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Estimating the Importance of Civil Construction for the Brazilian Economy Through Hypothetical Extraction of the Input-Output Matrix

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Abstract

This paper aims to undertake a systemic analysis of civil construction to verify whether public investments made from 2007 onwards were able to increase the sector's productive linkages in the Brazilian economy. For this, the hypothetical extraction method of the input-output matrix and the official matrices of the country from 2005 and 2015 are used. The results show that the importance of the productive structure of the construction sector - total extraction - exceeds 7.42% of GDP in 2005 to 10.06% in 2015. This fact reveals that the civil construction sector in 2005 was the seventh most important moving to the fourth in 2015 in a total of twelve sectors considered. Another important finding lies in the fact that despite the construction sector presenting an increase in the complexity of its productive structure, it showed strong backward linkage, but low forward linkage, in both analyzed periods. Through these results, it is possible to conclude that the tax exemption of some inputs, reduction of real estate interest, expansion of credit for housing through public housing and infrastructure policies may have been essential for the increase in the complexity of the sector's productive chains between the years' from 2005 and 2015. Such findings are useful for the scientific literature that investigates the sector by bringing evidence to Brazil and to policymakers given that possibly the construction sector can be used as a strategy to promote and stimulate economic activity in times of crisis.

Keywords: civil construction sector, production chains, input-output model, hypothetical extraction

JEL Classification: D50, D57, H20, H25.

1. Introduction

The civil construction sector has very unique economic and social characteristics, being able to stimulate an inversion of private investment and catalyze economic growth in the short term. In other words, civil construction is a sector that has a complex production chain, with many sectoral linkages, capable of increasing the supply of infrastructure, generating income and skilled jobs (or not), increasing the productivity of the economy, providing economic development (World Bank, 1984, 2022; Polenske and Sivitanides, 1990; Kureski et al., 2008). For the World Bank, the construction industry is among the most important and dynamic economic sectors, capable of boosting national economies (World Bank, 1984; 2022).

The literature points out that civil construction is a strategic sector for the development of national economies (Bon, 1988; 1992; Park, 1989; Bon and Pietroforte, 1990; Cardoso, 2013; Perobelli et al., 2016; World Bank, 2022). Second, Bon (1988), Kureski et al. (2008), Perobelli et al. (2016), Santos (2020) among others, economic development takes place through strong forward and backward productive linkages existing in the sector, showing the sector's ability to contribute to economic growth. Santos (2020) points out that the construction industry is a sector that creates economic infrastructure capable of facilitating the production process through its activities.

Despite the aforementioned, Bon (1992) points out that the process of economic development induced by the civil construction industry is directly related to the level of development of countries. According to Bon (ibid), economies with a higher degree of economic development have a large supply of infrastructure, a stabilized urbanization rate and a high stock of physical capital, making the participation of the civil construction sector in the economy low, being related only to activities of construction. maintenance and repair of existing buildings. In developing economies, on the other hand, the industrialization process, creation of infrastructure and the increase in the urbanization rate induce the

civil construction sector, expanding the level of product, employment and income through the sector's chains. Given this, the civil construction sector has been used as a strategy to promote and stimulate economic activity in developing countries (Giang and Pheng, 2011).

According to Santos (2020), investments in the civil construction sector can sustain economic activity in the short term by mobilizing a high amount of capital and creating many jobs. In the long term, the expansion of investments in infrastructure leads to an increase in the investment rate which, in turn, increases the productivity and competitiveness of the economy, generating sustained growth (Teixeira and Carvalho, 2005).

In Brazil, the adoption of an economic growth strategy based on investments in the civil construction sector began in 1956 with the Federal Government's Target Plan. After the Plano de Metas, the Brazilian construction sector went through a period of low investment. Investments increased again with the National Development Plans (I PND in 1972 and II PND in 1975). After this period, Brazilian economic policy was based on currency stabilization. Only in 2007, the construction sector was once again understood as strategic with the creation of the Growth Acceleration Program (PAC) and with countercyclical macroprudential measures to face the 2008 financial crisis.

