Construction sector and Nicaraguan per capita income: an econometric explanation

Sector construcción y renta per cápita nicaragüense: una explicación econométrica

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Abstract

The endogenous growth theory explains the relationship of the variables per capita income (GDP per capita), in relation to the private building construction sector, incorporating this approach to the Nicaraguan analysis, through the INSS insured, area effectively constructed and imports per unit of capital for construction. During the period 2006-2019, Nicaraguan GDP per capita showed an increasing trend, as did INSS insured persons in the sector, with a slight downward inflection in 2009, while the areas actually constructed of private buildings showed fluctuations with a substantial drop in 2009, 2010 and 2018. On the other hand, imports per unit of capital for construction reflect a contraction in 2009, subsequently reflecting an increasing trend, except for 2018. The econometric estimation identifies the study typology with a quantitative approach, of explanatory scope, evidencing the postulates of the reference theories, being relevant the result of the variable area effectively built, which has a negative effect on the dependent variable.

Keywords: GDP per capita; Construction investment; Economic growth.

Resumen

La teoría de crecimiento endógeno explica la relación de las variables renta per cápita (PIB per cápita), en relación al sector de construcción de edificaciones p rivadas, incorporado este enfoque al análisis nicaragüense, a través de los asegurados INSS, área efectivamente construida e importaciones por unidad de capital para la construcción. Durante el periodo 2006-2019 el PIB per cápita nicaragüense presentó tendencia creciente, así mismo los asegurados INSS del sector, con leve inflexión a la baja en el 2009, en cambio las áreas efectivamente construidas de edificaciones p rivadas p resentan fl uctuaciones co n caída sustancial en 2009, 2010 y 2018. Por otro lado, las importaciones por unidad de capital para la construcción reflejan una contracción en 2009, posteriormente reflejó tendencia creciente, exceptuando 2018. La estimación econométrica identifica l a t ipología d e estudio c on enfoque cuantitativo, de alcance explicativo, evidenciando los postulados de las teorías de referencia, siendo relevante el resultado de la variable área efectivamente construida, la cual ejerce efecto negativo en la variable dependiente.

Palabras claves: PIB per cápita; Crecimiento económico; Inversión; Construcción.

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Introduction

The construction sector can be considered of much importance in the success of eco- nomic policies (Yagual et al., 2018), as it reflects effect of attracting investment, hence, growth accelerating effect, and likewise in job creation, consumption and household investment.

The above has marked the development of the circular economy, supporting the dynamizing effect of the construction sector (CONAMA, 2018).

As of 2010, evidence of Nicaragua's macroeconomic stability and economic activities was reflected in the economic growth trend; which was interrupted by socio-political events in 2018.

According to the Central Bank of Nicaragua (2018), macroeconomic indicators identified a slowdown in domestic demand, affecting imports, trade and construction activity, the latter due to the deceleration of the private component, being relevant, the dis- minution in the area actually built.

This work is aimed at evaluating the effect of the variables investment in construction, employment in the construction sector, and area effectively constructed on Nicaraguan per capita income, taking GDP per capita as an indicator, justifying this relationship of variables, by the arguments put forward by the UN (2018), recognizing the importance of housing in the fulfillment of the 2030 Agenda, and in the National Plan for the Fight against Poverty and for Human Development 2022-2026, which establishes the actions and strategies to be followed by the Nicaraguan government.

The econometric methodology applied allows us to identify the study typology as long term, with a quantitative approach and explanatory scope, since it estimates and interprets the relationship of the dependent variable GDP per capita with the independent variables, through a double logarithmic model, contrasting the results with theoretical postulates of reference.

Theoretical framework

The widely developed theory of economic growth allows us to identify the perspective of the current endogenous growth models, which seek to explain the growth process by introducing the possibility of reaching a dynamic equilibrium, with Barro and Sala-I-Martin (1990) standing out by affirming that the process of sustained growth is a phenomenon endogenous to the dynamics of the economy itself.

Likewise, in the same endogenous growth current, an important contribution is the endogenous accumulation of human, physical and labor capital, which would explain the joint productivity of capital, if it were measured simply by the number of hours or people working, following the contributions of Arrow, Schultz, Becker, Ben-Porath, Phelps, Tamura and Uzawa, and being

Lucas (1988, 1993, 2002), who develops it exceptionally (Posada, 2015).

