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CIVIL CONSTRUCTION: GROWTH VERSUS CIVIL PRODUCTION COSTS

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ABSTRACT

The economic growth of a country is directly linked to the growth of several sectors, especially the industrial sector, in which the Civil Construction follow-up is highlighted. In this conjecture, the main objective of this study was to investigate the relationship between the growth of the civil construction industry in Brazil and its productivity costs in the period from 2000 to 2016. Two quantitative methodologies were adopted: the linear correlation method of Pearson and the ordinary least squares estimator. The database was composed of information collected by the Institute of Applied Economic Research (*Instituto de Pesquisa Econômica Aplicada* – IPEA) and the Brazilian Chamber of Construction Industry (*Câmara Brasileira da Indústria da Construção* – CBIC). The main results indicate that: i) no valid statistical evidence has been established that proves any direct or indirect relation of the costs with the growth rates of the sector; ii) as expected, it was found that the main determinant of the construction industry are investments. The main limitations faced in the present research refer to problems of variables omitted in the proposed estimates, whether due to errors in measurement and / or unavailability of information. In turn, the relevance of works of this nature stands out, since they make possible the construction of more effective public and private policies with the purpose of developing the sector. It is worth mentioning that there is undeniable absence of research with the approach addressed.

Keywords: Gross Domestic Product; Construction; Construction Costs; Investments in the Sector.

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1. INTRODUCTION

The economic growth of a country depends on several factors that provide the increase of wealth, making the population have greater purchasing power to improve their quality of life. At this point, the industrial and productive sectors contribute significantly to the rise of the economy in order to generate employment, and, consequently, the increase of income of the families (Teixeira et Carvalho, 2005).

In this conjecture, several sectors are essential for the growth and economic development of a country, especially those that have great influence on the economy and are linked to other areas, such as the civil construction industry (*indústria da construção civil* – ICC). This sector is one of the most important productive sectors of the economy, since it contributes substantially to the supply of direct jobs, that is, in the construction itself, and thousands of indirect jobs in other industrial areas, such as those of science and technology. It also has a strong participation in tax collection, and is responsible for building the entire infrastructure of a country, thus providing the growth of the entire production chain.

Several studies point to the relevance of construction in the Brazilian economy, including World Bank (1984), which states that the sector is widely coupled with the economy, to the point that changes in its demand originate direct and indirect influence in several economic segments, either through the generation of jobs and/or the supply of inputs for production. It means that the sector boosts, if not all, several important sectors. In sum, growth in ICC has a significant impact on industry, agriculture and the services sector.

Ghinis et Fochezatto (2013) found that the construction sector is the one that most impacts on reducing the country's poverty when compared to other economic activities, such as the agricultural sector.

According to Souza et al. (2015), the ICC is linked to variations in the national Gross Domestic Product (GDP). In addition, strong evidence is found that investments in infrastructure directly influence the rise of other industrial sectors and therefore contributes substantially to GDP growth.

On the other hand, Gondim et al. (2004) verified that the development of the sector is a great ally for the growth of the economy; however, this is not a rule. In the study, the growth of the economy and civil construction was evaluated in the years 1998 to 2002. In only two years, the growth of the sector and, in most years, the rise of the Brazilian national GDP was observed. In other words, the growth of the ICC generates more GDP, but the opposite is not necessarily valid. Figure 1 illustrates this relationship.

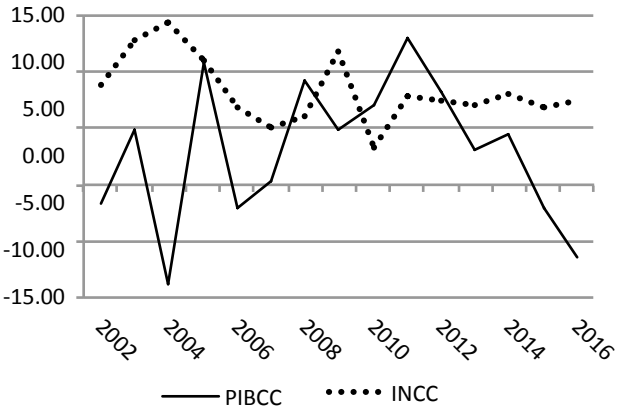

Figure 1. Gross Domestic Product of Civil Construction (GDPCC) versus National Index of Construction Costs (INCC) – Brazil, 2000-2014

Source: The authors themselves. Legend: PIBCC = GDPCC

Some studies have advocated that this phenomenon is due to the high cost of civil construction in Brazil. Thus, the question is: Does the cost of construction in Brazil inhibit the growth of the sector, whether operational, bureaucratic, environmental or legal? If so, these factors deserve special mention. Furthermore, as shown in Figure 1, there is no predictable cost pattern in the Brazilian National Construction Costs Index (Índice Nacional de Custos da Construção – INCC) with the production of the sector.

Therefore, this study has as its main objective to investigate the relationship between the growth of ICC in Brazil and its productivity costs in the period from 2000 to 2016. In other words, it was sought to determine if the costs decrease the growth capacity of the ICC. For that, several statistical tools were used, especially the descriptive ones. In addition, the Pearson coefficient was calculated in order to establish the existence of a correlation between the growth rate of ICC and the INCC. Finally, it was estimated a regression by the least squares method (OLS).

DEVELOPMENT

The construction sector is considered one of the most important productive sectors existing in a country, since it not only promotes development but is also responsible for creating multiple jobs and income. Therefore, several studies are developed to verify the importance of this sector in national productivity and development. From this perspective, this section will present important results from the literature on the subject in question.

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Growth and importance of the construction industry

The construction sector, which is largely responsible for a country's economy, is closely linked to national development and production. Thus, in the last 40 years, the growth of this sector has undergone changes due to the economic growth and moments of financial crises (FIRJAN, 2014).

