five different macro-regions – Center-West, North, Northeast, South, and Southeast. However, the GTAP database has been preserved the other countries and of trade flows identical to the original ones.

The PAEG is divided into a total of 12 regions and 19 sectors in its most recent version, compatible with *GTAPinGAMS* in the seventh version, that refer to the world economy for the year 2011, as a way of representing the economic flows present in the CGE model. The regions, sectors and the factors of production considered in the PAEG are described in Figure 3.

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)	Southeastern 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)		

Figure 3. Regions and sectors presents in the PAEG model.
Source: Pinto, et al., 2016.

As Gurgel *et al.* (2011) and Teixeira *et al.* (2013) defines, PAEG model represents the way goods and services are produced in Brazilian and world economies. The regions are represented by a final demand structure and the behavior of the players is that of an optimizer in that they maximize their welfare. These authors indicated that the productive sectors minimize their costs with a combination of intermediate inputs and primary factors given technology. Such as bilateral trade, transport costs, taxes, subsidies are part of the model. A set of PAEG's database is indicated in the Figure 4.

Index	Description
i, j	Sectors and goods
r, s	Countries and regions
f $\in$ m	Mobility`s Free Production Factors among a determined region: labor; capital
f $\in$ s	Fixed Production Factors: Natural resources

Figure 4. Regions and sectors presents in the PAEG model.
Source: Gurgel *et al.*, 2011.

In order to combine the database, regions and sectors is created some variables to represents the regional economy into the model. The variables of economic model are Y_{ir}, as production of good i in region r. The C_r, I_r and G_r, are private consumption, investment and public consumption in region r. The M_{jr} represents the importation of good j by the region r, as well the HH_r is the variable for representative consumer. The public sector or government in region r is the variable $GOVT_r$ and the activity through which specific inputs are allocated to private sectors is the FT_{sr}.

To exemplify how regional economy is structured in PAEG model the Figure 5 illustrated the structure and the economic flows.

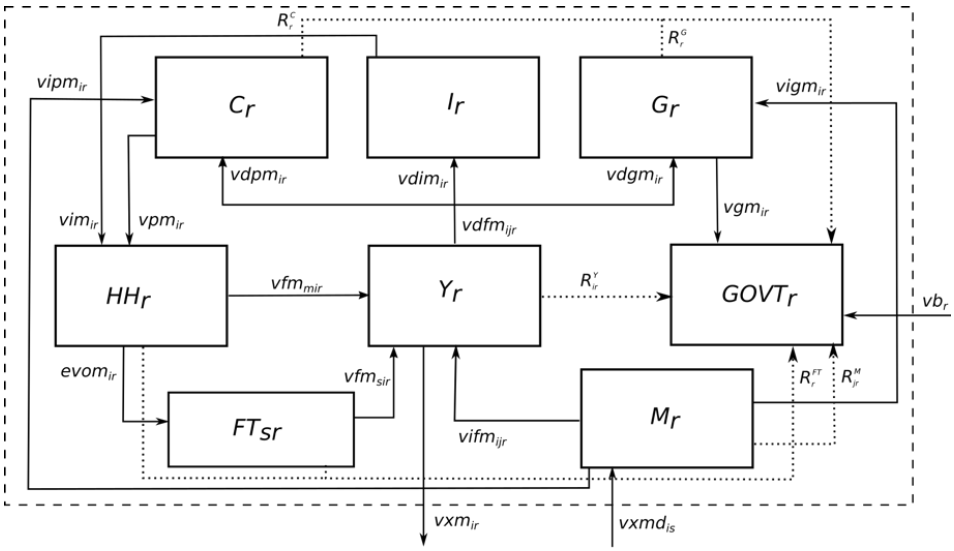

Figure 5. Regional economic structure and economic flow of the PAEG model.
Source: Pinto, et al., 2016.

In Figure 5, the dashed line defines a region r, the solid line indicates the flows of the variables and the dotted lines determinates the tax flow. Besides that, it is possible to see the variables – Y_i, C_r, I_r, G_r, M_{jr}, HH_r, $GOVT_r$ and FT_{sr}. – and the other parameters. These other parameters are the indirect taxes represents for the letter "R" and affects: production (R_{ir}^Y); consumption (R_r^C); public demand (R_r^G); factors of production (R_r^{FT}); and imports (R_{jr}^M).