To mitigate the effects of the crisis, a series of measures was launched by the Federal Government, among which we can mention: incentives for consumption, cycles of reduction in the basic interest rate, expansion of credit to consumers and producers, exemption taxes and government programs such as the Minha Casa Minha Vida Program (PMCMV) and the Growth Acceleration Program (PAC). Among these measures, those that directly impacted the construction sector were the tax exemption for some construction materials, the reduction of real estate interest rates and the expansion of credit for housing through the Minha Casa Minha Vida Program (PMCMV), in addition to the increase in investments in the Growth Acceleration Program (PAC) (Abramat, 2010, Monteiro et al., 2011, Castro et al., 2014).

It can be argued that these measures were important for the Brazilian civil construction sector, given that the share of occupations in the sector in total occupations in the Brazilian economy jumped from 6.78% in 2005 to 8.47% in 2015. In the same period, the share of added value grew by 23.60%, from 4.69% in 2005 to 5.80% in 2015. Finally, gross fixed capital formation increased from 46.90% in 2010 to 54.25% in 2015. These statistics reveal that the Brazilian state seems to have been able to foster the growth of the civil construction sector in the recent period.

Faced with the adoption of the strategy of using the construction sector as one of the inductors of economic growth, this work seeks to undertake a systemic analysis of the sector to verify whether the investments were capable of increasing the productive chains of the sector in the Brazilian economy. In other words, it will be analyzed whether investments in the construction sector in the recent period were able to increase the complexity and interrelationships of the sector with other sectors of the Brazilian economy.

To reach the proposed objective, the method of hypothetical extraction of the input-output matrix will be used, which evaluates the impacts of the withdrawal of a certain sector from the economic structure, applied to the matrices made available by the Brazilian Institute of Geography and Statistics for the years 2005 - the period before - and 2015 - the period after - the adoption of measures that could directly impact the Brazilian construction sector recently. The results show that the importance of the productive structure of the construction sector (total extraction) goes from 7.42% of GDP in 2005 to 10.06% in 2015, with the sector evolving from the seventh most important in 2005 to the fourth most important in 2015, among the twelve considered. These findings are useful for the scientific literature that investigates the sector by bringing evidence to Brazil, for policymakers who may consider the sector and for other economic agents who seek investment opportunities and are increasingly attentive to the quality of public spending.

In addition to this introduction, the paper comprises four more sections. In the next section, a literature review is presented, section three addresses the methodology as well as the description of the input-output matrices used, in section four the results are presented and discussed and, finally, section five concludes.

2. Literature Review

Aiming to understand the literature that analyzed the civil construction sector through an input-output matrix, it is necessary to present the main contributions of the works. Bon and Minami (1986) undertook an analysis of the construction sector for the US and Japanese economies after World War II. The input-output method was applied to the US economy with the matrices for the years 1947, 1958, 1963, 1967, 1972 and 1977 aggregated into six productive sectors. As for the Japanese economy, the analysis was undertaken for the years 1960, 1965, 1970, 1975 and 1980 with an aggregated matrix in nine productive sectors. The results revealed that the construction sector of both economies remained stable in the analysis period. An interesting result is the fact that the construction sector, despite having a complex production structure, showed strong backward linkage, but low forward linkage.

Using the same database used by Bon and Minami (1986), Bon (1988) carried out a systemic analysis of the construction sector for the US economy after World War II using the input-output method. The results revealed that the American construction sector has a complex structure of interdependence and strong productive linkages with other

sectors of the economy. The results also showed that the construction sector has strong direct and indirect backward linkages, but indirect forward linkages are more important.