According to Amorin (2014), a survey conducted by the Minas Gerais Construction Industry Union (*Sindicato da Indústria da Construção de Minas Gerais* – SINDUSCON-MG), using data related to the development of the ICC in the last 20 years, found that in the last decade there was an increase of 52.10 % in the sector, that is, an average annual rise of 4.28%; and in the last 20 years, this growth was 2.82%. Still, according to the study, unemployment fell significantly, from 8.9% in 2003 to 2.5% in 2014.

On the other hand, a study carried out by the *Sistema* FIRJAN (2014), in partnership with the Getúlio Vargas Foundation (*Fundação Getúlio Vargas* – FGV) and important business and academic leaders of the civil construction sector, investigated the main difficulties related to the growth of competitiveness and productivity of ICC in Brazil. Among the guidelines mentioned, one can highlight those capable of increasing productivity and competitiveness in the sector: improving the capacity of the workforce at all levels and intensifying the use of modern management practices, and streamlined, industrialized and innovative methods of construction. The main results indicate that the growth of the construction industry is directly related to the country's economic situation; thus, in times of crisis, there is a fall in the sector. In addition, it observed an increase of 170% of workers with a formal contract between 2003 and 2012. This evolution can be verified in figure 2.

In other words, the sector is responsible for increasing the population's income and consequently decreasing unemployment, as observed, for example, by Possenti et Pontili (2015). Using data from the Annual Survey of Construction in the period 2007 to 2012, the authors analyzed the impacts of the Growth Acceleration Program (*Programa de aceleração do Crescimento* – PAC) in the area of civil construction. The main results indicate that the sector generated income and employment for individuals with low educational and financial levels and the rise of micro and small companies linked to the sector, which was not observed in others. In addition, the creation and investment of public policies provided growth in the sector and, consequently, in the Brazilian economy.

In his study, Kureski (2011) obtained the direct, indirect and induced multipliers of employment and income for the economy of the state of Paraná in the year 2006, specifically those of the civil construction industry. To that end, he adopted the methodology of the Input-Output Matrix, which, in synthesis, associates the added value of each sector with the so-called aggregate expenditures, that is, general output (Guilhoto et Sesso Filho, 2005). As a result, it was verified that about 8% of the GDP of the State of Paraná in 2006 came from the construction sector and that the final consumption of the ICC generated 423,500 jobs.

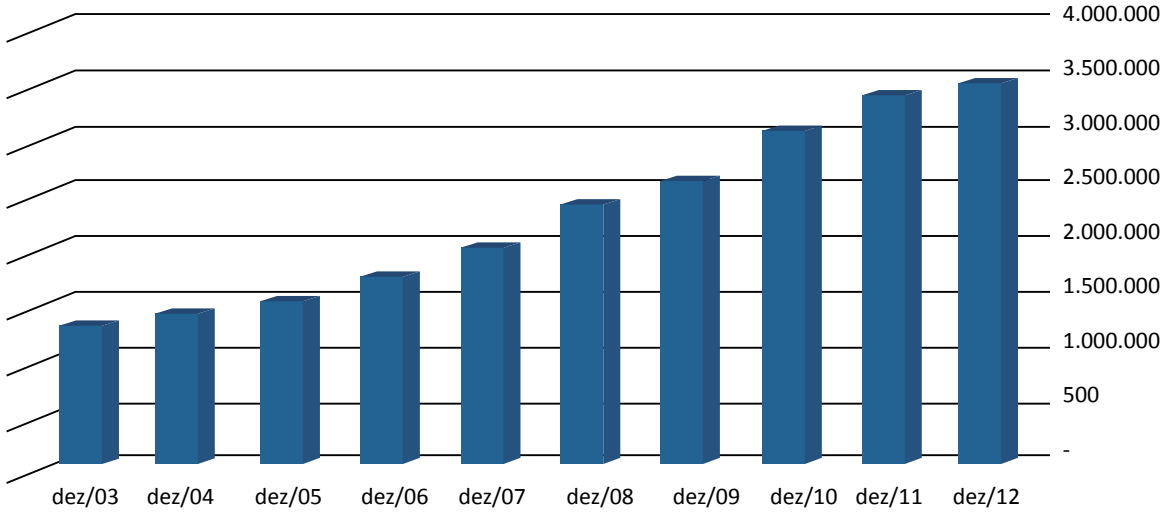

Figure 2. Number of jobs with a formal contract in the construction sector – Brazil, 2003-2012
Source: Federation of Industries of the State of Rio de Janeiro - FIRJAN, 2014

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Ghinis et Fochezatto (2013), in turn, studied the effects of civil construction for poverty reduction in Brazil from 1985 to 2008. Using information provided by the Annual Information of Social Information (*Relação Anual de Informações Sociais* – RAIS) and the Institution of Applied Economic Research (*Instituição de Pesquisa Econômica Aplicada* – IPEA) of all Brazilian states, a dynamic panel was estimated for all states. Thus, it was mainly verified that there is a strong correlation between the growth of the civil construction and the generation of low qualification employment in the studied period. In addition, it was observed that this sector provided higher salaries for low educational level persons when compared to other economic sectors, such as the agricultural sector.

In another study, Fochezatto et Ghinis (2011) evaluated some determinants that influenced the production of civil construction in the state of Rio Grande do Sul and in Brazil, from 1990 to 2008, based on an econometric panel data model. In this method, one has information about an individual (company, sector, country, etc.) in at least two different periods. From then on, the methodology manages to capture the influence of a certain characteristic of interest (Wooldridge, 2010). From the data, it was observed an exponential growth of the civil construction in the scenarios studied. In addition, the participation of the state of Rio Grande do Sul has more than tripled in the production of the construction sector. There was also an increase of 5.1% of formal jobs in this area in the country, although a large part of the workforce was not specialized, since 70.8% of the jobs were not qualified in 2008.