Also, Figure 5 brings PAEG's accounting identity for the players and how each one affects the trade flow. Teixeira *et al*. (2013) define PAEG model as a perfect competition and constant returns to scale, with intermediate input costs and production factors being equal to the production value and, thus, economic profits equal zero. To fulfill all these conditions the base accounting identity for the variables in the model is indicated in Equation 1 through 7.

Y_{ir}: $$\sum_f vfm_{fir} + \sum_j \left(vifm_{jir} + vdfm_{jir}\right) + R_{ir}^Y = vom_{ir} \quad (1)$$

M_{ir}: $$\sum_s \left(vxmd_{isr} + \sum_j vtwr_{jisr} \right) + R_{ir}^M = vim_{ir} \quad (2)$$

C_r: $$\sum_i \left(vdpm_{ir} + vipm_{ir}\right) + R_{ir}^C = vpm_r \quad (3)$$

G_r: $$\sum_i \left(vdgm_{ir} + vigm_{ir}\right) + R_{ir}^G = vgm_r \quad (4)$$

I_r: $$\sum_i v\dim_{ir} = vim_r \quad (5)$$

FT_{fr}: $$evom_{fr} = \sum_{i} vfm_{fir} \qquad f \in s \tag{6}$$

YT_j: $$\sum_{r} vst_{jr} = vt_{j} = \sum_{irs} vtwr_{jirs} \tag{7}$$

Gurgel *et al.* (2011) describes step by step each how these accounting identities are calculated which are composed of: domestic production (vom_{ir}); exportation ($vxmd_{irs}$); international transportation services (vst_{ir}); intermediate demand ($vdfm_{ijr}$); private consumption ($vdpm_{ir}$); government consumption ($vdgm_{ir}$); investment ($v\dim_{ir}$); imported goods (vim_{ir}); goods used in the intermediate consumption ($vifm_{ijr}$); private consumption ($vipm_{ir}$); government consumption ($vigm_{ir}$); consumption of public agent ($vigm_{ir}$); exportation of good i by region r (vxm_{ir}); importations of good i by region r ($vxmd_{irs}$); international transport services (vt_{j}); value of transport service exportation (vst_{jr}); bilateral transport service flows acquired in importation of goods ($vtwr_{jisr}$); budget constraint of government (vgm_{r}); and budget constraint of representative agent ($evom_{fr}$).

Presented the basic structure of the model and its accounting identities, the main use of the CGE occurs through simulation and scenarios analysis. In this paper, scenarios of increase on invested capital in agriculture will be simulated, due to the increase of land prices during the last year. This scenario is possible because the land is considered a productive factor and is exclusively for agriculture in PAEG model.

2.2. Scenarios: increase on invested capital in Brazilian agriculture

To reach the objective of this paper and quantify the influences of land appreciation in Brazilian agriculture, a scenario is simulated through a productivity shock by capital increase into agriculture sectors. Through the scenario simulation it will be possible to quantify the changes in imports, exports and agriculture and livestock prices.

In order to concentrate the analysis, the Brazilian agriculture and livestock will be representing in five sectors in PAEG model, being rice (pdr), corn and cereals (gro), soy and other oils (osd), sugar cane, sugar beet and sugar industry (c_b); meat and livestock (oap) and agribusiness products (agr).

The increase in land prices will reflect in the expansion of the cultivated area since it will be necessary a superior investment in the purchase of new areas for openness and planting. The expansion of the agricultural frontier and, both planted and harvested area, indicates the need for acquire new areas by farmers from all macro-regions. If the land prices grow up, more expensive is to expand the agricultural areas by acquisition of the new ones. Thus, a scenario of increased invested capital in land brings the possibility of analyzing the impacts of the agricultural sector by the CGE.

Meanwhile, the land is considered a production factor. Authors such Pindyck & Rubinfeld (2009), Belik (2014) and Hoffmann & Ney (2016) comments that in agriculture the land is a productive

input, such as capital and labor, whose land is a determining factor for Brazilian agricultural production according to Rahal (2003).