Bon and Pietroforte (1990) extended the work of Bon and Minami (1986) and Bom (1988) and made a comparative analysis of the construction sector for the economies of the United States, Japan, Italy and Finland. The objective of the work was to understand the relationship between economic maturity and the participation of civil construction in the Gross Domestic Product (GDP). The results showed the existence of a loss of participation in the construction sector with economic development. The authors conclude that the backward linkage structure decreases with the development of economies. Forward linkages increase directly with the level of economic maturity. Similar results were found by Bon (2000), Song et al. (2005) and Ilhan and Yaman (2011). Bon (2000) carried out a comparative study of the economies of Italy, Japan, Turkey, the United Kingdom and the United States. Song et al. (2005) compared the developed economies considering Australia, Canada, Denmark, France, Japan, Netherlands and the United States. Ilhan and Yaman (2011) compared the construction sector in Turkey and the European Union.

In the same tradition of previous works, Perobelli et al. (2016) carried out a systemic analysis of the civil construction sector for the economies of Germany, Canada, the United States, France, the United Kingdom, Italy, Japan, Brazil, China, India and Russia. To achieve the proposed objective, the authors used input-output matrices from the World Input-Output Database (WIOD) for the period from 1995 to 2009. The results showed that the civil construction sector has greater interconnections in developed economies than in developing economies. This result was different from the previously described findings.

Song and Liu (2006) undertook an input-output analysis seeking to quantify the sectoral interconnections for the Australian construction sector in the 1990s. The results indicated that the Australian construction sector had a lagged technological structure and stable productive chains. The authors conclude that the increased importance of the Australian construction sector was mainly due to increased government spending and foreign direct investment. Gundes (2011) carried out a similar analysis of the Turkish construction sector for the period between 1969 and 2006. The results revealed that the productive linkages of the construction sector in the Turkish economy reduced over the analyzed period. Thus, the author concludes her work by questioning the importance of the construction sector as a strategy to catalyze economic growth. Gül and Tasdogan (2020) found similar results to Gundes (2011). The authors also analyzed the productive chains of the Turkish construction sector and found that the sector also lost importance in the productive structure of the country in the period between 2002 and 2011.

Systemic analyzes of the Brazilian construction sector, using the input-output method, have also been undertaken. Teixeira and Carvalho (2005) sought to identify the direct, indirect and induced impacts of investments in the Brazilian construction sector on production, income, jobs and taxes for the year 2002. The results showed that the construction sector has a strong backward linkage since the sector demands above-average inputs. This result reveals that the growth of the construction sector also induces the growth of the sectors that supply it with inputs. As a result, the authors classified the Brazilian construction sector as a key sector for the Brazilian economy. Kureski et al. (2008), also seeking to measure the productive chains of the Brazilian civil construction macro sector, undertook an analysis for the year 2004. The results showed that the Gross Domestic Product (GDP) of the Civil Construction macro sector corresponded to 7.59% of the Brazilian economy and generated 15.2 million direct and indirect jobs in 2004. Finally, the authors, as well as Teixeira and Carvalho (2005), conclude that Civil Construction activity proved to be a key sector of the Brazilian economy.

Gonçalves Junior et al. (2014) aimed to measure, through the construction sector, the impact of the Minha Casa, Minha Vida Housing Program (PMCMV) on the Brazilian economy, using the input-output matrix for the year 2008. The results found showed that, Although the Program is important in generating employment and income, the civil construction sector presented backward and forward linkages below the average of other sectors of the economy.

Bueno (2019) carried out a systemic analysis of the socioeconomic impacts arising from the infrastructure sector in the period between 2000 and 2005. Through the input-output method, the results showed that the increase in investment in the sector in the order of 1.45 percentage points would lead to GDP growth of 2.5%, being able to generate 2.7 million new jobs.

