The export of commodities and the validity of the Export-Led Growth (ELG) hypothesis for the Brazilian economy: an analysis of the commodity boom period

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Abstract
The Export-Led Growth (ELG) hypothesis considers that rising exports can generate positive externalities, the so-called spillovers, which accelerate economic growth, mainly through gains in economies of scale. The present study examines the Brazilian economy in the light of the Export-Led Growth (ELG) hypothesis, in order to examine if this hypothesis is valid for periods in which commodities occupy a significant part of exports, for this reason, for the period known as the "commodity boom", characterized by the considerable growth of the Brazilian economy and the increase in the export of commodities, driven by economic relations with China. In order to address the proposed objective, the estimation method used was the Autoregression with Vector Error Correction (VEC) in its structural version. The results suggest that the economic growth that occurred in Brazil during the analyzed period does not corroborate the ELG hypothesis, which is endorsed by results obtained in similar studies that evaluate economies whose exports were qualitatively similar to the Brazilian ones.
Keywords: Commodities, Export-Led Growth, Exports.
JEL Classification: F41, F43, F47, Q17

Resumo
A hipótese Export-Led Growth (ELG) considera que a elevação das exportações pode gerar externalidades positivas, os chamados *spillovers*, que aceleram o crescimento econômico, principalmente por meio dos ganhos em economia de escala. O presente estudo examina a economia brasileira à luz da hipótese Export-Led Growth (ELG), com o objetivo de averiguar se esta hipótese é válida para situações em que as *commodities* ocupam parte importante da pauta exportadora, por este motivo, a análise será feita para o período que ficou conhecido como o "*boom das commodities*", caracterizado pelo crescimento considerável da economia brasileira e elevação das exportações das *commodities*, impulsionadas pelas relações econômicas com a China. De modo a contemplar o objetivo proposto, foi utilizado o método de Autoregressão Vetorial com correção de Erro na sua versão estrutural (SVEC). Os resultados alcançados indicam que o crescimento econômico apresentado no Brasil, durante o período analisado, não se ajusta à hipótese ELG, o que é corroborado por resultados obtidos em estudos semelhantes, que avaliam economias que apresentavam pautas de exportação qualitativamente similares à brasileira.
Palavras-chave: *Commodities, Export-Led Growth*, Pauta Exportadora
Classificação JEL: F41, F43, F47, Q17

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1. Introduction

Economic growth is a widely addressed subject in Economics. From the study of the Gross Domestic Product (GDP) to the study of labor productivity, from the macroeconomic to the microeconomic level, the exercise of studying the relationship between the variables that compose an economy in order to determine which are relevant for growth can be often repetitive and display different and confounding results depending on the variables considered and the statistical method employed. This paper discusses the influence of the balance of trade, more specifically the exports of commodities and their role on Brazilian economic growth within the scope of the export-led growth (ELG) hypothesis.

The ELG hypothesis states that an increase in exports can generate externalities that boost economic growth. Many papers that study this hypothesis analyze the influence of exports on growth as well as the reverse influence – the Growth-Led Exports (GLE) hypothesis, which states that economic growth promotes an increase in exports. Although both hypotheses are reasonable, many papers show that different economies in different periods verify (or not) either the ELG or the GLE hypothesis and, sometimes, both – that is, bidirectional causality.

Considering the recent Brazilian history, exports gained relevance during the so-called commodity boom period, which occurred in the mid-2000s, a period in which the Brazilian grew 4% per year on average according to BNDES (2012), characterized as a moment of external vigor by Bacha (2013). In this context, a considerable increase in the Brazilian exports was verified, relatively to imports, especially for commodities, in addition to a great availability of cheap foreign currency caused by the appreciation of the Brazilian currency and the inflow of foreign currency in the country (Barros, 2016).

Therefore, the aforementioned moment of the Brazilian economy is very interesting when compared to later periods in terms of carrying out an analysis in the light of the ELG hypothesis, because of both the high growth rate presented and the increase in exports, culminating thus in this paper's purpose of analyzing whether commodity exports can validate the ELG hypothesis based on the 2002-2012 period, known as commodity boom period. To do so, a model based on the existing literature is constructed and the estimation is performed using an autoregression with vector error correction (VEC) in its structural version (SVEC), which enables the observation of potential dynamic effects between the variables of interest.

In order to attain its objective, this paper is split into four sections in addition to this introduction. Second section brings a brief explanation of the ELG hypothesis and presents some papers that sought to verify it, as well as a brief contextualization of Brazilian exports during the time period considered. Third section presents the model, the methodology and the data, fourth section discusses the results and the last section draws the major conclusions reached in the study.

2. The Export–Led Growth hypothesis and the Brazilian exports during the commodity boom period

This section presents the main assumptions of the hypothesis considered in this study, in addition to some studies that use it to analyze the relationship between exports and growth in a certain country or region. Then, we provide some information about Brazilian exports and the economic scenario during the commodity boom period.

2.1 The Export-Led Growth (ELG) Hypothesis

The ELG hypothesis became relevant in the late 1970s replacing the import substitution industrialization as the basis for development policy decisions. It is possible to mention several recent papers that analyze such theory such as Palley (2011), Kumari & Malhota (2014), Carvalho (2015), Akpan, Nwosu & Eweke (2017), Vieira & Xavier (2017), among others.