Mujica (1991) identifies and indicates two relevant implications of Lucas (1988) relating human capital and growth. The first is the positive relationship that exists between physical capital, human capital (k), and these, exerting a positive effect on the growth of aggregate output. He plans a type of complementarity between these two capitals (physical and human).

Another relevant point is the contributions of the "neoclassical growth models", the most emblematic contributions being those of Solow (1956) and Swan (1956), "based on the basic assumptions of the model of a production function with constant returns to scale and decreasing returns to scale" (Mankiw, 2014), allows to explain the process of driving the growth process continuously, in the long run with full employment, reaching the so-called "steady state", thanks to the accumulation of physical capital, resorting to technological progress as an exogenous variable.

However, this contribution was taken up again with the work of Cass (1965) and Koopmans (1965), who proposed intertemporal optimization, taking up Ramsey's (1928) proposal, for the analysis of consumer behavior in a neoclassical model. The aforementioned contributions made it possible to explain the persistence of diminishing returns of the factors of production, indicating that it was unaffordable to maintain long-term growth, particularly in dependence on the accumulation of capital. Thus justifying the incorporation of technology as an exogenous variable, dynamizing growth.

With regard to the above, Lema (1999), with his contributions, states that the per capita growth rate is a function of the rate of prices and yields, among others. This model extrapolates agricultural data to construction data, linking with the contributions of Galindo and Sosvilla (2012), based on the contributions of Solow (1956) and Swan (1956), introducing the production function with constant and decreasing returns to scale for each of the productive factors, together with the assumption of perfectly competitive markets.

In the case of the construction sector itself, Wilkinson et al. (2016) evidence that the economy is explained, very significantly by the construction sector, since it energizes other economic sectors of the country, giving rise to the analysis in the Greek economy, in the economy of the four Asian tigers (South Korea, Taiwan, Hong Kong and Singapore), in the Ecuadorian economy, among others (Yagual et al., 2018).

Methodology

The study is a quantitative, longitudinal approach, analyzing econometrically through Ordinary Least Squares (hereinafter OLS), from 2006 to 2018, where the contribution of the construction sector in private buildings to the growth of GDP per capita is estimated.

The research carried out corresponds to a non-experimental design, with an explanatory scope,

this type of research analyzes the degree of relationship between two or more variables, contrasting with theoretical postulates (Hernández Sampieri et al. , 2014).

Data are obtained through secondary sources from the databases of the Central Bank of Nicaragua (BCN).

Econometric Methodology

For the analysis of the study, an econometric model is estimated using the OLS method, with log-log specification, where the dependent variable and the explanatory variables are in their logarithmic form (Gujarati, 2009).

Specification of the mathematical model

Taking into account the aforementioned theories, a model was estimated to explain the contribution of the labor factor (INSS construction insured), land (areas effectively built of private buildings) and capital (construction capital imports), to the growth of GDP per capita, all expressed in the following function:

$$LnY = \beta_0 + \beta_1 LnX1 - \beta_2 LnX2 + \beta_3 LnX3 \quad (1)$$

Where:

Y: Dependent variable

X1, X2*: Independent variables

β_0: Constant of the model, also known as intercept of β_1, β_2, β_3:

These are parameters called regression coefficients. Specification

of the econometric model.

$$LnPP = \beta_0 + \beta_1 Ln\_AI + \beta_2 Ln\_AEC + \beta_3 Ln\_IUC + \mu_i \quad (2)$$

In which it is defined:

LnPib_Y: The dependent variable GDP per capita.

β0: It is the intercept term.

β1Ln_AI: Measures the percentage change in the percentage increase by one unit in the number of employees insured by the INSS in the construction sector, all other things being equal.

β2Ln_AEC: Measures the percentage change in per capita GDP per unit increase of an additional percentage unit of the area effectively built, keeping the rest constant.

β3Ln_IUC: Measures the percentage change in GDP per capita in the event of an increase of one additional percentage unit of imports per unit of capital, all other things being equal.

This model is expressed by a double logarithmic multiple regression function for a time series from 2006 to 2019, and can be used as a tool to predict subsequent years with the variable explained in the Ceteris Paribus model.