Santos (2020) analyzed the productive evolution of the construction sector, in addition to verifying whether the sector could be considered strategic to, directly and indirectly, stimulate the Brazilian labor market. Through the input-output analysis for the years 2000, 2005, 2010 and 2015, the author concluded that the Brazilian construction sector had low backward and forward linkages and modest job multipliers. Based on this result, the author concluded that the civil construction sector cannot be understood as strategies to boost the Brazilian economy. This finding is in line with the work by Perobelli et al. (2016).

Finally, it should be noted that the input-output tool has also been used to analyze the intra and inter-sectoral importance

of the civil construction industry in regional economies. Kalluf and Kureski (2014) analyzed the productive chains of the civil construction industry in Paraná for the year 2006. Boaria (2016) measured the relevance of the civil construction sector for the Municipality of Laranjeiras do Sul in the State of Paraná in the years 2008 and 2013. Sobreira (2021) analyzed the importance of the construction sector for the economy of Minas Gerais between 2013 and 2016. For regional economies, it is possible to conclude that the civil construction sector has an above-average backward linkage and a high multiplier of jobs.

Through the undertaken review, it is possible to point out that the input-output method adheres to the objective proposed by the present work. Still, it is noticeable the existence of a well-documented systemic analysis of the construction sector, with mostly convergent results. Despite the literature being quite diversified, it should be noted that no studies were found that applied the hypothetical input-output extraction method to analyze the contributions of the last cycle of investments in the Brazilian civil construction sector for the product density and structure chains of the sector and, thus, it is possible to point out that this is the main contribution of the present work.

3. Methodology

3.1 Data

This work uses the input-output matrices released by the Brazilian Institute of Geography and Statistics for the years 2005 and 2015 as a database. Both input-output matrices are arranged with an aggregation of 12 productive sectors with sector technology by sector. The justification for choosing the period of the Input-Output Matrices used is because the hiring by the Fundo de Arrendamento Residencial (FAR)[1] of Minha Casa Minha Vida (PMCMV) undertakings, in addition to the Program itself (PMCMV), takes place between 2005 and 2015. Furthermore, the last official matrix released by the Brazilian Institute of Geography and Statistics is for 2015.

It should be noted that despite the Input-Output Matrix for the year 2005 using the System of National Accounts 1993 manual (SNA 1993) for data processing and the 2015 matrix making use of the SNA 2008 and, thus, despite the Input-Output Matrixes having different construction methodologies, it should be noted that the hypothetical extraction method, as it performs an analysis of the systemic importance (productive linkages) of the construction sector about other sectors of the economy, does not require that the matrices use the same construction method. If the objective of the work were to compare the construction sector in the two periods of time, the analysis could not be undertaken due to the different methodologies adopted in the construction of the Input-Output Matrices. As this is not the case, the Input-Output Matrices used to reach the results are consistent with the analysis. That said, the twelve productive activities contained in the Input-Output Matrices are described in Table 1.

Table 1. List of productive activities in the Input-Output Matrices for 2005 and 2015

Productive Activities (Sectors)	Abbreviation
Farming	Farm
Extractive Industry	Ext. Ind.
Transformation industry	Trans. Ind.
Electricity and gas, water, sewage and waste management	EGWSWM
Construction	Constr.
Business	Busin.
Transport, storage and courier	Transp.
Information and communication	Inform.
Financial, insurance and related service activities	Finan
Real estate activities	Real Est.
Other service activities	Oth. Serv.
Public administration, defense, health and education and social security	Admins.

Source: Elaborated by authors.

According to the Brazilian Institute of Geography and Statistics (2022), the construction sector analyzed in this work includes the construction of buildings, infrastructure works and specialized construction services (IBGE, 2022). The sector, in addition to promoting the entire economic structure aimed at providing housing for the various economic classes throughout the national territory, is responsible for supplying and promoting the development of the necessary infrastructure to increase the country's productive capacity.

3.2 Hypothetical Extraction of the Input-Output Matrix

[1] The Residential Leasing Fund (FAR) included low-income families (tier I of the Minha Casa Minha Vida Program (PMCMV). The use of this fund (FAR) had an effect similar to an investment in public work.