2. INVESTMENTS IN THE CONSTRUCTION INDUSTRY

Several studies have found that there is a significant influence of the ICC on the Brazilian economy. Notably, in times of contraction in the civil construction sector, there is a decline in the country's economic activity. In this configuration, it is noted that investments in this area, both public and private, are fundamental for the industrial, as observed in recent years, and economic development of Brazil.

Government incentives through social programs, for example, have been very important for the evolution of the ICC. An important public policy developed was the PAC, prepared in 2007, which aimed at investing in infrastructure in order to provide development in the civil construction sector and to reduce bottlenecks that negatively influenced growth. Possenti et Pontili (2015) found that PAC provided economic growth in the sector, especially in active companies, formal jobs and value added for the area. In addition to the PAC, the My Home, My Life (Programa Minha Casa, Minha Vida – PMCMV) Program was launched in 2009, with the main objective of making the construction of housing accessible to families through non-profit private entities.

On the other hand, the growth of investment by private companies is directly linked to several economic factors, such as inflation[1], interest rate[2] and market expectations[3], since entrepreneurs will only invest in the sector if they are assured of the return of capital.

Currently, there is a crisis in the Brazilian economy, which causes a fall in the construction industry. According to the IBGE (2016), there was a 3.8% reduction in GDP in 2015 compared to the previous year, and this was considered the largest drop since 1996. Parallel to this, comparing the periods from January to July of 2015 to the same period of the previous year, there was a decrease of 20% in the value of acquisition and construction of real estate and 25.8% in the amount of real estate financed (CBIC, 2015).

Gross Domestic Product of Civil Construction - GDPCC

GDP represents the sum of all products and services produced in the country over a given time period. GDP growth means that GDP was higher in one year than in the previous year. Otherwise, it is said that there was recession.

According to Souza et al. (2015), GDP represents the accumulation of wealth over a period of time and is determined on the basis of the accumulation of values from the sectors of agriculture, industry and services.

In this context, the ICC has a large impact on the value of GDP, since it is a sector that generates productivity and development in the economy. Figure 3 shows the variation of national GDP and GDPCC in the period from 2004 to 2016.

Figure 3 shows periods in which the GDPCC is much higher than the national GDP, as in 2007 and 2009, which may have resulted from the high investments in the sector due to the implementation of the PAC and the PMCMV, respectively. Few years later, however, the opposite occurred. One possible cause for this is the decrease in investments in the sector due to the fall in the national economy. In general, in almost all the years studied, there is the joint growth or recession of GDP and GDPCC.

Additionally, Teixeira et Carvalho (2005) evaluated that the investment in civil construction is of great importance in

1 Inflation: continued increase in the general price level.

2 Interest rate: price of capital (money). In Brazil, the basic interest rate is expressed by the Settlement and Custody System Rate (Taxa do Sistema de Liquidação e Custódia – SELIC).

3 Market expectation: forecasts of the main macroeconomic variables, for example, the degree of consumer confidence.

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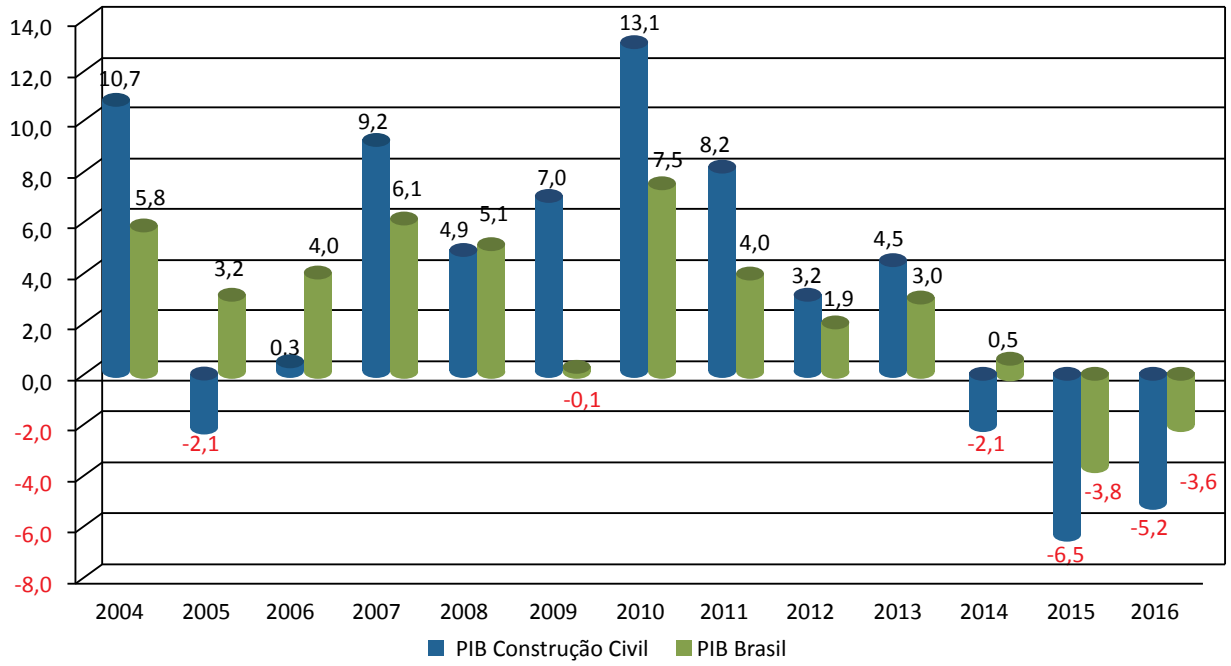

Figure 3. Gross Domestic Product (GDP) Brazil vs. Civil Construction GDP
Source: Brazilian Chamber of Construction Industry (2016)
Legend: in green - Civil Construction GDP; in orange - Brazilian GDP

the country's economy, as it generates an increase in terms of income and jobs, contributing to economic growth. In addition, the sector has a high impact on the tax generation of the economy, that is, about 23% of the expenses with production of construction activities return to the public coffers in the form of taxes on products and social contributions.