The ELG hypothesis postulates that the increase in exports can generate positive externalities, the so-called spillovers, which boost economic growth. That is, by joining international trade and being exposed to a more competitive market, the country may develop economies of scale, which offer an increasing rate of return, increasing productivity. It can also develop more efficient management techniques and broaden its relationship with other countries and the access to their markets. All these factors can affect other sectors of the economy that are not directly involved with exports, increasing both their productivity and efficiency and benefiting the entire economy.

According to Palley (2011), the ELG hypothesis is based on three pillars: the theory of comparative advantages (OHLIN, 1933; SAMUELSON, 1948; DORNBUSCH et al. 1980); ii) the benefits of liberalization to control rent-seeking[3]; iii) the benefits of liberalization to growth: the spillovers. Such pillars are assumptions of the new model named "the liberalization hypothesis". Therefore, according to the aforementioned author, the ELG hypothesis derives from this new model, especially applicable to developing economies.

The adoption of the ELG premises or its first stage, according to Palley (2011), occurred in economies such as Germany and Japan between the mid-twentieth century and the 1970s, approximately. These countries already had industrialized regions and used devaluation as a growth promoter. Later, the second stage was composed of countries such as the Asian tigers, which also devaluated their currency but, differently from the countries in the first stage, they needed to import technology and, therefore, depended on foreign technology, but exported through national companies. The third stage aggravated even more this foreign dependence, since countries like Mexico, which composed this stage, served basically as a platform for multinationals and there was no incentive to local industries, only foreign direct investment-seeking. Therefore, countries from the third stage were subjected to the needs of foreign companies and the ultimate goal of this arrangement was to carry out the production in developing countries via multinationals and export it to developed countries.

The fourth stage, still according to Palley (2011), had China as its exponent and some fundamental changes occurred in the arrangement in relation to the previous stage. The main ones were the asymmetric global agreements made by China, the currency devaluation managed by controlling the flow of foreign capital, and the incentive given by the Chinese government to joint ventures in order to absorb technological knowledge and develop the local industry, even though exports were still made by multinationals.

It is noteworthy that even though the ELG hypothesis is the most explored, there is also in the literature a hypothesis opposite to it, the Growth-Led Exports (GLE) hypothesis, which states that economic growth precedes the increase in exports, that is, the economy

[3] Rent-seeking: seeking to obtain income without the corresponding generation of value through political or social means (for example: lobbying).

grows and develops its productive capacity, becomes more efficient and, therefore, more competitive and, with a more efficient production, prices drop and the process of exporting is facilitated (LANCASTER, 1980; KRUGMAN, 1984; KÓNYA, 2006).

Although the ELG hypothesis is quite coherent, many factors must be considered when one aims to investigate if it can be verified for a certain economic scenario. Since the exports of an economy can be composed of several different types of products, from commodities such as meat, soy and coffee – which have a low value added, since much can be added to them after their purchase – to high value-added final goods such as state-of-the-art electronics, vehicles and goods with a high degree of Research & Development, it is reasonable to ask whether the ELG hypothesis applies to all exportable goods. Thus, many authors segment the exports when studying the ELG hypothesis, such as Carvalho (2015), who splits the goods exported by Portugal into processed and unprocessed goods. The author studies the ELG hypothesis in the Portuguese economic scenario from 1970 to 2012 and also indicates the possibility of verification of the GLE hypothesis. In the conclusions, which corroborated the existence of ELG, the author also verifies through the model that the share of unprocessed goods in the exports, such as commodities, had a negative effect on GDP. The author states that due to these products not providing a sustainable flow of spillovers, they do not serve as growth promoters in the sense of the ELG hypothesis. In this case, it is supposed that, for ELG to occur, high value-added exports are required.

Still with regard to papers that investigate the ELG hypothesis, we can mention Ghatak, Milner & Utkulu (1997), which carried out their analysis for Malaysia during the 1955-1990 period and found a positive relationship between total exports and economic growth. However, a more thorough investigation carried out by the authors revealed that there was a negative impact of exports of primary products on growth, with the exports of manufactured goods (which have a higher value added) accounting for the aggregate positive impact.

Myovella, Paul & Rwakalaza (2015) study the possibility of occurrence of ELG and GLE for Tanzania between 1980 and 2013. The authors indicate the adoption, by many countries from 1980 on, of the new paradigm of growth through the promotion of exports – especially the acceptance of this new model by organizations such as the International Monetary Fund (IMF) and the World Bank. The authors concluded that the ELG hypothesis was not corroborated by the data; however, Tanzanian foreign trade policy is recent, so this might have affected the results. They also suggest that a segmentation of exportable goods into manufactured and primary products, following Carvalho (2015) might have generated different results.

Akpan, Nwosu & Eweke (2017) analyze the effects of the exports of non-oil derivatives and their impact on the growth of Nigeria, as well as the effect of the development of the financial sector on growth, and conclude that there is a positive relationship between the variables of the financial sector and GDP. Therefore, a developed financial system, taking advantage from the extra income generated by the expansion of exports more efficiently, can help expand the spillover effect and promote ELG.

Tessema (2017) assesses the relevance and the performance of the balance of trade in the Ethiopian economy between 1981 and 2014 using ELG as reference. Through an econometric model that enables studying the relationship between the exporting sectors and the short- and long-run growths, the author analyzes which would be the best set of policies to be adopted in that developing economy out of the paradigms of import substitution industrialization and promotion of exports. The author concludes that the Ethiopian

economy had a deficit in its balance of trade in the period analyzed. Thus, due to the relevance of the balance of trade in the economy, the study recommends the use of policies based on the ELG hypothesis.