Data processing

Microsoft Excel 365 was used to create the database in order to structure the database and then transfer it to Gretl, the data were processed in Gretl through multiple regression of double logarithmic characteristics, which will represent the percentage increase in GDP per capita for the increase in each variable. The model is validated with the assumptions made by the econometric methodology of Gujarati (2009). The postulates of economic theory propose that the coefficients of INSS insured in the construction sector and imports per unit of capital for construction have a positive sign (Lucas, 1988; Solow, 1956; Swan, 1956) due to their complementary relationship with each other and their positive effect on production. On the other hand, a negative sign is expected for the variable area actually constructed, due to the presence of increasing returns to capital accumulation (Cass, 1965; Koopmans, 1965; Ramsey, 1928).

Results

The GDP per capita shows an increasing trend, from the year 2006 to the year 2007, in the year 2008 it decreases, this due to the real estate crisis that affected the United States same that expanded to the American continent, while for the following years from 2009 to 2017 the GDP per capita remained in an increasing manner, while, in the year 2018, a decline in this indicator can be appreciated, which generates a lower disposable income for the population. This decline is due to the socioeconomic conflict, which the country went through since April 2018.

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Figure 1
GDP per capita
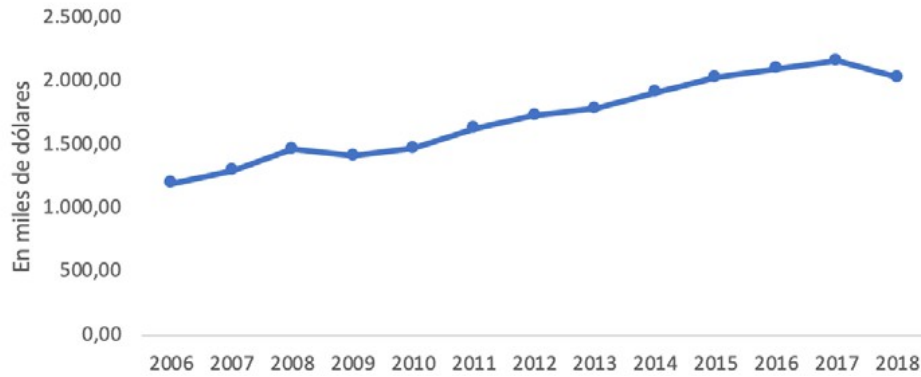
Source: Own elaboration with NCB data.

The insured INSS construction reflects a growing trend from 2006 to 2007, in the years 2008-2009 with a decrease due to the international crisis, which caused companies to reduce their costs, which did not rule out the reduction of staff, for the following years 2010-2013 period where it remained growing, in 2014 there was a slight decrease, but from 2015 to 2017 the construction sector reflected an increase. For the year 2018 the situation changed and reflected a significant reduction from 34,842 registered to 26,692 due to the crisis affecting the country since April of the same year.

Figure 2
*Insured INSS construction*
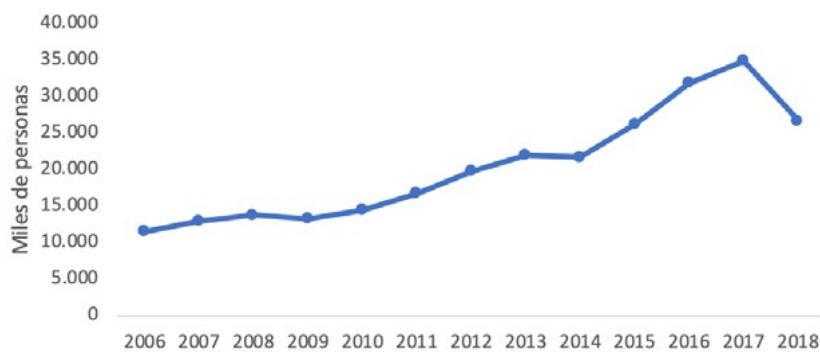
Source: Own elaboration with NCB data.

The graph shows fluctuations with respect to the trend, clearly from 2005 to 2010 the area actually built shows a substantial decline represented with approximately 45% less with respect to 2006, for the years 2011-2015 the area

The number of square meters (m²) built effectively resumed its upward trend, reaching 1,527,320.60 square meters (m²) built, after which it was again affected, decreasing steadily until 2018, barely reaching 1,069,343.10 square meters (m²) built.