Costs of the construction industry

The construction industry encompasses several services that require skilled labor, in addition to the use of various types of inputs. To do so, all associated activities generate associated costs. If these costs are high, the investment capacity in the sector decreases, as risks to the profitability of invested capital are generated.

In this way, the State Civil Construction Trade Unions (SINDUSCONS) monthly calculate and disclose a cost indicator in the civil construction called Basic Unit Cost (*Custo Unitário Básico* – CUB), governed by Federal Law 4591/64, decreed on condominium in buildings and real estate incorporations. Using the values of the indicators obtained in the Brazilian states, the Brazilian CUB is calculated by means of a weighted average (CBIC, 2017).

According to SINDUSCON-PR (2017), this index indicates the global cost of the work and is expressed per square meter unit. The CUB portrays the variation of the monthly costs with labor and inputs. However, this indicator does not reflect the true cost of the work. This cost is only obtained by budgeting all the services that will be executed.

In addition to the CUB, the INCC is also fundamental to verify the development of costs in the construction industry. Calculated and published monthly by *Fundação Getúlio Vargas* (FGV), INCC reflects the evolution of construction costs nationwide (IBRE/FGV, 2015). The calculation is based on prices raised in seven Brazilian capitals: São Paulo, Rio de Janeiro, Belo Horizonte, Salvador, Recife, Porto Alegre and Brasília.

Unemployment rate of civil construction (Taxa de desocupação da construção civil – TDCC)

The unemployment rate is the ratio of people who are unemployed in the reference week, that is, those who are not working, who are looking for work in the corresponding week or waiting to start in the week after that, and people in the workforce during the same period. That is, the sum of occupied and unoccupied individuals. In summary, the TDCC can be expressed as follows: (rate of unoccupied persons) / (rate of people in the workforce) (IBGE, 2017).

This rate is calculated based on data extracted from the IBGE's Monthly Employment Survey (PME), based on six metropolitan areas - Recife, Salvador, Belo Horizonte, Rio de Janeiro, São Paulo and Porto Alegre - that depict unemployment of the country as a whole (CBIC, 2016).

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3. METHOD

This study adopts two empirical strategies, but in particular, quantitative aspects are addressed, since the main objective is to measure the role of construction costs in the performance of the sector, that is, the growth of construction. However, it should be noted that the information set also reflects qualitative features of the sector, since the higher the production and the lower the observed cost, the greater the social welfare.

The data were collected at the IPEA and at the Brazilian Chamber of Construction Industry (CBIC), from 2000 to 2016.

Descriptive Statistics

A number of descriptive tools were used on the database. In particular, mean values, variance, standard deviation, graphical illustrations, and tables for various ICC scenarios were calculated.

Pearson's Linear Correlation Coefficient

The magnitude of the linear association between two variables can be measured using the Pearson Correlation Coefficient (PCC). In summary, PCC, also known as product--moment correlation coefficient or Pearson's *r*, measures the degree of linear correlation between two quantitative variables. It is a dimensionless index with values in the interval [-1,1], which can also be used to capture the level of linear relationship between two sets of information, where *r* = 1 reports a positive and perfect linear relationship, while *r* = -1 indicates a perfectly negative relationship, that is, as one variable grows the other decreases proportionally. The , in turn, establishes that both variables are independent, that is, it may mean the existence of a non-linear relationship. Therefore, this result must be compared with other instruments.

Formal expression:

$$r = \frac{\sum(x_i - \bar{x})(y_i - \bar{y})}{\sqrt{(x_i - \bar{x})^2 (y_i - \bar{y})^2}} \quad (1)$$

Where and represent the values of the variables and . And and represent, respectively, the means of the observed values of and .

Ordinary least squares regression (OLS)

According to Gujarati (2009), the OLS method is attributed to Carl Friedrich Gauss, a German mathematician. The OLS presents some very interesting statistical properties, which made it very widespread and used.

It is accepted a population regression function (PRF) expressed by:

$$Y_i = \beta_1 + \beta_2 X_i + u_i \quad (2)$$

Where represents the variable of interest. In this study, the values observed for the growth of ICC; the intercept; to each of the independent variables. That is, what the influence of a given factor is on the result. In this case, the main observed is the cost of production of civil construction represented by the INCC.

However, it is known that on most real occasions we do not have observable data on the whole population in question. That is, facts in general are not directly observable. For example, there is no data available on all the characteristics that affect the growth of ICC. However, it is plausible to admit that there is available information of some fundamental characteristics, so that the sample regression function (*função de regressão amostral* - FRA) is estimated from:

$$\hat{Y}_i = \beta_1 + \widehat{\beta_2} X_i + \hat{u}_i \quad (3)$$

Thus, we can obtain:

$$Y_i = \hat{Y}_i + \hat{u}_i \quad (4)$$

In which is the value – conditional average - estimated from Thus, we have:

$$\hat{u}_i = Y_i - \hat{Y}_i \quad (5)$$

It is shown that – residues – represents the differences between the estimated values and the actual values . Therefore, if are pairs of observations and , we need to identify the FRA that represents the closest possible actual .

Chart 1 presents the variables used in this work. It is highlighted that the data set was selected obeying economic aspects and model specification tests. Although the limitations imposed by the problem of omission of variables are known, essentially referring to non-observable factors, the work does not propose to investigate causality, but rather correlation. In this sense, the problems highlighted do not compromise the proposed objectives.

