Engines off: A Structural Decomposition of the Brazilian (De-)Growth in the 2010s

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Abstract

After almost a decade of high economic growth rates (at least compared to its own standards), from 2013 on, the Brazilian economy turned back to grow at a slower pace, and, more recently, it started to shrink. This paper seeks to identify the sources of such sudden stop. According to Biechowsky (2012), the Brazilian growth engines are natural resource-based exports, public investment in infrastructure and housing and household consumption. This paper investigates to what extent each one of these engines has impacted output by using a Structural Decomposition Analysis (SDA). Leontief-Miyazawa matrices were constructed for the Brazilian economy with the aim of treating consumption as endogenous, and they are used to analyze the contribution of each factor to output (de-)growth in the 2010s. The main conclusion is that commodity prices explain more than one-third of the drop in output from 2013 to 2016, whilst reduction in infrastructure and housing investments explains almost one-half of such drop.

Resumo

Depois de quase uma década de altas taxas de crescimento econômico (pelo menos em relação a seus próprios padrões), a partir de 2013, a economia brasileira voltou a crescer em um ritmo mais lento e, mais recentemente, começou a encolher. Este artigo procura identificar as fontes de tal parada súbita. Segundo Biechowsky (2012), os motores de crescimento brasileiros são as exportações baseadas em recursos naturais, o investimento público em infraestrutura e habitação e o consumo doméstico. Este artigo investiga em que medida cada um desses mecanismos impactou a produção usando a Análise de Decomposição Estrutural. Matrizes Leontief-Miyazawa, construídas para a economia brasileira com o objetivo de tratar o consumo como endógeno, são usadas para analisar a contribuição de cada fator para o (de)crescimento do produto durante os anos 2010. A principal conclusão é que os preços das commodities explicam mais de um terço da queda na produção entre 2013 e 2016, enquanto a redução nos investimentos em infraestrutura e habitação explica quase metade dessa queda.

Key-words: Structural Decomposition Analysis, Leontief-Miyazawa, Brazilian economy, Natural resource-based exports, Infrastructure investment, Housing investment

1. Introduction

After more than two decades of virtual stagnation, in the last decade the Brazilian economy gained momentum. Between 2004 and 2010, Brazil has grown by 4.5% per year on average, contrasting with the growth rate of the preceding years, when the country had grown by 2.0% per year between 1980 and 2003. This period of high economic growth rates (at least compared to its own standard) also contrasts with the following years. After 2010, the Brazilian economy turned back to grow at a slower pace, and, more recently, it started to shrink. From 2010 to 2013 the Brazilian annual GDP growth rate was 3.0%, in 2014 it has dropped to 0.5%, and between 2014 and 2016, the country faced a reduction of its GDP of 6.7%, which means that it has reduced by 3.4% per year.[1]

The aim of this paper is to identify which factors contributed the most for such sudden stop. The period of expansion brought some clarification of the Brazilian main growth engines. According to Bielchowsky (2012), Brazil has grown led mainly by natural resource-based exports, by public investment in infrastructure and housing and by household consumption due to its large domestic market. These three engines put the Brazilian economy back on trails, enabling the country to have a relatively stable growth path.

Nevertheless, after 2010 (and definitely after 2013) the country saw these engines stop working. Firstly, the domestic consumption stopped growing as fast as before despite government anticyclical policies. Consumption credit, that has enabled it to grow, has stagnated. The main issue with the consumption, however, was not only its de-acceleration, but the incapacity of national producers to absorb it. Virtually all the additional demand was absorbed by imports.

In 2014 another engine has stopped: the resource-based exports. Commodity prices has drop significantly during this year, and its capacity to generate income for the economy due to the multiplier effects has reduced. Besides these effects, due to the country dependence of such exports to guarantee current account surplus, the impact of the drop of commodity prices has forced the country to increase interest rates to attract capital, which led to an increase on fiscal deficit.

Finally, in 2015, the remaining engine has been also turned-off. Public investment in housing and infrastructure has sustained Brazilian growth in 2014. The Federal housing investment program, *Programa Minha Casa Minha Vida* (PMCMV), was incredibly reduced from 2013 on, and the investments in infrastructure has been reduced by a half, mainly due to the reduction of public investment. This engine was especially relevant due to their potential to

[1] SCN/IBGE

increase country's long-term productivity since Brazil has a relevant infrastructure gap. In the last decades the country investment in this area was significantly lower than other developing economies, which may explain why many sectors are not internationally competitive.