The analytical structure of input-output, developed by Leontief (1941) provides a complete description of the interdependencies or interactions (from the point of view of buying and selling) of the productive sectors in a given time and location (nation, region, state) (Miller and Blair, 2009).

One of the main assumptions of the input-output matrix is based on the assumption of balance between the quantity demanded and the quantity produced of goods and services, that is, it is based on the condition of equality of both the capacity to consume and the capacity to produce in the economy. The input-output model has the following assumptions: (i) constant technological coefficient, (ii) constant returns to scale, (iii) exogenously defined final demand and (iv) sticky prices. The key equation of the input-output model for n productive sectors is equation (1):

$$X = (I - A)^{-1}Y\#(1)$$

Where:

X is a vector $(nx1)$ that contains the gross value of production;

I is a dimension identity matrix (nxn);

A is a matrix (nxn) that denotes the technical production coefficients and is also known as the direct coefficient matrix $\left(A = Z(\hat{X})^{-1}\right)$;

Z is a matrix (nxn) that represents the intermediate flows;

$(I - A)^{-1} = B$ is a matrix (nxn) known as an inverse Leontief matrix, interdependence matrix or matrix of direct and indirect coefficients.

Finally, *Y* denotes the components of final demand (gross fixed capital formation – *I*, exports – *E*, government consumption – *G* and household consumption – *C*).

The model used in this work will follow the basic Leontief model classified with industry-based technology and with a sector x sector focus. Based on Equation 1, the hypothetical extraction method was proposed by Dietzenbacher et al. (1993). This method applied to the input-output matrix seeks to measure the intra and inter-sectoral importance of a given sector for the productive structure analyzed through the analysis of sectoral interdependence. Put another way, the method provides forward (destination of production), backward (origin of purchases) and total dependency indicators for the analyzed sector. The extraction method follows the tradition initiated by Rasmussen (1956) and Hirschman (1958) of using input-output matrices to quantify sectoral interdependencies.

Perobelli et al. (2010) point out that the indicators of the hypothetical extraction method applied, in two periods of time, are capable of verifying the evolution of sectoral interdependencies and the importance of the sector studied for the other sectors of the economy in terms of acquisition of inputs (dependency for backward) and product sales (forward dependence) and total (joint extraction of sales and purchases). According to Bon (1988), the input-output structure is capable of studying the direct and indirect requirements as well as the sectorial interdependencies of the construction sector. In this way, the proposed methodology has adherence to reaching the proposed objective.

The idea of the extraction method consists, therefore, of the hypothetical and/or imaginary extraction of a certain sector of the input-output structure. The extraction can be carried out at three levels, namely: total extraction (rows and columns extraction), purchasing structure extraction, backward linkage (BL) (columns extraction) and sales structure extraction, forward linkage (FL) (line extraction). The objective of this method is to quantify the importance of the production structure of the jth sector in the structure of interdependence with the other sectors of the economy if the structure of purchase and/or sale of this sector were removed from the analyzed economy.

To implement the BL, zero must be assigned to column j of matrix A, being *j in* the construction sector. Using $A^*_{(j)}$ to denote the matrix of technical coefficients with construction sector purchases at zero, the key equation of the input-output model is equation (2):

$$X^*_{(j)} = \left(I - A^*_{(j)}\right)^{-1}Y\#(2)$$

One way to quantify the importance of the purchasing structure in the construction sector for other sectors of the economy is through equation (3).

$$BL_i = X - X^*_{(j)}\#(3)$$

Where BL_i is a vector $(nx1)$ that denotes the sectorial importance of the structure of purchases in the construction sector for the other *n* sectors of the Brazilian economy. An aggregate metric of sector importance can be obtained by algebraically manipulating Equation 3, have the equation (4):

$$BL = i'X - i'^{X^*_{(j)}}\#(4)$$

Where *i'* is a transposed column vector of dimension $1xn$.