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Chart 1. Description of variables

Variables	Description
PIBCC	Growth rate - Variation - Civil Construction GDP
Independent variables	
INCC	National Construction Cost Index
CUB	Basic Unit Cost
INVCC	Civil Construction Investments
TDCC	Unemployment Rate in Civil Construction

Source: The authors themselves

It can be seen from Table 1 that the GDPCC varied in the period studied by approximately 15.7 to 78.8 billion. Its average value was 41.7 billion, and the average growth rate in the period was 2.48%, although in 24 of the 68 quarterly periods analyzed the variation was negative.

Regarding the INCC, it had a peak with a value of 5.369 and an average of 1.98, a behavior almost identical to that of the CUB. This result was already expected, since the INCC and CUB had a correlation of 0.94, that is, almost perfect. In addition, the maximum and minimum values for GDPCC were approximately 3.9 billion and 9.7 million, respectively, with an average value of 1.06 billion. Finally, TDCC presented values ranging from 2.43 to 9.43 with a mean of 5.26.

It is interesting to note that the unemployment rate of any sector is a thermometer of the respective activity, and is therefore not different for the Civil Construction sector. It implies that the lower the level of activity, the lower the employment and the higher the unemployment rate. This explains why the unemployment rate varied so much in the period, thus explaining the behavior of the sector.

4. RESULTS AND DISCUSSION

Figure 4 shows the performance of the variables used in the present study over the time analyzed. As can be verified, the GDPCC - percentage variation - has a very atypical behavior when compared to the other independent - explanatory variables. However, it is possible to visually evidence some kind of relationship between them, especially with regard to the cost indicators used: INCC and CUB. It should be noted that, in general, the INCC, not the CUB, is used as a representative of construction costs because the results do not change significantly.

Inferences regarding the set of information used in this study could only be elaborated through econometric procedures. At this point, we initially sought to show the normality of the variable of interest, that is, the GDPCC. It is clarified that these procedures aim to analyze whether the data is normally distributed in order to show the most robust results possible.

According to Figure 5, it can be observed that the data regarding the GDPCC are normally distributed, and, therefore, presents important desirable characteristics[4]. However, such prognostics can only be affirmed through specific and formal tests. From this perspective, the Shapiro-Wilk normality test was applied. Briefly, it is reported that this test was proposed in 1965, based on the W statistic (Cameron et Trivedi, 2005). In this context, the normality test was applied and satisfactory results were obtained. In summary, the test proved the normality in the distribution of the data referring to the rate of change of the GDPCC.

4 In this case deviations are usually distributed around the mean, reducing variance and standard deviation by increasing the significance of the OLS estimator.

Table 1. Descriptive statistics

Construction GDP - R$			
Minimum value 15.699.095.488,09	Mean 41.698.132.279,08	Maximum value 78.802.630.811,78	Standard deviation 2,38 e+10
National Construction Cost Index			
Minimum value 0,349	Mean 1,98	Maximum value 5,369	Standard deviation 1,262
Basic Unit Cost of Construction			
Minimum value 0,324	Mean 1,865	Maximum value 5,513	Standard deviation 1,114
Civil Construction Investments - R$			
Minimum value 9.708.195,00	Mean 1.060.181.363,31	Maximum value 3.950.678.413,00	Standard deviation 0,95 e+08
Unemployment Rate of Civil Construction			
Valor Mínimo 2,430	Mean 5,260	Maximum value 9,430	Standard deviation 2,319

Source: The authors themselves

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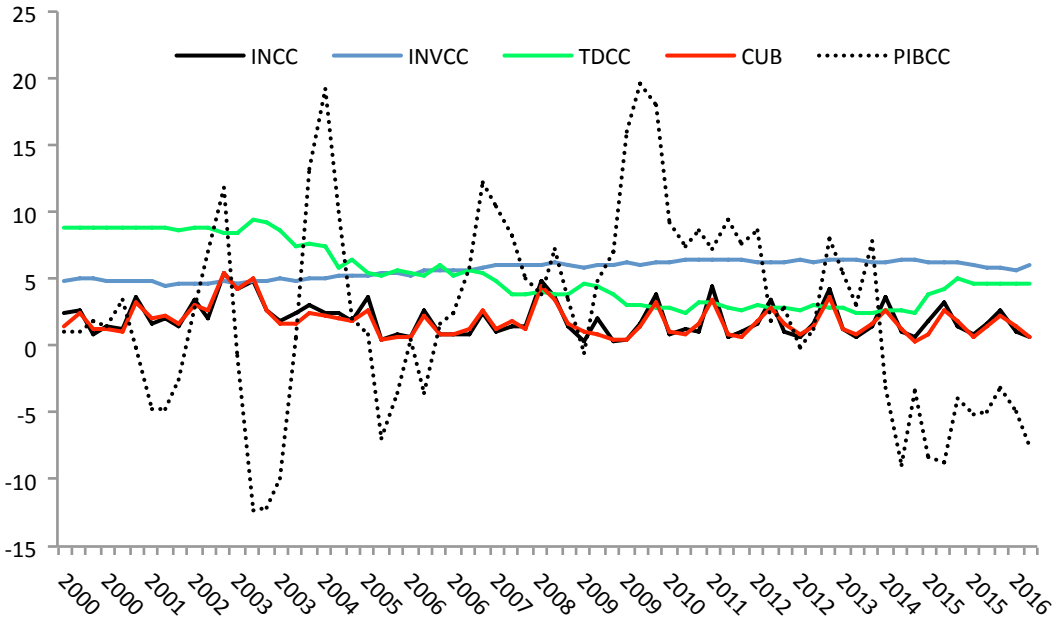

Figure 4. GDPCC behavior and its determinants

Source: The authors themselves

*PIBCC: GDPCC

Legend: Left Graph: Distribution Density (Vertical); Estimated Kernel Density (Horizontal); Growth Rate - Variation - Civil Construction (Horizontal). Right Graph: GDPCC Variation Rate (Vertical); Normal Inverse (Horizontal)

After that, we used calculations to obtain Pearson's linear correlation coefficient, followed by the significance test. It is highlighted that this procedure portrays one of the main objectives proposed in the research.