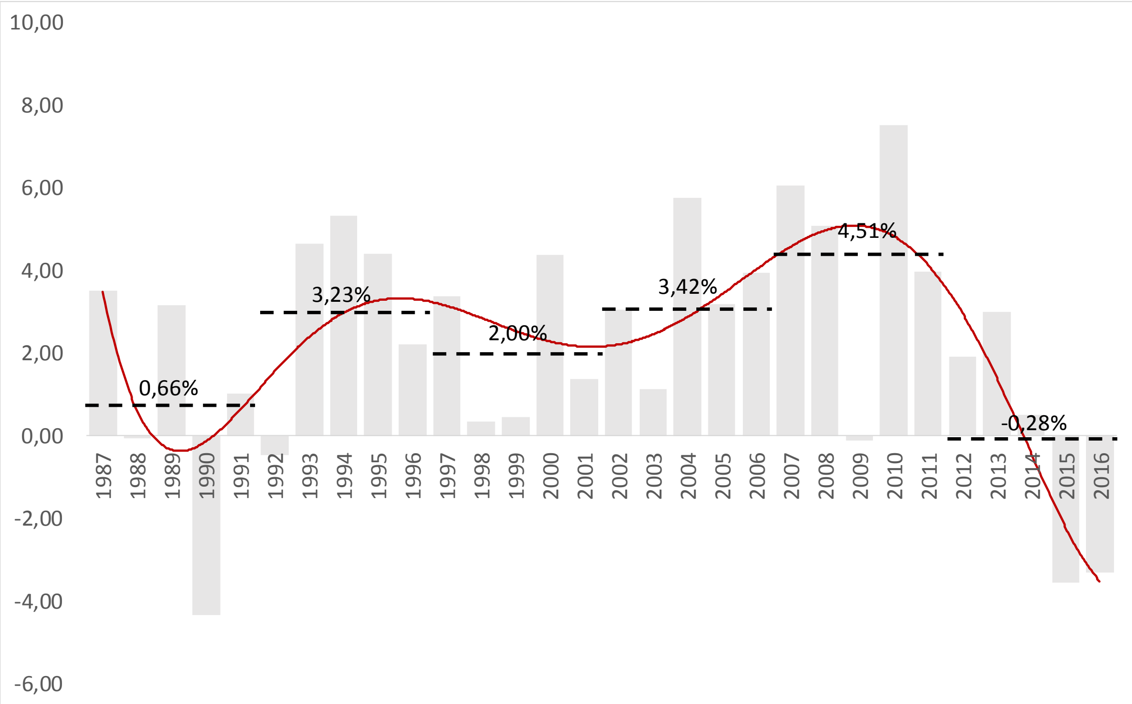
This paper aims at identifying the relevance of each of these engines for the Brazilian economy using input-output matrices, and then it seeks to verify whether the drop in the growth rates and the following stagnation can be explained by the shutdown of such engines. To do so, it uses a Structural Decomposition Analysis (SDA). This method enables us to estimate the direct and indirect impact of (de-)growth of each component of demand, as well as their potential impacts on income growth due to the multiplier effects.

The first section after this introduction presents the Brazilian growth engines based on Bielchowsky's (2012) analysis. It discusses the relevance of such engines for the Brazilian economy and the evolution of each component in the last ten to fifteen years. The following section reviews the theoretical and empirical basis of the SDA, highlighting the recent studies that split changes in technical coefficients and substitution of domestic inputs for imports. The forth chapter applies the methodology developed to the Brazilian matrices between 2010 and 2016 to verify to what extent the drop in Brazilian growth rate and its recession was due to reduction in resource-based exports, drop of public investment and the incapacity of domestic consumption to boost output growth. Finally, the conclusion seeks to discuss the possibility of Brazil to restore its growth potential.

2. The engines of Brazilian growth in the 2000s

From the beginning of the 1980s until 2003, the Brazilian economy was marked by low growth rates. The average growth rate between 1980 and 2003 was 2.0% per year. Although there were some years that this economy grew by faster, such as 1993-95, when the average growth rate reached 4,8%, the economy was characterized by a stagnation which contrasts with the fast-growing preceding decades. In 2004, however, the Brazilian economy starts to grow fast again – even though not like before the 1980s. The average growth rate between 2003 and 2010 was 4.5% per year. These six years of fast-growing GDP contrasts with both the preceding decades and the years that followed it, especially after 2013. As can be seen from Figure 2.1, after a long period of stagnation, the Brazilians saw its economy growing faster during the mid- and late-2000s and also during the early-2010s, although in a slower pace. Nevertheless, after 2013, Brazil's growth rate dropped substantially, becoming negative from 2015 on.

Figure 1 – Brazilian GDP annual growth rates (1987-2016)



Source: IPEADATA; author's elaboration

Understanding what happened to the Brazilian economy during the "booming" years is not only a nostalgic exercise. This analysis is necessary to understand also the reasons why this country have been facing years of recession after almost one decade of fast-growing GDP. The reasons behind the sudden stop of the Brazilian economy must be conceived by identifying the engines of the growing period and what happened to these engines after 2013.

Bielchowsky (2012) presents a clear and concise explanation for the Brazilian GDP acceleration during the 2000s. According to him, there were three engines that put this economy on a fast-growing trajectory: the world demand for natural-resources, the public and private investment in infrastructure and housing; and the large domestic market for mass consumption goods.