In Equation 4, BL can be interpreted as an aggregate measure of the backward linkages of the construction sector. It should be noted that the greater the value of BL, the greater the interdependence of the construction sector in terms of purchases with the other productive sectors of the economy. Thus, the greater the investment in the sector, the greater the drag capacity of the other sectors of the analyzed economy.

About the computation of FL, the procedure adopted is similar to that previously described for calculating the BL. Thus, zero should be attributed to sales in the construction sector. Put another way, zero is assigned to line i of the matrices A and Y, being i in the construction sector. Using $A^*_{(i)}$ and $Y^*_{(i)}$ to denote the matrix of technical and final demand coefficients, respectively, with construction sector sales at zero, the key equation of the input-output model is equation (5):

$$X^*_{(i)} = \left(I - A^*_{(i)}\right)^{-1} Y^*_{(i)} \#(5)$$

Following a logic similar to that used in calculating Equation 3, a way of quantifying the importance of the sales structure in the construction sector for other sectors of the economy can be the equation (6):

$$FL_i = X - X^*_{(i)} \#(6)$$

Where FL_i is a vector $(nx1)$ that denotes the sectorial importance of the sales structure of the construction sector for the other *n* sectors of the Brazilian economy. An aggregate metric of sector importance can be obtained by algebraically manipulating Equation 6, having the equation (7):

$$FL = i'X - i'^{X^*(i)} \#(7)$$

In Equation 7, BL can be interpreted as an aggregate measure of the forward linkages of the construction sector. In this way, the greater the value of FL, the greater the interdependence of the construction sector in terms of sales to the other productive sectors of the economy and final demand.

Finally, the total extraction of the sector can also be analyzed. The total extraction can be modeled by assigning zero to the line i and column j of matrix A, being i and j in the construction sector. As seen previously, when assigning zero to the sales of the sector of interest, the final demand of that sector is also zeroed $\left(Y^*_{(i)}\right)$. Using $\bar{A}$ to denote the matrix of technical coefficients without the construction sector, the key equation of the input-output model is the equation (8):

$$\bar{X} = (I - \bar{A})^{-1} Y^*_{(i)} \qquad \#(8)$$

As in the extractions described above, the importance of the interdependence structure of the construction sector for the other sectors of the economy can be measured as equation (9):

$$T_n = X - \bar{X} \#(9)$$

Where T_n will be a vector $(nx1)$ which denotes the sectorial importance of the productive structure of the construction sector for the other n sectors of the Brazilian economy. As realized by Equations 4 and 7, an aggregate metric of sector importance can be obtained by algebraically manipulating Equation 9, having equation (10):

$$T = i'X - i'^{\bar{X}} \#(10)$$

In Equation 10, T can be interpreted as an aggregate measure of the total linkages of the construction sector (*j*), after all, this Equation calculates the total effect of sector extraction, demonstrating its importance for the economy as a whole. It's worth pointing out that the higher the value of *T*, the greater the interdependence of the construction sector with the productive sectors of the analyzed economy, therefore, the greater the importance of the sector for the national economy.

Equation (10) can be divided by the original Gross Production Value (GPV) $(i'X)$ and multiplied by 100 to provide an aggregate measure of the loss of the economy in percentage terms as in equation (11):

$$\bar{T} = \left[\frac{(i'X - i'\bar{X})}{i'X}\right] 100 \#(11)$$

An alternative way of calculating the importance of the construction sector to other sectors of the economy as a whole can be computed as in equation (12):

$$T^{(A)} = \left[\left(i'X - x_j\right) - i'^{\bar{X}}\right] \#(12)$$

Where x_j refers to the Gross Value of Production (GVP) of the external sector.