According to the results shown in Table 2, there is strong evidence that the INCC has no direct correlation with the PIBCC at statistically significant levels, that is, different from zero. On the other hand, the INCC has a negative correlation with the Civil Construction Investments (*Investimentos da Construção Civil* – INVCC) (-0.2466). In other words, this result shows that the construction costs represented by the INCC seem to negatively affect the investments in the sector around 24.66%.

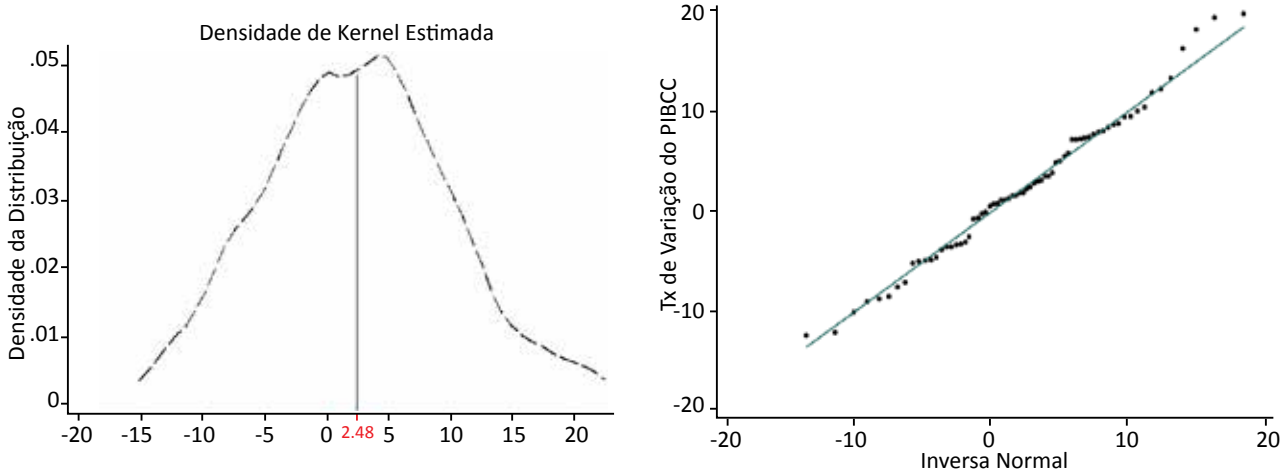

Figure 5. Distribution of Data - GDPCC 2000/2016 - Quarterly

Source: The authors themselves

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As for the unemployment rate, this ratio is positive. In figures, there is a 0.2774 correlation between unemployment and inflation - INCC - of the sector. It is important to note that this result is contrary to the Philips curve. The Phillips curve is a macroeconomic phenomenon in which inflation and unemployment are inversely proportional: the higher the inflation index the lower the unemployment rate and vice versa. However, the Phillips curve is not a general rule. In addition, an indirect relationship may be evidenced. That is, the higher the inflation - INCC - the lower the investment indexes, therefore, the higher the unemployment rate in the sector.

Table 2. Pearson's Linear Correlation Coefficients

Variables	GDPCC	INCC	INVCC	TDCC
GDPCC	1			
INCC	0.055 (0.654)	1		
INVCC	0.2205* (0.0708)	-0.2466** 0.0426	1	
TDCC	-0.2608** (0.0317)	0.2774** (0.0220)	-0.963*** (0.000)	1

Source: The authors themselves

Level of Statistical Significance: * p<0.10; ** p<0.05; *** p<0.01

The values in parentheses refer to the values of the p-values.

On the other hand, there was a positive relationship at 0.2205 between investments - INVCC - and the GDPCC in the analyzed period. In turn, the results regarding the unemployment rate of the sector reflect the expected. Numerically, the TDCC has a negative correlation of 0.2608 with the growth of the sector. In sum, the lower the production - growth - of the construction sector the lower the employment rate and the higher the unemployment.

However, the most interesting result refers to the observed correlation between the unemployment rate and investments in the sector: there is a statistically valid correlation of -0.963. In practical terms, each incremental percentage point in investment in the construction sector may lead to a drop of 0.963% in the sector's unemployment rate. This result, although coherent, is much more intriguing, since the method captures an almost exact proportional relation. It means that if there were a *ceteris paribus* scenario - all the more constant - the decrease in unemployment in the sector by 10% would be accompanied by an equally high increase in investment.

However, it is necessary to consider that the results obtained only portray relations and not cause. In summary, there is no way of stating scientifically that the fall in investment causes unemployment, higher levels of investment cause industry growth, and that lower industry prices cause higher investments. However, the correlations found indicate that there is a close relationship between the variables studied, with the exception of INCC and GDPCC, although this relationship may be occurring indirectly, since the INCC has a negative correlation of -0.2466 with the investments of the sector, and, on the other hand, the INVCC has a positive relation of 0.2205 with GDPCC. Thus, in practical terms, the INCC may be hampering investments by 24.66% and, consequently, the growth of the sector by 5.44%[5]. Table 3 shows the results obtained from the estimation methodology by OLS.