Brazil has abundance of natural resources. Water, sun, earth, energy and many other resources can be easily found in such country. In the early 2000s, the world demand for these resources start increasing, and the it brought back the centrality of the agriculture and mining sectors to the Brazilian economy. The most important products in Brazil's current account are soybeans and iron ore, and the prices of these products in the international market had presented a highly upward trend. From October of 2004 to August of 2012, the price of soybeans increased from US$ 193 per metric tons to US$ 623 per metric tons (an average growth rate of 16% per year). The price of ores also increased significantly from the 2000s on: a metric ton of iron ore, which was sold by US$ 13.82 in 2003, was sold by US$ 177.45 in July of 2011 (an average growth rate of 37.6% per year).[2] In parallel with this increase in prices, the volume exported of these products also presented an upward trend in Brazil. Consequently, the country, which is a net exporter of natural-resource products, took advantage of it, triggering a long period of high GDP growth rates.

The Brazilian natural-resources export growth is presented in Table 2.1. From 2002 to 2011, the revenue of these exports has increased from US$ 27.3 billions to US$ 163.6 billions, which means that it has grew by 22.0% per year on average. The direct impact on the national income, however, must consider the currency (de)valuation, since it reduces the revenue in national currency if there was a valuation, and a devaluation has the inverse impact. Considering that, the impact is lowered, but it still very high: from 2002 to 2011, Brazilian natural-resource exports grew by 14.7% per year in Brazilian Reals, which is much higher than the country inflation during the period, which was 5.9% per year on average. Thus, in real terms the average growth rate of Brazilian exports of natural-resources increased by 8,3% per year, generating income in all the related sectors and activities.

Table 1 – Growth of Brazilian natural-resource exports (% per year)

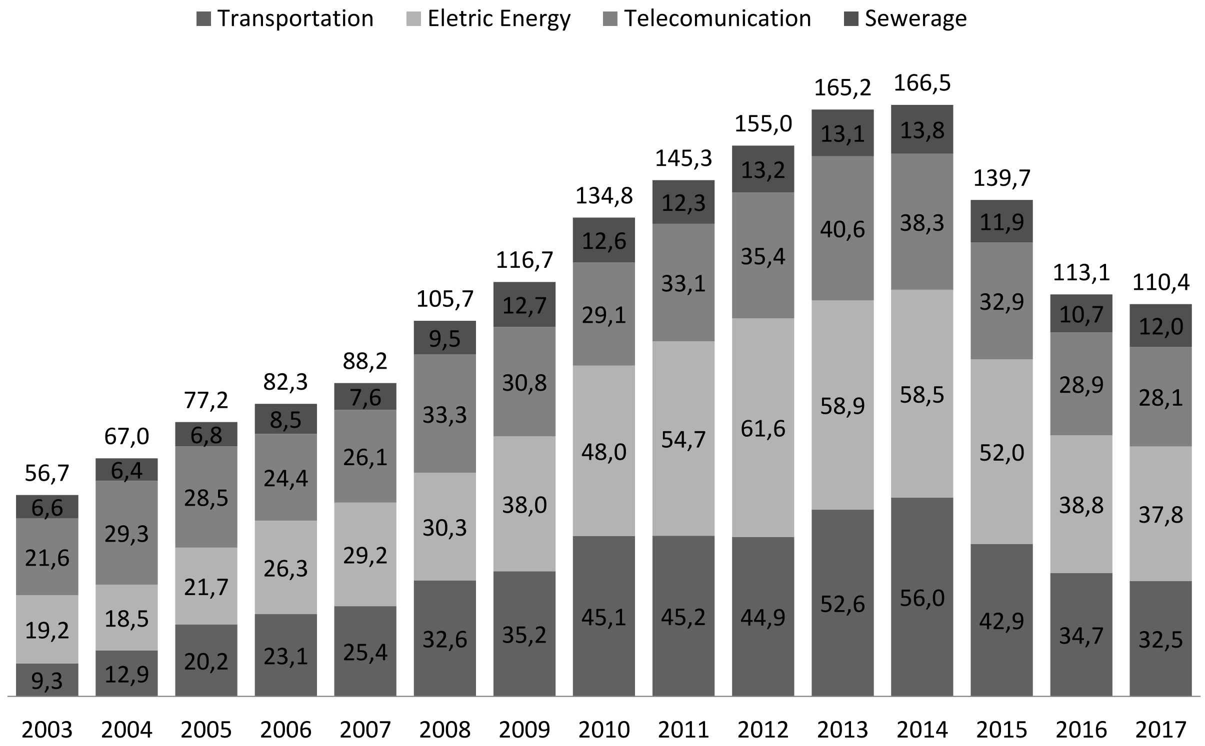
	2002-2005	**2005-2008**	**2008-2011**	**2002-2011**
Natural-resource exports growth in US$	25.2%	24.9%	16.2%	22.0%
Natural-resource exports growth in R$	17.8%	13.6%	12.7%	14.7%
Consumer's Price Inflation (IPCA)	7.5%	4.5%	5.6%	5.9%
Natural-resource exports growth deflated by the IPCA	9.6%	8.8%	6.7%	8.3%