Analogously to Equation (11), one can calculate the percentage aggregate loss as in equation (13):

$$\bar{T}^{(A)} = \left[\frac{\left(i'X - x_j\right) - i'^{\bar{X}}}{i'X}\right] 100\#(13)$$

All algebraic manipulations carried out from Equation 11 can be easily replicated to compute similar measurements of the BL and FL.

4. Results

With the method of hypothetical extraction of the input-output matrix, which evaluates the impacts of the removal of a certain sector from the economic structure, the importance of purchases (backward linkage, BL), sales (forward linkage, FL) and the importance of the productive structure of the Brazilian construction sector and its interdependence with other sectors of the Brazilian economy (total extraction). The results are displayed in Table 2.

From the results, it was verified that the importance of the productive structure of the construction sector (total extraction) was of the order of 7.42% of the gross domestic product (GDP) for the year 2005. This result reveals that the construction sector in the year 2005 did not have a significant weight in the Brazilian economy, since the extraction showed that the importance of sector linkages was the seventh most important in the total of 12 sectors considered. As for the year 2015, the extraction of the construction sector was able to reduce the national GDP by 10.06%, proving to be the fourth most important activity in the Brazilian economy behind only the Manufacturing Industry, Other Services and Commerce. It should be noted that in 2015, all sectors of the Brazilian economy grew in importance. However, it can be said that the four sectors mentioned above accounted for about half of the country's economic activity in 2015.

Regarding partial extraction from the construction sector, it can be seen that in 2005 backward linkages (BL) represented approximately R$ 213 billion. When analyzing the BL for the year 2015, it appears that the value jumped to around R$ 464 billion. This result reveals that chain purchases in the construction sector increased by R$ 251 billion in the period. When compared relatively, it is possible to point out that the importance of the impact of purchases on GDP increased from 3.2% in 2005 to 4.53% in 2015.

When the FL is analyzed, by extracting the sales structure of the Brazilian construction sector, it can be seen that despite the improvement in the importance of linkages in the sector's sales structure in the period, it is low compared to other sectors of the economy. In 2005, FL was around R$ 60 billion, representing 0.9% of GDP. In 2015, despite the sector's importance doubling in monetary terms by R$ 129 billion, its share in GDP remained low, representing 1.26%.

Based on the results, it is possible to conclude that the productive linkages in the Brazilian construction sector increased over the analyzed period. Another interesting finding of the results lies in the fact that despite the construction sector presenting an increase in the complexity of its productive structure, the referred sector presented strong backward linkage, but low forward linkage, in both analyzed periods. This result is in line with the literature as can be seen in the works of Bon and Minami (1986), Bon (1988), Teixeira and Carvalho (2005) among others.

Through these results, it is still possible to point out that the measures that directly impacted the construction sector in the last cycle of investments in the sector, namely, tax relief for some construction materials, reduction of real estate interest, expansion of credit for housing through the Minha Casa Minha Vida Program (PMCMV) and increased investments in the Growth Acceleration Program (PAC) may have been essential for increasing the importance of the productive structure of the construction sector in the Brazilian economy. Finally, given the high backward linkages that reveal that the growth of the construction sector also induces the growth of the sectors that supply it with inputs, showing that the sector can be an important strategy for promoting economic growth.

Table 2. Results of the Hypothetical Input-Output Extraction for the 2005 and 2015 matrices