It is also noteworthy the work of Shafillah, Selvanathan & Naranpanawa (2017), which investigated ELG in Australia and its regions. The authors segmented the exports of the country into agriculture, minerals and oil, manufactured goods and others. The evaluation was carried out for the 1990-2013 period and, as a result, the authors found that ELG works differently in each region analyzed, but can be verified in the long run for the country as a whole.

All the aforementioned papers sought to verify (or not) ELG in several countries. For the Brazilian case, there are also papers dedicated to the issue. Among them we can mention Campos (2009), which seeks to evaluate ELG for Brazil considering the January 1975-February 2008 period and concludes that there is a bidirectional relationship between exports and GDP in the short run. Machado (2017) also evaluates ELG for Brazil in the 1975-2017 period, but does not find evidence of the hypothesis for the period analyzed, only a bidirectional Granger causality between PIB and Brazilian exports.

In a more specific manner, Munduruca & Santana (2012) do not use the term ELG, but analyze the possibility of economic growth through the exports of primary products for the Brazilian state of Sergipe. To determine the products of the exports of Sergipe that had greater potential, the authors use a matrix that determines export potential based on the revealed comparative advantage (RCA) index together with data from the Brazilian Institute of Geography and Statistics (IBGE) for the 2001-2008 period. The authors found that out of a total of 99 items exported by Sergipe, 35 did not display export potential, 8 are dynamic and 56 displayed export potential.

Vieira & Xavier (2017) also tested ELG for Brazil and verified if the result was linked with the increase in the exports for China. To do so, they evaluated the 1983-2003 period using the Johansen cointegration, the Granger causality test and the synthetic control method for comparative studies. The authors found that there are indications that the Brazilian economic growth was already led by exports before China became the major destination of such exports.

Therefore, it can be observed in the small sample of aforementioned papers that, in general, there is no unanimity with regard to proving (or not) the ELG hypothesis – and the same can be noted for the Brazilian case. This encourages the elaboration of new studies, such as this paper, in order to reinforce (or not) the verification of the ELG hypothesis. Moreover, it is noteworthy that the objective of this paper is to verify if a certain segment of exports – namely commodities – are able to validate ELG for Brazil, proposing, thus, an analysis focused on an important sector of Brazilian exports, as suggested by Carvalho (2015) and Myovella, Paul & Rwakalaza (2015).

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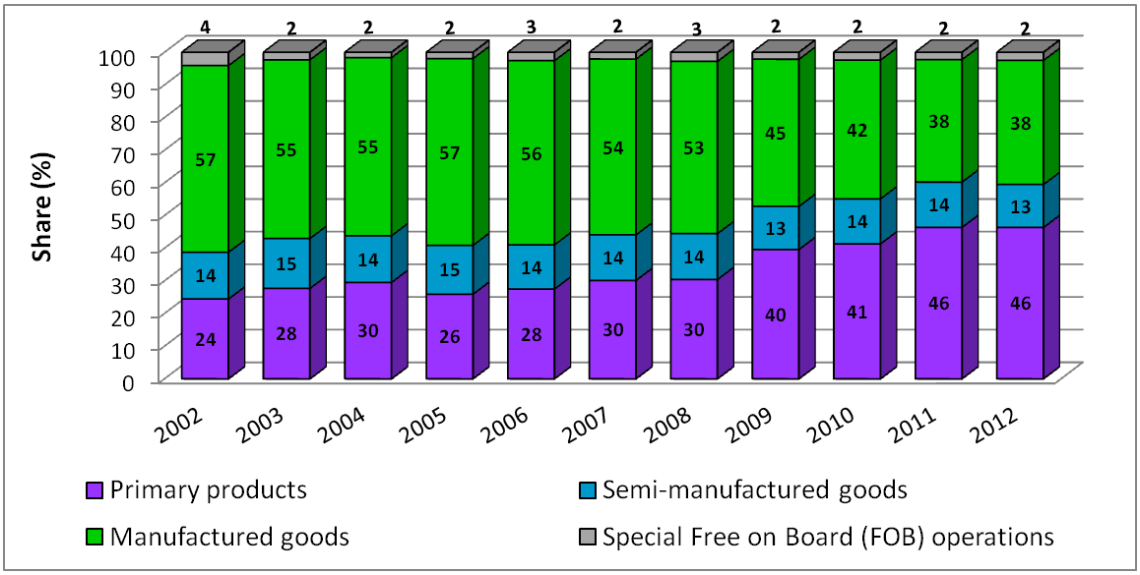
2.2 Brazilian exports and the commodity boom period

As it has been made clear in the previous subsection, a fundamental item for verifying the ELG hypothesis is the exports of the region or the country analyzed; thus, it is important to understand its composition. With regard to Brazilian exports, it has varied considerably between 2002 and 2012, considering the segmentation by value added. Figure 1 presents the share of primary products, semi-manufactured goods, manufactured goods and special Free on Board (FOB) operations in dollars. It can be observed that the share of primary products almost doubled in the period considered, rising from 24% in 2002 to 46%

in 2012. Conversely, the share of manufactured goods fell from 57% in 2012 to 38% in 2012, what indicates a gradual increase in the prominence of primary products – which, according to the Ministry of Industry, Trade and Services (MDIC), are unfinished products or products that do not incorporate technology, that is, primary agricultural commodities and minerals – in Brazilian exports in relation to the other products in the period considered, which, due to such prominence, is known as the commodity boom period.