Source: World Bank and IPEADATA; author's elaboration

The growth of natural-resource exports has not only preceded the other engines, but also allowed them to grow. From 2003 to 2013, due to the increase on government revenues, the reduction of external constraints and the expansion of the Brazilian Development Bank, the BNDES, public and private investments in infrastructure became a relevant source of demand. Investments in electric energy, transportation, sewage and telecommunications were multiplied by three, jumping from R$ 56.7 billion to R$ 165.2 billion, as can be seen from Figure 2. In real terms, the growth during these ten years was 70.3%, which means an annual growth rate of 5.5% per year, and hence these investments are seen as an important engine of growth by Bielschowsky (2012). The period of faster growth of these investments were from 2003 to 2010, when it reached an annual growth rate of 7.5%. From 2010 on, the investments in these areas stopped increasing faster as before, but the government keep stimulating investment.

[2] IMF Commodity Price Indices (https://www.imf.org/external/np/res/commod/index.aspx)

Figure 2 – Investment in infrastructure (public and private), 2003-2017



Source: ABDIB; data does not include Oil & Gas

In 2009, the Brazilian Federal Government has launched a large housing program – the Programa Minha Casa Minha Vida (PMCMV). The program subsidises housing investments for low-income families (less than R$ 1.800 per month) and facilitates acquisition for middle-income families (less than R$ 7.000 per month). From 2009 to 2013, the number of housing unities of the PMCMV increased from 286.3 thousand to 912.9 thousand, as shown in Table 2. In monetary terms, it means that in 2013 the housing investment by the PMCMV was greater than R$ 100 billion. Thereby, although infrastructure investments stopped growing faster from 2010 on, until 2013 investment in housing has maintained this engine working.

Table 2 – Housing unities hired by the PMCMV, 2009-2016

	Faixa 1	Faixa 2	Faixa 3	**Total**
2009	143.894	98.593	43.818	**286.305**
2010	338.847	277.174	102.805	**718.826**
2011	104.310	296.707	77.935	**478.952**
2012	384.821	307.018	97.711	**789.550**
2013	537.185	281.744	93.961	**912.890**
2014	200.289	331.002	37.447	**568.738**
2015	16.890	349.486	40.557	**406.933**

2016	35.008	277.193	68.204	**380.405**

Source: Brazilian National Congress

The third engine of Brazilian growth highlighted by Bielschowsky (2012) is the mass production and consumption. According to him, there were four reasons for this engine works in Brazil during the "booming" years: i) fast growth of wages and employment; ii) income transfers for low-income families; iii) reduction of popular industrial products due to exchange rate valuation and to imports from China; and iv) growth of credit for consumption.

The wage bill in Brazil has grown incredibly fast from 2004 to 2013. In real terms, the average growth rate during these nine years was 7,5% per year. The reduction of unemployment rate and the increase of minimum wage were factors that corroborates for that. In 2004 the minimum wage was R$ 240.00 por month, and it reached R$ 678.00 per month in 2013 – in real terms it has increased by 6.6% per year. The unemployment rate, which had peaked 13.1% in March of 2004 (the highest level of the series) dropped to 4.3% in December of 2013, reaching its lower level since the data is computed by the Brazilian Geography and Statistics Institute (IBGE).

Besides the growth of wage bill, other factors collaborate for mass consumption to be an engine for the Brazilian growth between 2004 and 2013. Pension programs in Brazil are associated to the minimum wage, which means that the growth presented before also had a relevant impact on that. Moreover, the Brazilian government has created one of the most important minimum income programs in the world: the Bolsa Familia. More than 13.7 million families benefit from this program which spends around R$ 30 billion per year. Finally, credit for private consumption also boost mass consumption from 2004 on. According the Brazilian Central Bank, the total credit has almost doubled as a share of GDP between 2004 and 2013: it grew from 25.5% in December of 2004 to 50.8% in the same month of 2013. The total credit for households also presents the same trend. Even though this data is not available before March of 2007, in this month it represented 9.9% of GDP, and it reached 14.2% of GDP in the same month of 2013.

These three engines were definitely very important to boost Brazilian growth until 2013. They grew almost every year during all these years ahead the rest of the economy, and hence they were essential to bring back to this country stable and high GDP growth rates – at least compared to the preceding decades. Nevertheless, from 2013 to 2016, Brazilian growth rates have dropped again. As discussed in the introduction, the Brazilian economy grew at a very low rate in 2014 and started to shrink after them. In 2014 the growth rate dropped to 0.5%, in 2015 the Brazilian economy decreased by 3.5% and, in the subsequent year, the growth rate was negative again, now by 3.3%. To understand the reasons why Brazilians are facing negative growth rates, this paper analyses the three growth engines abovementioned and its direct and indirect impact on the economy through a Structural Decomposition Analysis. It aims at identifying to what extent such engines, which were so important for the country growth were turned off, and what could be done to put the Brazilian economy back on the rails.