Table 3. GDPCC determination coefficients

Variables	β			p-value	Interval
INCC	0.812	0.715	1.14	0.261	-0.616| 2.241
INVCC	0.797**	0.325	2.45	0,017	0.148 | 1.447
TDCC	-0.706**	0.332	-2.13	0.037	-1.369 | -0.042

Source: The authors themselves

Level of Statistical Significance: * p<0.10; ** p<0.05; *** p<0.01

In line with the central objective of the study - to investigate whether the costs are reducing the growth capacity of the ICC through the multivariate analysis of correlations, the coefficients of determination of the GDPCC were estimated using the OLS methodology, for the purposes of: i) corroborating/comparing the results obtained through Pearson's linear correlation method; ii) allowing a greater analysis and inference on the variable of interest; and (iii) obtaining a confidence interval of the relationship established between the variables, as well as a mean coefficient of determination.

According to the results reported in Table 3, the INCC has no direct relationship with the statistically proven growth of the construction sector. Regarding investments in construction and growth in the sector, it can be seen that for each Real invested in the sector, the influence on the GDPCC is on average approximately 0.80 cents, ranging from 0.148 to 1.447 Reais. While these results are pertinent, the confidence interval is still quite specious. This fact diminishes the capacity for punctual inference, but not the direction of the facts.

Regarding the unemployment rate of the sector and GDPCC, the estimated average value is -0.706. In words, there is a punctual negative relation of approximately 71% between civil construction unemployment and

5 When considering the percentage values we have: (-0.2466 * 0.2205) × 100 = 5.44%.

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GDPCC. In this case, a confidence interval ranging from -1.369 to -0.042 is observed. However, since no direct relationship was found between PIBCC and INCC, it was decided to adopt another empirical strategy: a new exercise was carried out in which the influence of the INCC on the INVCC was investigated as well as what the indirect influence of the INCC is on the GDPCC, since the INVCC is positively related to GDPCC.

It is emphasized that this procedure happened due to the statistically valid correlation obtained between INCC and INVCC and, consequently, a possible indirect relation between GDPCC and INCC. Given this, it was estimated the influence of the INCC, GDPCC and TDCC on the INVCC, the results obtained being arranged in Table 4.

Table 4. INVCC determination coefficients

Variables	B			p-value	Interval
INCC	0.015	0.021	0.70	0.485	-0.028 | 0.058
GDPCC	0.613***	0.099	101.12	0.000	0.596 | 0.620
TDCC	-0.133***	0.010	-12.23	0.000	-0.155 | -0.111

Source: The authors themselves

Level of Statistical Significance: * p<0.10; ** p<0.05; *** p<0.01

Table 4 ratifies the results presented previously. That is, there is no empirical evidence to prove the direct relationship between INCC and GDPCC, because although the linear correlation coefficient has a priori evidenced a negative relation between INCC and GDPCC, estimates by OLS do not validate this correlation.

In summary, there is no empirical evidence that makes it possible to infer that the INCC has affected the growth of the construction sector in the proposed period, neither directly nor at least indirectly. That is, the low growth observed, on average, 2.48%, cannot be attributed to the sector's costs. However, the high statically proven correlations between investments and the sector's growth rate confirm a more rational view. Briefly, it was possible to identify that the major determinant of growth in the sector during the period investigated is the investment.

In this configuration, some investment numbers were analyzed more precisely. In particular, there was marked heterogeneity in the period analyzed. In a peculiar way, one perceives a sudden drop in investment. This phenomenon is observed both in the financing of the construction of new units and in the acquisition. In figures, investments in these modalities between 2011 and 2016 plummeted 67.7%. In the same period, the amounts referring to housing units declined 42.3%.

Therefore, it is believed that the main determinant of the low and inconsistent growth of the sector occurs essentially of the behavior of investments in the construction industry. However, in order to draw a better picture of the situation - problem - it would be interesting to consider other scenarios, since it is plausible to consider that other sectors not taken into account contributed to this, although, endogenously, these sectors are present in the data. For example, the country's economic and political crisis.

It can also be assumed that the low growth of construction is also due to factors linked to the historical unemployment rates present in all economic sectors and their interconnections. Another problem would be the lack of consumer confidence, as well as the fall in average income observed, especially in 2016, according to data from the Brazilian National Survey of Household Sample (*Pesquisa Nacional de Amostra de Domicílios* – PNAD), among other factors.

5. CONCLUSION

The main problem of this study was to investigate the relationship between the costs of civil construction - INCC/CUB - and the growth of civil construction - GDPCC. To achieve these objectives two empirical strategies were adopted. First, the Pearson correlation for the variables of interest was verified. It should be noted that quarterly data were used in the period from 2000 to 2016 with information on GDPCC, INCC, INVCC and TDCC.

The first reports informed that there was no evidence linking the low growth in the construction industry to the costs inferred by the industry in the period analyzed. That is, the costs of construction - INCC/CUB - did not affect the low performance of the sector. On the other hand, in this first conjecture a possible indirect relation was found between INCC and GDPCC, since the INVCC showed an important correlation with the GDPCC and the INCC.

In this context, the OLS methodology was applied in order to corroborate/confront these results. In this scenario, the results were similar: it was found that the INVCC positively influenced the GDPCC and that there was a clear negative correlation between GDPCC and TDCC. However, the results regarding the INCC and GDPCC remained statistically void.

Given these results, a new approach was adopted. Briefly, the order of the variable of interest was changed. That is, instead of pulling back the GDPCC against the other variables, the relation of the INVCC with the others

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was analyzed, composing the group of explanatory variables. However, the results remained in the same direction. In summary, there is no scientific evidence - statistical - that proves a valid relation between the costs of civil construction - INCC/CUB - and the growth of the sector - GDPCC - in the analyzed period. On the other hand, the results indicate that the main component of growth of the ICC is investments. This result is perfectly expected; however, it seems contradictory that the costs do not affect the behavior of the sector.