Out of the primary products, one that stands out among the main exported products listed by MDIC, between 2002 and 2012, is "soybeans (including crushed soybeans)", which, throughout the entire decade considered, was among the three main products exported by Brazil in US$ FOB, being, in some years, the main exported product according to MDIC (2018). Another commodity that stands out as one of the main exported products in the period considered is "bran and residues from the extraction of soybean oil", which is usually among the ten main exported products in US$ FOB, reaching, in the period, an average exported value of US$ 3.8 billion according to MDIC (2018). This sheds light on the importance of the soy complex[4] for Brazilian exports. Thus, this paper will use information from such set of products as a proxy of the commodities exported by Brazil in the model that will be estimated in the next sections.

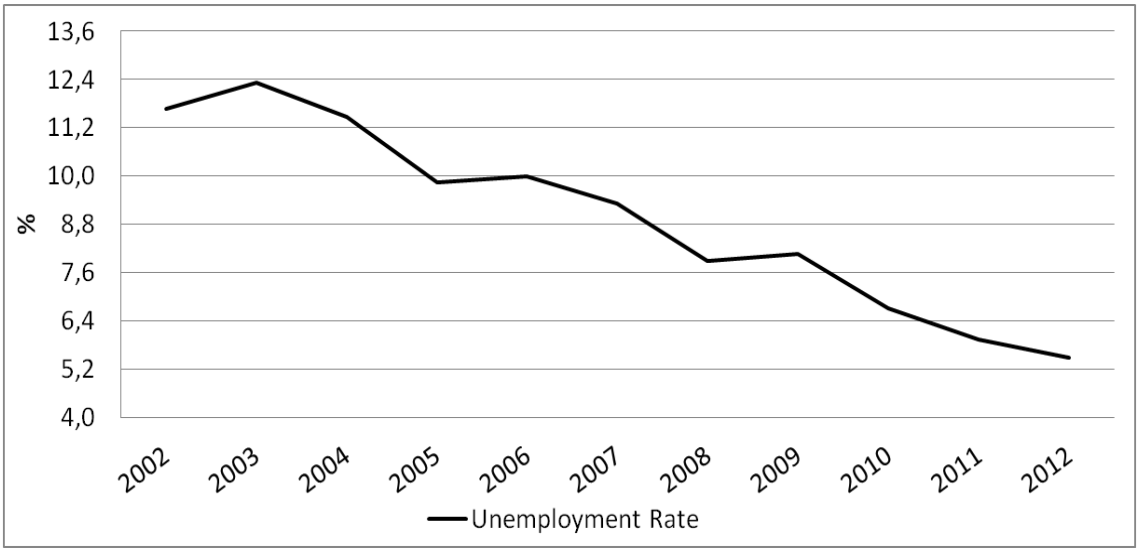


Source: MDIC (2018)

Figure 1 – Brazilian exports by value added – 2002-2012

In this same period, the country presented an average growth of 4% per year (BNDES, 2012) and an average inflation of 6.5% per year (IPEADATA, 2018). According to BNDES (2012), there has been a considerable improvement in income and quality of life of lower-income households, since the unemployment rate increased between 2002 and 2003, possibly due to the presidential transition, reaching 12.3% in 2003, but from 2004 on it presented successive declines, reaching 5.5% in 2012 as can be seen in Figure 2.

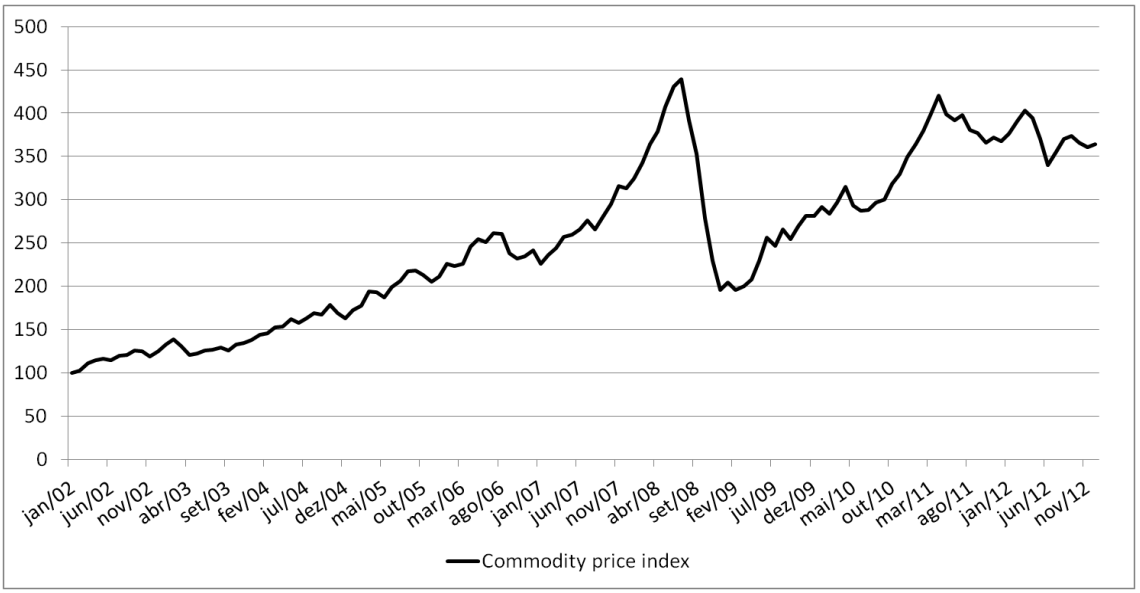
[4] According to MAPA (2018), this complex is composed by soybean bran, soybean oil and soybean grains.