3. Structural Decomposition Analysis and the Leontief-Miyazawa approach

The first economist to conduct an economic structural analysis by using input-output methods was Leontief (1936, 1941). Following his work, many other authors have applied such method to analyze economic structures. Hirschman (1958, 1968), for example, have used input-output methods to study the effects of economic conditions on political outcomes through the use of backward and forward linkages. The use of decomposition methods to analyze the sources of structural changes, however, was only introduced in the 1970s by Skolka's inaugural paper (Skolka, 1977).

In the 1980s this methodology was applied for different countries. Feldman *et al.* (1987), for example, decomposed industry output changes in the United States in 1963 and 1978 into changes in final demand and in input-output coefficients. Skolka (1989) analyzed the composition of net output in terms of the contributions of technological shifts, domestic final demand, foreign trade, and labor productivity. Rose and Casler (1996) and Dietzenbacher and Los (1998) organized such methodology. Rose and Casler (1996) described its fundamental principles, whereas Dietzenbacher and Los (1998) discussed the different results obtained by the application of different SDA methods.

Despite being used widely to understand structural changes in different economies, the SDA was applied only recently to analyze the effects on output growth following changes in coefficients due to substitution between imports and domestic suppliers. Based on Chenery et al. (1962)'s decomposition of sectoral deviation from proportional expansion, Pamukçu and de Boer (1999) have proposed a primary extension for the SDA method to evaluate the demand that was not absorbed domestically as a consequence of substitution between domestic suppliers and imports in different sectors. In the same vein, Magacho et al. (2018) followed Miller and Blair's (2009) approach to extend SDA to consider the substitution between domestic and imported inputs.

Nevertheless, these SDA extensions were made only for the basic Leontief method, which does not consider the economy as a closed system. In the basic Leontief model, final demand is not determined endogenously by income. Miyazawa (1966; 1968) brought a Keynesian perspective for the Leontief approach and introduced the idea of endogenous consumption in such models. The author developed a closed input-output system where consumption is endogenously determined by income, bringing the Keynesian multiplier idea for the Leontief approach.

Following Miyazawa's works, this paper analyses the impact of changes in autonomous demand on economic growth considering consumption as an endogenous variable. Magacho et al. (2018) extended the SDA approach to incorporate substitution between domestic and imported inputs. Such method is extended for a closed economy, where consumption is endogenous. This methodology is important firstly because it allows us to identify to what extent the reduction of domestic absorption is explained by consumption's good import growth. Moreover, it provides the basis for the analysis of the impact of investment and exports drop on the economy considering their multiplier effects.

The Leontief-Miyazawa matrix can be written in the addictive form as $= (I - A_n - CV_n)^{-1}$, where M is the Leontief-Miyazawa matrix, A_n is the domestic input-output coefficients matrix, and CV_n is the matrix of domestic consumption by income. Considering the Leontief-Miyazawa model for two distinct years (0 and 1), the vector of gross output x in year t = 0, 1 is given by:

$$x^1 = M^1 f^1 \text{ and } x^0 = M^0 f^0 \tag{1}$$

where, and f is the vector of final demand excluding consumption. Following Miller and Blair (2009), but replacing the Leontief matrix by the Miyazawa-Leontief matrix, as well as the vector of final demand by the vector of final demand excluding consumption, the observed change in gross output is:

$$\Delta x = x^1 - x^0 = M^1 f^1 - M^0 f^0 \tag{2}$$

Some possible rearrangements may be applied to decompose the changes in M and f, and their effects on Δx. Two alternative methods are presented:

$$\Delta x = L^1(f^0 + \Delta f) - (L^1 - \Delta L)f^0 = (\Delta L)f^0 + L^1(\Delta f) \tag{3}$$

$$\Delta x = (L^0 + \Delta L)f^1 - L^1(f^1 - \Delta f) = (\Delta L)f^1 + L^0(\Delta f) \tag{4}$$

Here we will follow Dietzenbacher and Los (1998) and adopt the average approach, which, according to them, is often an acceptable method for SDA, Summing equations (3) and (4)

$$2\Delta x = (\Delta M)f^0 + L^1(\Delta f) + (\Delta M)f^1 + L^0(\Delta f) \tag{5}$$

and averaging gives:

$$\Delta x = \frac{1}{2}(\Delta M)(f^0 + f^1) + \frac{1}{2}(M^0 + M^1)(\Delta f) \quad (6)$$

where the first term refers to the effects of the change in the Miyazawa-Leontief coefficients over the change in gross output, and the second term refers to the effects of the change in final demand excluding consumption.