In the classical microeconomic theory of, the value of the land can also be interpreted by the theory of fixed factors. In the long run, Varian (2003) places that certain factors are fixed for the economy. Specially in agriculture sector, the field of plantation is limited by the amount of land available for planting and this is fixed in the long-term equilibrium, since there is no way to produce more land artificially.

Consequently, the demand for new arable areas increases the price of land as occurs over the last decades. The Compound Annual Growth Rate (CAGR)[1] for agricultural lands in Brazilian macro-regions is about 13.63%, which is established in Figure 6.

Region	CAGR (%)
Midwestern Brazil	13.56
Northern Brazil	15.49
Northeastern Brazil	12.89
Southern Brazil	13.36
Southeastern Brazil	12.86
Brazil average	**13.63**

Figure 6. CAGR for agricultural land price in Brazil between 2002 and 2016.
Source: Research data.
Note: data extract from Informa Economics FNP, 2002 - 2017.

To simulate the scenario with the productivity shock on invested capital in Brazilian agriculture sector, the CAGR will be considered imputing these values of Figure 6 in the PAEG model. The incidence of the capital increase will occur into a factor of production named capital (cap) in agricultural sector.

This scenario is justified with the ideas of technical change and the aggregate production function. The capital increase will affect directly the Y_{ir} where the region r is Brazil and good i are the agricultural products selected in the model (pdr, gro, osd, c_b, oap and agr). Therefore, those depends on the interaction of capital (K) and labor (L) over time (t), following the Solow (1957) idea which the aggregate production function is calculated by Equation 8.

$$Q = F(K, L; t) \tag{8}$$

Thus, with this CGE simulation it will be possible to know and quantify the influences of the increase in land prices for Brazilian agriculture. Through the productivity shock directly affecting the Brazilian agricultural sector that resulted in the effects on the entire Brazilian and world economic balance.

[1] The CAGR is calculated by equation $\mathrm{CAGR} = \left(\frac{Value_t}{\mathrm{Value}_{t-n}}\right)^{\left(\frac{1}{n}\right)} - 1$.

3. Impacts of land appreciation in Brazilian agriculture sector

Over the years, the Brazilian land appreciation and its determinants has been studied by authors such as Sayad (1977), Doll *et al.* (1983), Reydon & Plata (2000), Rahal (2003) and Gasques *et al.* (2008) and Reydon et al. (2014). All these authors have different studies and standpoint, but the importance of land price for Brazilian agribusiness is assent.

Through this land appreciation a simulated scenario that shows the increase of invested capital in the formation and expansion of the agricultural area (harvested and planted area) for all the Brazilian macro-regions. The value used as a guide to the increase in invested capital is shown in Figure 6.

According to Goodman *et al.* (1985) and Frederico (2013) the agriculture is considered a capital-intensive sector. Having this characteristic, it is expected a greater availability of capital to be employed in the agriculture sector. Under these circumstances and following the production function of Solow (1957), the productivity shock into the PAEG model will respect the newer conditions of the production function for each macro-region and each selected good indicated in Equations 9 to 13.

COE: $Y_{ir} = F(1.1356 * K, L; t)$ (9)

NOR: $Y_{ir} = F(1.1549 * K, L; t)$ (10)

NDE: $Y_{ir} = F(1.1289 * K, L; t)$ (11)

SUL: $Y_{ir} = F(1.1336 * K, L; t)$ (12)

SDE: $Y_{ir} = F(1.1286 * K, L; t)$ (13)

At this point, the technologic structure to produce some amount of agriculture goods required a fixed combination of intermediate inputs, even domestic or imported, and primary factors as capital and labor. The Figure 7 illustrated the structure to produce on PAEG's model.

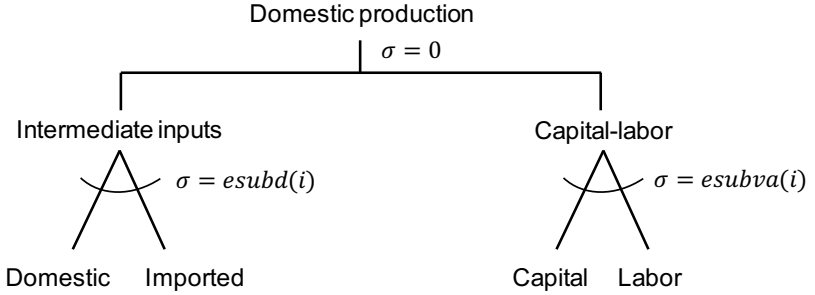

Figure 7. Structure to produce with a production function.
Source: Research data.