Source: IBGE

Figure 2 – Unemployment rate 2000-2012

Thus, there was an economic scenario of growth, given the conjunction of the positive trend of important economic variables for the period considered – the commodity boom period. Such increase in the exports was motivated by the rapid growth in the demand for commodities, especially by China, which consolidated as a world great power and as one of the main Brazilian partners in international trade. With the sharp increase in the demand for commodities and a restricted supply, such products had a vigorous increase in their prices and despite naturally showing volatility in prices, the boom period represented an exception increase in them, as can be seen in Figure 3.



Source: IMF

Figure 3 – Commodity price index - IMF

It is clear in Figure 3 the quite dramatic rise in commodity prices from 2004 on. Between 2008 and 2009 the impact of the international crisis occurs, causing prices to fall; however, between 2009 and 2010 prices start rising again.

Once the impulse to exports provided by the commodity boom period and the economic scenario of growth that marked the period are proven evident, this paper aims at tacitly analyzing the possibility of the emergence of spillovers in this framework of exports composed mainly by commodities.

3. Methodology

This section presents the data, the model and the econometric methods that were used.

3.1 The estimated model

In order to attain our goal and following Shafiullah, Selvanathan & Naranpanawa (2017), this paper estimates the following equation:

$$h_t = \sum_{i=1}^{n} \alpha_{1i} \mathrm{h}_{t-i} + \sum_{i=1}^{n} \beta_{1i} \mathrm{quant}_{t-i} + \sum_{i=1}^{n} \gamma_{1i} \mathrm{e}_{t-i} + \varepsilon_{1t} \qquad (1)$$

where h is the output gap, which will serve as a measure of economic growth[5], *quant* is the exports quantum index of the soybean complex, which will serve as a proxy for the commodities exported by Brazil, e is the real exchange rate, n represents the amount of required lags, ε is the random error term.

It is important to notice that the exports quantum of the soybean complex was chosen as a proxy for exported commodities due to its relevance among the products that compose Brazilian exports, as previously highlighted.

3.2 Data

To estimate our model, we used monthly data from January 2002 to December 2012. All series were transformed into indices being January 2002 the basis – then, they were expressed in logarithms.

[5] When output gap is positive, actual output is greater than potential output and growth is occurring.

Table 1 - Variables

Variables	Representation	Description
Output gap	*h*	To calculate the gap, the following expression was used: $\frac{(PIBreal - PIBpotencial)}{PIBpotencial}$ where, in order to represent GDP, the series Monthly GDP – Current values (R$ million) was used. (Series nº 4380 - Source: Central Bank of Brazil). The potential GDP was estimated by the Hodrick – Prescott* filter.
Exports quantum of the soybean complex	*quant*	Exports quantum of the soybean complex in kg. Source: Brazilian Ministry of Agriculture, Livestock and Supply (MAPA).
Exchange rate series (Source: Central Bank of Brazil)	*e*	Real exchange rate index (IPCA) – June 2014=100 – North American dollars. Series nº.11753 - Source: Central Bank of Brazil.

Source: The authors.

*With the Hodrick-Prescott (HP) filter, the potential output is calculated by minimizing the sum of the squares of the differences between the effective series and its long-term trend subject to the constraint that the sum of the squares of the second differences of the trend must be zero. The weight of the latter constraint, represented by λ, may vary, and the idea is that the greater the weight, the greater the trend of the derivative of the HP filter to become a straight line. In contrast, the smaller the weight given to the smoothing of the trend, the more it gets closer to the original series. In this paper, the weight attributed to smoothing was 14,400, since this is the standard value suggested in the literature for monthly series (Hodrick & Prescott, 1997).

3.3 The estimation method

In order to ensure goodness of fit, the first tests we performed were the ADF-GLS (Elliot, Rothenberg & Stock, 1996) and the KPSS (Kwiatkowski et al., 1992)[6] tests, which verified the stationarity of the series. Such tests were chosen because they are deemed more efficient in relation to the ADF test (Dickey & Fuller, 1981) since, according to Hatanaka (1996), the changes introduced by these procedures aim at correcting power and size issues observed in the original Dickey-Fuller test.

After the unit root tests, the Johansen cointegration test (1988) was carried out in order to capture the existence of a long-term relationship between the variables of the model. The Granger causality test was also performed in order to verify the existence of causality in the sense of Granger, that is, from the past to the present, between the variables of the model. The results led to employing the autoregression with vector error correction (VEC), which was estimated in its structural version (SVEC) following Enders (2004). The described procedures were carried out with the aid of the econometric software WinRats.

[6] Kwiatkowski et al. (1992) propose a unit root test where, differently from the traditional ones, the null hypothesis is that the observed series is stationary, testing this hypothesis against the hypothesis of existence of unit root. Following Maddala & Kim (1998), KPSS can be considered a confirmatory test that increases the efficiency of the analysis and ensures more robust results for the verification of the order of integration of time series.