Thereafter, the changes in Leontief-Miyazawa coefficients have to be divided into technological changes and substitution between national and imported inputs. Given Equation (1), post-multiply L^1 through by $(I - A_n^1 - CV_n^1)$

$$M^1(I - A_n^1 - CV_n^1) = I = M^1 - M^1(A_n^1 + CV_n^1) \quad (7)$$

and pre-multiply M^0 through by $(I - A_n^0 - CV_n^0)$

$$(I - A_n^0 - CV_n^0)M^0 = I = M^0 - (A_n^0 + CV_n^0)M^1 \quad (8)$$

Rearrange (7) and post-multiply by M^0

$$M^1 - I = M^1(A_n^1 + CV_n^1) \Rightarrow M^1M^0 - M^0 = M^1(A_n^1 + CV_n^1)\, M^0 \quad (9)$$

Similarly, rearrange (8) and pre-multiply by M^1

$$M^0 - I = (A_n^0 + CV_n^0)M^0 \Rightarrow M^1M^0 - M^1 = M^1(A_n^0 + CV_n^0)M^0 \quad (10)$$

Subtract (10) from (9)

$$\Delta M = M^1(A_n^1 + CV_n^1)M^0 - M^1(A_n^0 + CV_n^0)\, M^0 = \\ = M^1(A_n^1 - A_n^0)M^0 + M^1(CV_n^1 - CV_n^0)M^0 \quad (11)$$

Because A_n^t is the difference between the total direct coefficient matrix (A^t) and the direct coefficient matrix of imported goods (A_m^t), and CV_n^t is the difference between the total consumption by income matrix (CV^t) and the consumption of imported goods by income (CV_m^t), the change in the Leontief-Miyazawa matrix can be written alternatively as

$$\Delta M = M^1[(A^1 - A_m^1) - (A^0 - A_m^0)]M^0 + M^1[(CV^1 - CV_m^1) - (A^0 - A_m^0)]M^0 \quad (12)$$

Rearranging, the decomposition of changes in the Leontief-Miyazawa matrix into changes in total coefficients and substitution between national and imported goods is given by

$$\Delta M = M^1(\Delta A)M^0 + M^1(-\Delta A_m)M^0 + M^1(\Delta CV)M^0 + M^1(-\Delta CV_m)M^0 \quad (13)$$

where the first term is the contribution of the changes in total direct coefficients (technological change[3]) to changes in the Leontief-Miyazawa coefficient, the second term is the contribution of changes in imported direct coefficients (substitution of national inputs), the third term is the contribution of changes in total consumption coefficients by income, and the forth term is the contribution of changes in imported direct consumption coefficients (substitution of national consumption) .

Finally, substituting (13) in (6), the total output growth can be divided into the contribution of (i) technological change, (ii) substitution of national inputs, (iii) changes in consumption by income, (iv) substitution of national consumption, and (iv) final demand growth excluding consumption:

$$\Delta x = \underbrace{\frac{1}{2}[M^1(\Delta A)M^0](f^0+f^1)}_{technological\ change} + \underbrace{\frac{1}{2}[M^1(-\Delta A_m)M^0](f^0+f^1)}_{substitution\ of\ national\ inputs} + \\ + \underbrace{\frac{1}{2}[M^1(\Delta CV)M^0](f^0+f^1)}_{changes\ in\ consumption\ by\ income} + \underbrace{\frac{1}{2}[M^1(-\Delta CV_m)M^0](f^0+f^1)}_{substitution\ of\ domestic\ consumption} + \\ + \underbrace{\frac{1}{2}(M^0+M^1)(\Delta f)}_{final\ demand\ growth\ e} \tag{14}$$

The final demand growth can also be split into its different components. In the next section we will break it into the impact of changes in relative export prices on the Brazilian exports, and the impact of infrastructure and housing investment growth to evaluate to what extent these variables are relevant to explain the Brazilian (de)growth in the 2010s.

4. Structural Decomposition Analysis of the Brazilian growth (2010-2016)

One of the main engines of the Brazilian growth was the export of Natural Resources. As discussed in the second section, both the price and the volume of Brazilian natural-resource based exports increased substantially from the beginning of the 2000s until the beginning of the following decade. However, the commodity prices started to drop in 2013 and 2014. The price of soybeans, for example, has dropped from US$ 547.19 per metric tons to US$ 320.13 between April of 2014 and February of 2016. Following the same pace, but more even deeply, the price of iron ore has dropped from US$ 154.64 per metric tons in February of 2013 to US$ 40.88 per metric tons in December of 2015.

[3] In SDA, technological changes mean changes in the input-output. According to Rose and Castelar (1996:42), “In nearly all SDA formulations, changes in the structural matrix are ascribed to a nebulous 'technological change', which is often broadly interpreted to include any factor that causes a change in a technical (structural) coefficient, such as true technological change, technical substitution (response input price changes) and scale effects.”