In Figure 7, the intermediate inputs are a combination of domestic and imported under elasticity of substitution esubd and the primary factors are combined under elasticity of substitution esubd esubva.

Satisfying all the conditions above, the PAEG model create the scenario with increase of invested capital in Brazilian agriculture with the results shown in the Figure 8.

Parameter	Sectors	NOR	NDE	COE	SDE	SUL	Average
Exportation	pdr	0,877	-0,22	-0,17	-0,392	-0,01	**0,017**
	gro	0,077	-0,231	-0,059	-0,294	-0,118	**-0,125**
	osd	0,259	0,34	0,278	-0,355	0,138	**0,132**
	c_b	0,429	-0,031	0,051	-0,196	-0,135	**0,024**
	oap	0,219	-0,005	-0,116	-0,245	-0,049	**-0,039**
	agr	0,332	-0,239	-0,143	-0,713	-0,109	**-0,174**
Importation	pdr	-0,33	-0,005	-0,035	-0,048	-0,052	**-0,094**
	gro	-0,064	-0,038	-0,089	-0,045	-0,033	**-0,054**
	osd	-0,128	-0,04	-0,08	-0,08	-0,076	**-0,081**
	c_b	-0,17	-0,091	-0,105	-0,075	-0,004	**-0,089**
	oap	-0,118	-0,071	-0,058	-0,063	-0,049	**-0,072**
	agr	-0,095	-0,072	-0,041	0,075	-0,005	**-0,028**
International commodity price	pdr	0,002	0,116	0,115	0,132	0,095	**0,092**
	gro	-0,003	0,114	0,069	0,146	0,084	**0,082**
	osd	-0,011	0,11	0,116	0,139	0,091	**0,089**
	c_b	-0,011	0,079	0,067	0,11	0,098	**0,069**
	oap	-0,004	0,074	0,114	0,146	0,088	**0,084**
	agr	0,001	0,089	0,104	0,162	0,093	**0,090**
Value of production	pdr	0,366	-0,11	-0,107	-0,162	-0,029	**-0,008**
	gro	0,056	-0,147	-0,08	-0,22	-0,068	**-0,092**
	osd	0,232	-0,239	-0,221	-0,269	-0,084	**-0,116**
	c_b	0,167	-0,048	-0,016	-0,036	-0,078	**-0,002**
	oap	0,12	-0,023	-0,087	-0,132	-0,046	**-0,034**
	agr	0,144	-0,079	-0,093	-0,258	-0,07	**-0,071**

Figure 8. Results on equilibrium after CGE's simulated scenario of land price increase in the Brazilian macro-regions (%).
Source: Research data.

In general terms, there was an average fall in imports from the sectors analyzed in all regions of the country. It can be inferred that the greater production of the agriculture and livestock sectors succeeds even more the need for consumption of these products by the region, reducing the need to import. The search for self-sufficiency can be interpreted as a positive point since the dependence on food imports can cause imbalance in the region's trade and supply.

The rice; soybean, sugar industry has an increased in exports. While the corn and other grain cereal sectors; meat and live animals; and other agricultural products had some decrease exports. The sectors that had an increase in exports are those that are prominent in the Brazilian export agenda. As a commodity exporting country, soybeans, livestock and sugar stand out among

agricultural commodities obtains prominence in exports, placing Brazil among the largest players in the market.

Analyzing separately the soybeans, the influence of the increase in the price of agricultural land via capital increase employed in the sector is beneficial, whose increase in capital employed in the oilseed sector would benefit exports. This indicates that the expansion of soybean growing area in recent years through new agricultural frontiers increases the production and export of grain.

These movement of the soybean and other oilseeds sector can be verified with the expansion of the planted area that grew 83.54% between the 2002/2003 and 2016/2017 crop, while the production also increased by 119.30% for the same period. The Figure 9 illustrates the soybean growth.