This finding undoubtedly leaves room for other contributions to the theme. For example, what underlying factors behind this relationship contributed to this outcome? In this perspective, this study believes that it has left at least two important contributions: i) to prove that investment is the main determinant of growth; and ii) the high correlation observed between the unemployment rate and investments in construction.

REFERENCES

Amorin, K. (2014), Construção civil cresceu 74,25% nos últimos 20 anos, revela estudo do SindusCon-MG. Construção Mercado, Portal PINIweb. Disponível em: <http://construcaomercado.pini.com.br/negocios-incorporacao-construcao/negocios/construcao-civil-cresceu-7425-nos-ultimos-20-anos-revela-estudo-323993-1.aspx>. Acesso em: 20 mar. 2017.

Câmara Brasileira da Indústria da Construção – CBIC (2015), O cenário econômico atual e a Construção Civil - Desafios e perspectivas. In: Encontro Nacional da Indústria da Construção - ENIC, Salvador, 23-25 set. 2015.

Câmara Brasileira da Indústria da Construção – CBIC (2016), Pesquisa Mensal de Emprego – IBGE, CBIC, Belo Horizonte. Disponível em: <http://www.cbicdados.com.br/menu/emprego/pesquisa-mensal-de-emprego-ibge> Acesso em: 15 abril 2017.

Câmara Brasileira da Indústria da Construção – CBIC (2017), CUB Médio Brasil - Custo Unitário Básico de Construção por m². CBIC, Rio de Janeiro. Disponível em: <http://www.cbicdados.com.br/menu/custo-da-construcao/cub-medio-brasil-custo-unitario-basico-de-construcao-por-m2>. Acesso em: 21 mar. 2017.

Cameron, A. C.; Trivedi, P. K. (2005), Microeconometrics: methods and applications. Cambridge University Press.

Federação das Indústrias do Rio de Janeiro – FIRJAN (2014), Construção Civil: Desafios 2020. FIRJAN, Rio de Janeiro.

Fochezatto, A.; Ghinis, C. P. (2011), Determinantes do crescimento da construção civil no Brasil e no Rio Grande do Sul: evidências da análise de dados em painel. Ensaios FEE, Vol. 31, No. Esp., pp. 648-678.

Ghinis, C. P.; Fochezatto, A. (2013), Crescimento pró-pobre nos estados brasileiros: análise da contribuição da construção civil usando um modelo de dados em painel dinâmico, 1985-2008. Economia Aplicada, Vol. 17, No. 3, pp. 243-266.

Gondim, I. A. et al. (2004), Análise da economia nacional e a participação da indústria da construção civil. In: Encontro Nacional de Tecnologia do Ambiente Construído. Anais... ENTAC, São Paulo, 18-21 jul. 2004.

Guilhoto, J. J. M. et al. (2005), Estimação da matriz insumo-produto a partir de dados preliminares das contas nacionais. Revista Economia Aplicada, Vol. 9, No. 1.

Gujarati, D. N. (2009), Econometria básica, McGraw-Hill Education.

Instituto Brasileiro de Economia, Fundação Getúlio Vargas – IBRE/FGV (2015), Índice Nacional de Custos da Construção - INCC. IBRE/FGV, Rio de Janeiro. Disponível em: <http://portalibre.fgv.br/main.jsp?lumPageId=402880811D8E34B9011D984FCB953849>. Acesso em: 21 mar. 2017.

Instituto Brasileiro de Geografia e Estatística – IBGE (2016), Em 2015, PIB cai 3,8% e totaliza R$ 5,9 trilhões. IBGE, Rio de Janeiro. Disponível em: <https://agenciadenoticias.ibge.gov.br/agencia-noticias/2013-agencia-de-noticias/releases/9610-em-2015-pib-cai-3-8-e-totaliza-r-5-9-trilhoes.html>. Acesso em: 20 mar. 2017.

Instituto Brasileiro de Geografia e Estatística – IBGE (2017), Conceitos e definições. IBGE, Rio de Janeiro. Disponível em: <http://www.ibge.gov.br/home/estatistica/indicadores/trabalhoerendimento/pnad_continua/primeiros_resultados/analise01.shtm>. Acesso em: 15 abril. 2017.

Kureski, R. (2011), Produto interno bruto, emprego e renda do macrossetor da construção civil paranaense em 2006. Ambiente Construído, Vol. 11, No. 3, pp. 131-142.

Possenti, C.; Pontili, R. M. (2015), Influências do PAC no setor da construção civil, no período de 2007 a 2012. In: Conferência Internacional em Gestão de Negócios – CINGEN, Cascavel, PR, 16-18 nov. 2015.

Sindicato da Indústria da Construção Civil no Estado do Paraná - SINDUSCON-PR (2017), O que é o CUB. Como é calculado. SindusCon-PR, Curitiba. Disponível em: <http://sindusconpr.com.br/o-que-e-o-cub-como-e-calculado-394-p>. Acesso em: 21 mar. 2017.

Souza, B. A. et al. (2015), Análise dos indicadores PIB nacional e PIB da indústria da construção civil. Revista de Desenvolvimento Econômico, Vol. 17, No. 31.

Electronic Journal of Management & System
Volume 12, Number 3, 2018, pp. 366-377
DOI: 10.20985/1980-5160.2018.v13n3.1419

Teixeira, L. P.; Carvalho, F. M. A. (2005), A construção civil como instrumento do desenvolvimento da economia brasileira. Revista Paranaense de Desenvolvimento, No. 109, pp. 9-26.

Wooldridge, J. M. (2010), Econometric analysis of cross section and panel data. MIT press, Cambridge.

World Bank (1984), The Construction Industry: issues and strategies in developing countries. The World Bank, Washington, DC

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