With the aim of analysing the impact of commodity prices variation between 2010 and 2013 and between 2013 and 2016 on the Brazilian economy, vectors of export variation due to relative price changes was constructed. Using the Brazilian Supply and Use Tables (SUT) for all years between 2010 and 2016, firstly we built deflators for each of the 128 products. The deflators were built dividing the exports of each year in current prices by the exports of the same year measured in last year prices. After that, the deflators of 2011, 2012 and 2013 were aggregated and it was divided by the GDP deflator of the same period, and the deflators of 2014, 2015 and 2016 were aggregated and divided by the GDP deflator of the same period. Then, changes in relative price for each product for the period 2010-2013 was applied to the 2013 exports, and the one for the period 2013-2016 was applied to the 2016 exports. These results give the variation in exports due to relative price change by product. Finally, the most important commodities that suffered from relative price reductions between 2013 and 2016 were selected for building vectors of export variation due to commodities relative price changes: $\Delta f_{com\_p}^{2010-13}$ and $\Delta f_{com\_p}^{2013-16}$. These vectors give the direct impact of commodity price changes on final demand growth between 2010 and 2013, and between 2013 and 206, respectively.

Another engine of the Brazilian growth discussed before was the investment in both infrastructure and housing. The investment in infrastructure, which was R$ 134.8 billion in 2010, peaked in the period 2013-2014. In 2013 it reached R$ 165.2 billion, and in the following year it has increased to R$ 166.5 billion (in 2017 prices). However, from this year on, it has start decreasing year-by-year. In 2015 the Brazilian investment in infrastructure was R$ 139.7 billion, and in 2016, it was only R$ 113.1 billion. Thereby, from 2013 to 2016 it has reduced R$ 52.1 billion, impacting the demand for investment by the same amount.

Housing construction followed a similar trend. The PMCMV, which is the government program to promote investments in housing, is the main responsible for such kind of investment in the country, and the numbers show a relevant decrease. The number of hired residential unities (houses and apartments) has dropped from 912.9 thousands in 2013 to 380.4 thousands in 2016. The program is divided into three groups: *faixa 1*, *faixa 2* and *faixa 3*, according to the income of the house buyer. The first group, which is for the poorest buyers, saw the most significant drop: if the number of residential unities hired in 2013 was 537.2 thousands, in 2016 only 35 thousands units were hired. The number of hired units in the other groups also decreased, but not at the same pace as the *faixa 1*.[4]

To analyse the impact of infrastructure and housing investment drop between 2013 and 2016 on the Brazilian economy, we built two vectors of change in investment: one for the period 2010-

[4] We assume that houses value are the same for all groups, and the value is R$ 100,000 measured in 2016 prices. Based on this we have an investment of R$ 71.9 billion in 2010, R$ 91.29 billion in 2013 and R$ 38.0 billion in 2016.

2013 and the other for the period 2013-2016. Vectors are obtained by considering that all changes in investment but changes in construction are zero, whilst changes in construction are equal to the sum of the increase in housing and infrastructure investment between 2010 and 2013 as well as between 2013 and 2016. These vectors, $\Delta f_{infr\_hous}^{2010-13}$ and $\Delta f_{infr\_hous}^{2010-13}$, give the direct impact of changes in infrastructure and housing investment on final demand growth.

Table 2 presents the results for the structural decomposition of the Brazilian growth between 2010 and 2016 for all sectors. To obtain such results, Equation (14) was applied. Moreover, the final demand growth was split into the impact of commodities price changes, infrastructure and housing investment (de)growth and all other variations of final demand excluding consumption.

Table 2 – Contribution of each component of the SDA for the Brazilian (de-)Growth

	2010-2013	2013-2016
Technological change (dA)	3.58 p.p.	1.78 p.p.
Substitution of National Inputs (dAm)	–3.60 p.p.	0.77 p.p.
Changes in consumption by income (dCV)	0.35 p.p.	1.72 p.p.
Substitution of Domestic Consumption (dCVm)	–0.74 p.p.	0.65 p.p.
Final demand growth (df)	10.18 p.p.	–12.60 p.p.
Variation in commodity prices (df_comm)	–0.70 p.p.	–2.65 p.p.
Variation of infrastructure investment (df_infr)	0.63 p.p.	–1.63 p.p.
Variation of housing investment (df_hous)	0.99 p.p.	–1.60 p.p.
Other changes in final demand (df_oth)	9.26 p.p.	–6.72 p.p.
Total change in output	9.77%	–7.68%

Author's elaboration based on National Accounts (IBGE, 2018)

From Table 2 it is possible to analyse the impact of each component of the SDA on the Brazilian output growth between 2010 and 2013, as well as on the Brazilian output decrease between 2013 and 2016.

In the first period, output has grown mainly by changes in final demand. However, substitution of national inputs and domestic consumption for imported inputs and final goods ha reduced such positive effects. Substitution for imported inputs contributed negatively by 3.60 percentage points (p.p.), whilst substitution of domestic consumption for imported final goods contributed negatively by 0.74 p.p. Such result shows that the Brazilian engines were losing its potential to promote growth once the economy was losing capacity to absorb demand. Although demand was growing, the impact of such growth in the economy was lowered by the increase in imports.

In the second period results are much less satisfactory. Although imports have stopped increasing, which is shown by positive values in the respective lines (0.77 p.p. and 0.65 p.p.), final demand has drop substantially. The impact of such reduction on output is 12.60 p.p., showing that it has more than compensated for the positive effects caused by technological change, increase in consumption by income and import substitution.