4. Results

This section presents the results of the auxiliary tests – stationarity, cointegration, Granger causality – and the estimation of the proposed model.

4.1 Results of the unit root tests

The tests were carried out with the variables in logarithms and the number of lags was chosen based on the modified Akaike criterion (MAIC) which, given the number defined as the maximum[7], indicates the number of lags appropriate for the variable being tested. Table 2 displays the results obtained and we can verify that, by the ADF-GLS test, only the variable gap was stationary at 5%[8] for both the test with a constant and the test with constant and trend. For the KPSS tests with constant and constant and trend, all variables are stationary at 5%.

To correct the existence of unit root found in the tests (in the case of the variable gap, only by KPSS), the first difference was applied to all series – then, the tests were performed again and the issue was corrected. Thus, all variables used in the estimation are I(1), that is, integrated of order 1.

Table 2 – Results of the ADF unit root test

Variable		ADF-GLS test (test values) *	KPSS test (test values) **
Gap (lh)	Constant	-2.96	1.10
	Constant and trend	-3.22	0.20
Quantum (*lquant*)	Constant	0.30	0.50
	Constant and trend	-1.24	0.15
Exchange (*le*)	Constant	-0.70	1.73
	Constant and trend	-1.50	0.20

Source: The authors.

* Critical values with constant: -1.61 to 10%, -1.94 to 5% and -2.57 to 1%. Critical values with constant and trend: - 2.64 to 10%, -2.93 to 5% and -3.46 to 1% (values provided by the GRETL program following Elliot, Rothenberg & Stock (1996)). ** Critical values with constant: 0.347 to 10%, 0.463 to 5% and 0.739 to 1%. Critical values with constant and trend: 0.119 to 10%, 0.146 to 5% and 0.216 to 1% (values provided by the GRETL program following Kwiatkowski et al. (1992).

4.2 Results of the cointegration test

In order to verify the existence of long-term relationship between the variables, the Johansen cointegration test was performed. The number of lags used in the test was chosen following the Bayesian criterion (BIC), which indicated two lags as the appropriate

[7]The criterion used to define the maximum lag (p_{max}) for the variables used in this paper was the one proposed by Schwert (1989), where $p_{\max} = \text{int}\left[12 * \left(\frac{T}{100}\right)^{1/4}\right]$, with T being the number of observations. Thus, since all the series used have 132 observations, the maximum lag found for them was 13.

[8]Significance level that will be used as parameter for all the tests performed in this paper.

number. Table 3 presents the results obtained from the test, which, at the 5% level, indicates that we fail to reject the hypothesis of existence of at most one vector against the alternative hypothesis that there is more than one cointegration vector.

Table 3 – Results of the Johansen cointegration test

Null hypothesis (H_0)	Alternative hypothesis	Trace statistics	Critical values at 5%*
r=0	r>0	55.98	29.68
r=1	**r>1**	**13.08**	**15.41**
r=2	r>2	1.09	3.76

Source: The authors.

*Critical values according to Osterwald-Lenum (1992)

With the verification of the existence of cointegration between the variables of the model, we included in the estimation of the autoregressive vectors the terms of error correction, culminating in an autoregressive model with vector error correction (VEC) which will be estimated in its structural version, enabling the identification of structural shocks with a theoretical basis and not only by the Cholesky ordination.

Before estimating the model, it is possible to analyze the estimates of the short-run (α) and long-run (β) coefficients of the model within the scope of the results of the Johanson cointegration test, as can be seen in Table 4. It is noteworthy that the variable gap takes value 1 for the long-run estimate because conjectures on the other parameters were drawed in relation to this variable. According to the results, a shock of 1% in the exports quantum of the soybean complex corresponds to a 0.55% elasticity of transmission from this variation to the output gap, what shows that the exports of the soybean complex exert a positive influence on total output. With regard to the exchange rate, all other things being equal, a rise of 1% in the exchange rate affects the output gap in 0.24%.

Table 4 – Estimates of the short- and long-run coefficients of the model

Variables	Estimate for the α's (short-run adjustment coefficients)*	Estimate for the β's (long-run coefficients)*
Gap	0.039	1.00
Quantum	-0.402	0.556
Exchange	0.001	0.242

Source: The authors.

*The signs of the exposed coefficients are inverted in relation to the results of the estimation – this change was made because, with the normalization of the cointegration vector, the variables remain on the same side of the cointegration equation; thus, to proceed with the analysis, the opposite sign must be used.

With regard to the short-run coefficients of adjustment, it is noted that temporary imbalances of the output gap are corrected at a rate of 3.9% in each period, that is, the positive impact that the exports considered in this study or the exchange rate may generate on the output gap is corrected in 3.9% each month. In relation to the exports quantum of the soybean complex, the speed of adjustment of an imbalance reaches 40.2%, the greatest among the variables considered in the model. Exchange rate is the variable that presents the slowest adjustment (0.1% in each period).

4.3 Results of the Granger causality test

Before the SVEC estimationl, it is important to note the existence of causality between the variables of the model, pointing out that it will be verified only in the sense of Granger, that is, from the past to the present; therefore, the effects of expectations are not considered in this type of test.