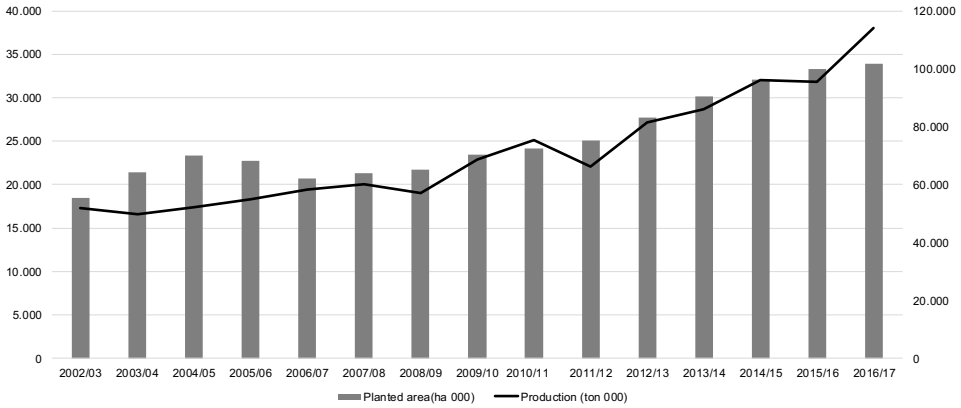

Figure 9. Soybean planted area and production between 2002/2003 to 2016/2017 crop.
Source: Research data.
Note: Brazilian Institute of Geography and Statistics, 2017.

Leading to international commodity prices, in all sectors there was a small price increase in order of 0.069% to 0.092%. At this level it can be inferred that agriculture price gains can be derived from other variables against land price, such employment of technology or improvement in the field. Because they are commodities, price is governed by a global demand and supply, which in the long term, there is a balance in prices due to market regulation.

When comparing the land appreciation with the gains in the value of production a disparity is found, all the value of production decrease within the increase in land prices. The high yields do not come only from the capital employed to increase the planted area, but other characteristics contribute to the composition of the gross value of production.

Generally, the impacts of the land appreciation in Brazilian agriculture sectors are positive. There are increase in export and decrease in importation goods which indicates a positive balance trade, which is beneficial to the economy of the country attracting foreign exchange. The raise of international commodity prices implies in a greater amount of resources for Brazil being a commodity exporter.

Therefore, the value of productions of agriculture and livestock was harmed by increase of invested capital. This fact is comprehensive because the needed more investment to maintain the agriculture production, or even maintain the same level of welfare state which cause and effect isn't analyses in this paper.

4. Final remarks

This paper had the main objective of quantifying the gains in production by the increase in invested capital, represented by the increase in land prices. To quantify the influences of land appreciation in Brazilian agriculture and livestock, a scenario is simulated through a productivity shock by capital increase into agriculture sectors per CGE model.

The results indicate influences in Brazilian agricultural and livestock sectors. With a simulated scenario, justified by the valorization of the land, that is, investment for agricultural expansion, there were implications for export, import, international commodity price and in value of production.

The decrease in imports indicates a gain in self-sufficiency of rice, corn and cereals, soy and other oils, sugar industry, livestock and other agribusiness products. All the agriculture sectors analyzed got a reduce in importations. Ally to this, the increase in exports of rice, soy and other oils, sugar industry, livestock and other agribusiness products benefits the Brazilian trade balance with surplus.

By analyzing both, export and import, it can be inferred that the production of these sectors is adequate to supply the need for internal trade with a surplus to enable the supply of foreign trade. This fact is important for a country if it ensures food security necessary for regional development.

As for international commodity price, there was little gain in all sectors. However, commodity prices are governed by numerous factors of which land value is one of its determinants. Even a top player as Brazil in soybeans and livestock isn't able to change international prices very much.

Inquiring is the decrease in value of production for all the sectors. With an improvement in agricultural area is natural an increase in production which would lead to an increase in the value of production. Meanwhile, there was a decrease in production value for all sectors analyzed which leads to the conclusion that the increase in capital invested and the increase in the area used is not only a reason for increasing the value of production.

Thereby, the land appreciation influence positively the Brazilian agriculture sector, especially if considering the use of invested capital as an increase in area used in agriculture.

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