Commodity prices drop is very relevant to explain such outcome. The international price reduction of the main commodities exported by Brazil contributed negatively for the Brazilian de-growth by 2.65 p.p., despite the currency de-valuation that has reduced these negative impacts due to its price effects. Since output has de-grown by 7.68% during the period, one may say that the reduction in commodity prices explains 34.5% of the Brazilian output reduction in the period.

As can be seen from Table 2, other relevant components to explain Brazilian de-growth during the period 2013-2016 is the reduction of infrastructure and housing investments. The negative contribution of infrastructure investment reduction on output was by 1.63 p.p., whilst the negative contribution of housing investment drop was by 1.60 p.p. between 2013 and 2016. Considered together, these two impacts contributed negatively by 3.23 p.p., which means that these two components of final demand were responsible for 48.1% of the Brazilian output reduction in the period.

Besides the aggregate analysis, it is also possible to evaluate the contribution of each component for each sectors' output growth. Table 3 presents such results for the period 2013-2016 considering (i) the impact of commodity prices reduction and (ii) the drop on infrastructure and housing investments. It is important to consider that data is deflated by the GDP Deflator, and not by sectoral deflator as the multiplier analysis must consider the income effect, and not the volume effect.

Table 3 – Contribution of specific components for sectoral growth (selected sectors)

	Commoditiy prices change	Investment in housing and infrastructure
Agriculture, including supporting activities	–4.8 p.p.	–1.8 p.p.
Mining of coal and non-metal minerals	–1.8 p.p.	–7.7 p.p.
Mining of oil and gas, including supporting activities	–21.6 p.p.	–3.3 p.p.
Mining of metal ores	–55.9 p.p.	–0.4 p.p.
Manufacturing of wood and wood products	–1.5 p.p.	–4.2 p.p.
Manufacturing of non-mineral metals	–1.0 p.p.	–9.6 p.p.
Construction	–0.3 p.p.	–14.3 p.p.
Water transportation	–8.5 p.p.	–2.5 p.p.
Public education	0.0 p.p.	0.0 p.p.
Private education	–3.8 p.p.	–3.3 p.p.

Public health	0.0 p.p.	0.0 p.p.
Private health	–3.0 p.p.	–2.7 p.p.

Author's elaboration based on National Accounts (IBGE, 2018)

The analysis of the contribution of each factor for the sectoral output growth provides some interesting results. The impact of the reduction in commodity prices affected mainly the sectors that produce these commodities. Mining of metal ores and Mining of oil and gas were the the sectors where the output reduced the most due to the drop in prices. However, another sector that was significantly affected by this effect is Water Transportation. The reduction of commodity prices has impacted negatively this sector because logistics is an important link in the value chain of commodity exports.

By analyzing the impact of reduction in infrastructure and housing investments, these input-output relations becomes clearer. Besides Construction, which is the sector directly affected by the investment drop, many other suppliers were significantly affected due to the indirect impact. Mining of coal and non-metal minerals and Manufacturing of non-mineral metals were the most negatively affected sectors, followed by Manufacturing of wood and wood products.

Table 3 also presents the impact of commodity prices reduction and the drop in infrastructure and housing investment on public and private education and on public and private health. It shows that private education and private health are both affected by these phenomena. Because consumption is endogenous and these sectors depend on consumers demand, the income reduction affected these sectors. In the case of public education and public health, sectors where demand comes exclusively from government expenses, the impact is null.

5. Concluding remarks

After almost a decade of high economic growth rates (at least compared to its own standards), from 2013 on, the Brazilian economy turned back to grow at a slower pace, and, more recently, it started to shrink. With the aim of identifying the sources of such sudden stop, Leontief-Miyazawa matrices were constructed for the Brazilian economy between 2010 and 2016, the SDA method was extended to incorporate consumption as endogenous.

According to Biechowsky (2012), the Brazilian growth engines are natural resource-based exports, public investment in infrastructure and housing and household consumption. These engines were, thereby, analyzed using the SDA method.

The analysis of the period between 2010 and 2013 shows that substitution for imported inputs and substitution of domestic consumption for imported final goods contributed negatively by for the output growth. Thereby, Brazilian engines were losing its potential to promote growth as it has lost capacity to absorb demand growth. The main conclusion of the paper, however, comes from the analysis of the period 2013-2016. It shows that drop in commodity prices explains more than one-third of the drop in output, whilst reduction in infrastructure and housing investments explains almost one-half of such drop.

The paper also shows that not only the producers of commodities and the construction sectors were affected, but also the suppliers for these sectors and those that depend on the household consumption. Because demand and income has drop in the directly affected sectors, the suppliers also had their output reduced, which is clearer in the sectors that supply inputs for Construction. In the same vein, because some sectors, such as private education and private health, depends on the demand of households, and it is reduced by the drop in export prices and infrastructure and housing investment, the output of the sector has reduced, and almost every sector in the economy is affected by that.

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