In order to perfom such causality test, the number of lags was chosen based on the Bayesian criterion (BIC). As it has been verified in Table 5 and considering a 5% significance level, the only pair of variables that presented causality in the sense of Granger was the output gap (*h*) and the exports quantum of the soybean complex (*quant*) - a bidirectional causality, that is, at 5%, both the exports quantum affect the output gap in the sense of Granger and the output gap affects the quantum, what was expected since Campos (2009) and Machado (2017) also obtained these same results for the relationship exports-GDP, despite using different time periods and products in their analyses. The most interesting direction of the causality, according to the goal of this paper, is the one that stats that the exports quantum of the soybean complex causes the output gap. Proceeding with the estimation, it will be possible to define if such relationship, which has already been proven to exist in the long run, is robust enough to verify the ELG hypothesis.

Table 5 – Granger causality test

Null hypothesis	Nº of lags	F-statistics	Conclusion
quant does not cause ***h***	2	5.01	Rejects
h does not cause ***quant***	2	13.18	Rejects
e does not cause ***h***	2	1.35	Rejects
h does not cause ***e***	2	0.51	Fails to reject
quant does not cause ***e***	3	0.12	Fails to reject
e does not cause ***quant***	3	0.21	Fails to reject

Source: The authors.

4.4 Results of the structural vector error correction (SVEC) model

It was initially defined the matrix of contemporaneous relationships, which considers the economic relations existing between the variables, constituting, thus, the structural part of the model. The matrix was constructed based on the following sequence of variables: output gap, exports quantum and exchange rate. The constraints imposed ensured that the gap was written as a function of the quantum and the exchange rate and that the quantum was written as a function of the exchange rate. With such constraints, the matrix was exactly identified so no test was needed to evaluate overidentified constraints.

4.4.1 Results of the matrix of contemporaneous relationships

Using Table 6 we can evaluate the coefficients obtained through the specification of the matrix of contemporaneous relationships. We note that the only contemporaneous relationship considered that was significant at 5% was the one between exchange rate and output gap. According to the results, a contemporaneous increase of 1% in the real exchange rate corresponds to a 0.12% increase in the output gap, indicating that a real exchange devaluation in the present can contribute to increase the difference between real and potential output. With regard to the relationship of greatest interest to this paper, it was

not possible to obtain any information via matrix of contemporaneous relationships due to the statistical insignificance of the coefficient obtained.

The results in Table 6 are related only to the contemporaneous behavior of the variables without considering their dynamic interactions over time. Such aspect will be dealt with in the following sections.

Table 6 – Results of the matrix of contemporaneous relationships

Contemporaneous relationships		Estimated coefficients	Standard Deviation	t* statistics
FROM	TO			
Dl*quant*	Dl*h*	0.00008	0.007	0.01
Dl*e*	Dl*h*	0.12648	0.072	1.74
Dl*e*	Dl*quant*	0.14699	0.853	0.17

Source: The authors.

* The *t* statistics measures the significance of the estimated coefficients for each contemporaneous relationship (H_0: coefficient is zero). However, it is noteworthy that this statistics is not as rigorous for analyzing the significance of the coefficients of the matrix of contemporaneous relationships from the VAR methodology as it is for the ones from the ordinary least squares method (Bacchi, 2005).

4.4.2 – Results for the decomposition of the variance of the forecast error

Since we are focused on finding evidence that commodity exports (represented here by the exports quantum of the soybean complex) have impacted economic growth positively in the period known as "commodity boom period", it is fundamental to understand the importance of the exports quantum on the variations of the output gap.

Table 7 presents the decomposition of the variance of the output gap forecast error.

Table 7 – Decomposition of the variance of the output gap forecast error

Periods	Std. Dev.	Dl*h*	Dl*quant*	Dl*e*
1	0.030086	97.663	0	2.337
2	0.034478	95.07	2.277	2.652
3	0.03474	94.354	2.533	3.113
4	0.034909	93.914	2.876	3.209
5	0.035049	93.845	2.957	3.198
6	0.03508	93.848	2.96	3.192
7	0.035081	93.847	2.961	3.193
8	0.035083	93.844	2.963	3.192
9	0.035085	93.844	2.964	3.192
10	0.035085	93.844	2.964	3.192
11	0.035085	93.844	2.964	3.192
12	0.035085	93.844	2.964	3.192

Source: The authors.

As can be seen in Table 7, in all periods (months) considered, great part of the variation of the output gap (94.31% on average) is explained by the variable itself. In the first two periods such percentage is higher since the quantum has no influence on the variation of the analyzed variable and the real exchange rate affects it only by 2.33%. In the

second period, the quantum explains a small part (2.27%) of the oscillations in the gap and the influence of the exchange rate also rises (2.65%). From the third period on it is possible to verify that the importance of the exports quantum and the exchange rate on the variations of the gap still shows some increases, but these are getting smaller, in a way that in the last month considered, the exports quantum explains about 2.96% of te variations in the gap and the exchange rate, 3.19%. This suggests that the quantum of commodity exported by the country has some influence on the variations of the output gap, but it is not relevant.

4.4.3 Results for the impulse-response functions

This subsection presents the responses of the output gap to exogenous and individual shocks in the variables that compose the model.

Figure 4 presents the response of the output gap to a positive shock in the exports quantum of commodities. It is possible to note that if we consider a positive shock of 1% in the exports quantum, the initial response of the gap is a reduction that reaches its peak in the second period (-0.015%), but, afterwards, the response of such variable reverses and between the third and the fourth periods we can verify an increase of 0.0009% that slowly dissipates. From the seventh period on, no relevant variation can be observed anymore. Corroborating these results, Carvalho (2015) and Ghatak, Milner & Uktulu (1997) also verify negative effects of commodity exports on the output of the economy they analyze.