Sectors	BL (2005) (R$)	FL (2005) (R$)	BL% (2005)	FL % (2005)	BL (2015) (R$)	FL (2015) (R$)	BL% (2015)	FL % (2015)
Farm	247.772,27	408.687,15	3,72	6,14	321.581,18	443.125,78	3,14	4,33
Ext. Ind.	159.497,97	255.982,01	2,39	3,85	188.188,11	256.007,60	1,84	2,5
Trans. Ind.	1.771.407,43	1.443.631,05	26,64	21,71	2.159.586,08	1.680.590,12	21,11	16,43
EGWSW M	132.711,93	276.668,12	1,99	4,16	220.502,93	311.749,16	2,15	3,04
Constr.	213.177,59	60.458,77	3,2	0,9	464.161,55	129.252,80	4,53	1,26
Busin.	218.898,36	369.254,45	3,29	5,55	558.958,68	742.738,13	5,46	7,26
Transp.	244,484,59	347.629,04	3,67	5,22	367.419,40	567.639,38	3,59	5,55
Inform.	142.572,70	265.814,40	2,14	3,99	195.182,85	274.529,30	1,9	2,68
Finan	149.734,37	269.935,15	2,25	4,06	245.961,67	433.813,63	2,4	4,24
Real Est.	27.644,94	90.338,23	0,41	1,35	59.929,26	155.813,30	0,58	1,52
Oth. Serv.	480.469,12	438.410,42	7,22	6,59	695.352,62	982.162,22	6,79	9,6
Admins.	397.159,82	25.660,97	5,97	0,38	460.931,69	58.768,75	4,5	0,57

Source: Elaborated by authors.

5. Conclusion

The present work sought to verify whether the public policies implemented in 2008 that directly impacted the Brazilian civil construction sector, such as tax relief, reduction of real estate interest, expansion of credit for housing through the Minha Casa Minha Vida Program (PMCMV) and the increase in investments in the Growth Acceleration Program (PAC) were able to increase the complexity of the intra and inter sector relations of the construction sector with other sectors of the economy, contributing to the strengthening of the Brazilian economy.

For this, the methodology of hypothetical extraction of the input-output matrix and the official matrices for the Brazilian economy referring to the years 2005 and 2015, before and after the public policies, were used. Through the results, it is possible to conclude that the productive linkages of the Brazilian construction sector increased between 2005 and 2015. In 2005, the direct and indirect importance of the construction sector represented 7.42% of the Brazilian GDP. In 2015, this share grew to 10.06%. A result reveals that among the twelve sectors analyzed, the construction sector moves from the seventh most important in 2005 to the fourth most important in 2015. The forward and backward linkages also increased over the analyzed period. But the result that draws attention is the fact that the construction sector has high backward linkage and low forward linkage.

This result is in line with the literature (Bon and Minami, 1986; Bon 1988), but in disagreement with other works that analyzed the importance of the Brazilian construction sector for other periods and with Input-Output Matrices made available by unofficial bodies (Gonçalves Junior et al., 2014; Perobelli et al., 2016; Santos, 2020). These authors found that the construction sector has backward and forward links below the average of other sectors of the economy.

However, as pointed out by Bon (1992), the construction sector has a low backward linkage in developed economies. In developing economies, such as Brazil, a high backward linkage is expected due to the need for infrastructure to catalyze the industrialization process and the increase in the urbanization rate. Thus, it is concluded that the results found by this work are robust and consistent with the literature. The low linkages forward and backward in the construction sector found by other works may be because investments in the sector did not mature in the Input-Output Matrices analyzed.

Through these results found, it is still possible to point out that the measures that directly impacted the construction sector in the last cycle of investments in the sector may have been able to increase the importance of the productive structure of the construction sector in the Brazilian economy. An important conclusion is that due to the demand for inputs in the construction sector being largely supplied by national products, the sector has a low demand for imports and is responsible for almost 50% of gross fixed capital formation, sector can be used as a strategy to catalyze and influence national economic growth. In the short term, a policy to promote the construction sector through its productive chains could expand the level of product, employment and income. In the long term, the expansion of investments in infrastructure would possibly increase gross fixed capital formation, which - in turn - would increase the productivity and competitiveness of the economy, generating sustainable growth.

Therefore, this work shows that the civil construction sector could be used as a strategy to promote and stimulate Brazilian economic activity as an alternative to overcome possible crises experienced by the country. As a suggestion for future research, the importance of the civil construction sector for the Brazilian economy could be evaluated through a computational simulation model based on agents.

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