From this result, it is possible to conclude that in periods where commodity exports rise, like the commodity boom period, there is a generally positive effect on the output; however, such effect is rather small and lasts for only a few periods – thus, it does not seem to be robust enough to generate the positive externalities (spillovers) required to ensure economic growth within the scope of the ELG hypothesis. Some indications of this result had already been heralded by the decomposition of the variance of the output gap exposed above.

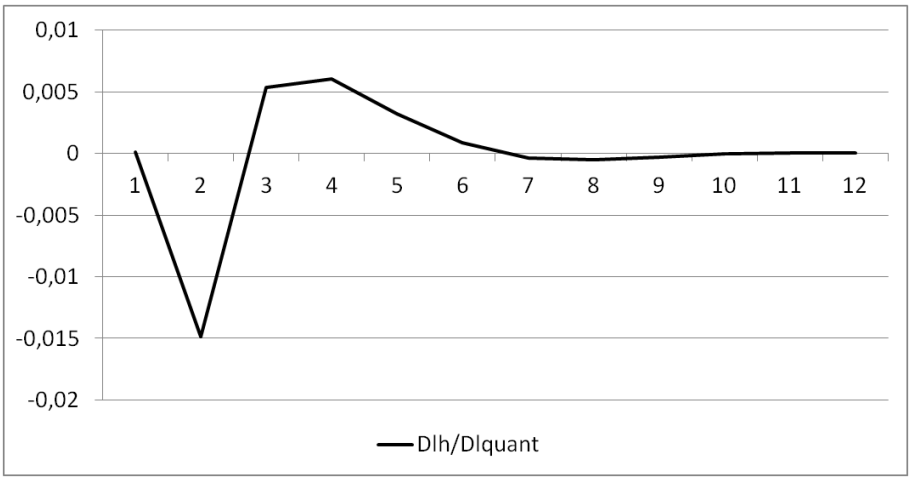


Figure 4 – Impulse-response function: response of the output gap to a shock in the exports quantum of the soybean complex
Source: The authors.

Still in the scope of the instruments of the impulse-response function, it is possible to observe the variation of the output gap when a shock in the real exchange rate occurs. Figure 5 shows that, if the exchange rate increases by 1%, the output gap in the first period

increases by 0.13%, which dissipates over time, reaching the sixth period with such response almost exhausted. This result reinforces something that had been already indicated by the decomposition of the variance of the gap: an influence of the real exchange rate on the output greater than that of the exports quantum. Thus, a variation in exchange rate causes a greater response in the output, showing that if the Brazilian currency is devaluated – which makes domestic products cheaper to foreigners – the trend is that this is reflected in the Brazilian domestic product, since the items that will benefit from it will not be only commodities, the focus of this paper, but all the exports of the country.

Figure 5 – Impulse-response function: response of the output gap to a shock in the real exchange rate.
Source: The authors.

5. Conclusions

The Export-Led Growth is not recent in the literature – the export-led growth model is a paradigm long studied and discussed since it became the new standard, in many countries, after the decline of the import substitution model in the 1970s (Palley, 2011). However, such a paradigm presents different characteristics depending on the economy where it is verified.

The Brazilian exports are highly dependent on commodities, what became evident during the period known as commodity boom, when the Chinese demand for such products boosted its prices. In this scenario, this papers sought to analyze if this export-led growth paradigm, more specifically the ELG hypothesis, is validated by commodity exports for the Brazilian economy during the commodity boom period.

Based on the estimated short- and long-run coefficients, it was possible to observe that there is a long-run relationship between the exports quantum considered in this study and the output gap, with the speed of adjustment of the latter to any given shock being not too high (3.9% per month); thus, shocks from exports would have a chance of lasting for some time. It was also verified a bidirectional causality in between commodity exports and output gap in the sense of Granger, that is, from the past to the present. Through the estimation of a structural vector error correction model, it was possible to verify that the contemporaneous relationship between the exports quantum of commodities and the output

gap is not significant. Conversely, through the decomposition of the variance of the forecast errors, the results indicated an influence of the exports quantum on the output gap, corroborating the result of the estimated long-run coefficient; it is, however, a small influence of 2.61%. Analyzing the impulse-response functions, this weak influence was confirmed, since the positive response of the output gap to a shock in the exports quantum that can be verified only from the middle of the second period on was once again small and not robust enough to generate the spillover of positive externalities to other sectors as the ELG hypothesis states. As it is reinforced by Carvalho (2015), for ELG to occur, the generation of spillovers is required, that is, the increase in productivity generated by economies of scale, with this expansion, that occurs in the exports sector, overflowing to the other sectors.

Thus, it can be stated that the ELG hypothesis was not captured by the results of this paper, which is not a surprise since Myovella, Paul & Rwakalaza (2015) did not obtain the comprovation of the hypothesis in a similar context either. Moreover, Carvalho (2015) also does not prove it for the Portuguese sector of low value-added products and Machado (2017), despite the difference in relation to this paper with regard to time period and type of product analyzed, also did not verify the ELG hypothesis for Brazil.

Finally, a potential advance or continuation to this paper could be carried out in order to estimate a new model for the same time period, but considering only Brazilian agribusiness exports so as to produce a comparison with the results obtained in this work.

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