Figure 3

Effective Built-Up Area of Private Buildings.
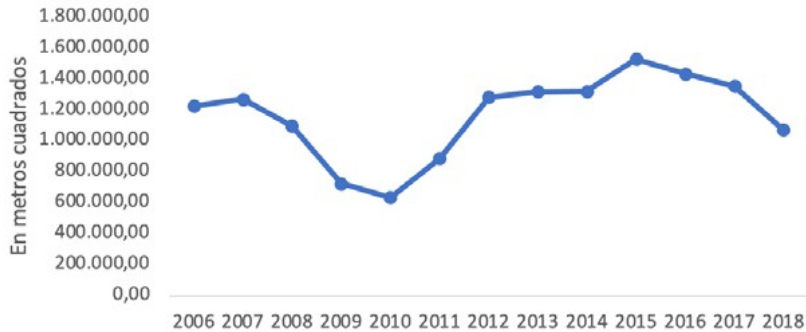
Fuente: Elaboración propia con datos del BCN.

Capital imports for the construction sector are considered significant, reaching US$350 million, although it is true that in 2006 there was a decline of US$158.1 million in capital imports for the construction sector, this grew until 2008 reaching US$216.1 million, in 2009 it weakened to US$162.3 million, due to the international crisis affecting the continent.

Figure 4

Imports per unit of capital
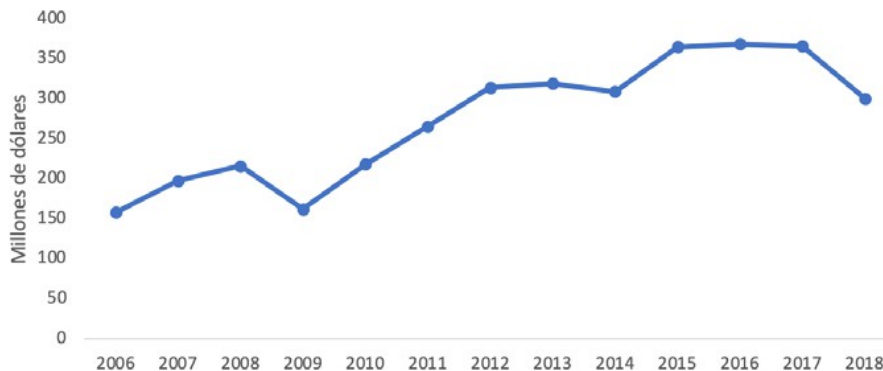
Source: Own elaboration with NCB data.

On the other hand through the whole period imports decreased in large amounts, for the subsequent years 2010-2013 it was established in a positive trend, in such a way reaching 319.1 million dollars, in 2014 a slight decrease is observed, for the years 2015-2017 imports continue to grow, this time reaching its maximum point in the series es- tudied, standing at 368.6 million dollars, this growth is not followed for the year 2018 as it decreased to 300.6 million dollars.

Econometric analysis

Table 1
OLS, using 2006-2018 observations (T = 13)

	Coeficiente	Desv. Típica	Estadístico t	valor p	
const	3.95301	0.629372	6.281	0.0001	***
l_Aseguradosinsscontrucion	0.367018	0.0771868	4.755	0.0010	***
l_areaefectivamenteconstruida	−0.0937357	0.0479701	−1.954	0.0824	*
l_Importacionesdecapitaldecon	0.209792	0.0969970	2.163	0.0465	**
R-cuadrado	0.970933	R-cuadrado corregido	0.961244		
F(3, 9)	100.2099	Valor p (de F)	3.11e-07		

Note: Dependent variable: l_pibpercap
Source: Own elaboration, estimated in Getl software.

The following results were obtained after estimating the model using the OLS method:

LnPP= 3.95301 +0.367018 Ln_AI-0.0937357Ln_AEC+0.209792Ln_IUC+ui   (3)

Taking into account the econometric result, the coefficient of multiple determination (corrected R-squared) is 0.9627, which indicates that 96.12% of the growth of GDP per capita is being explained by the insured INSS construction, the area effectively built and by imports per unit of capital.

Parameter interpretation

LnAI: For each additional percentage unit of LnAI growth, a percentage increase in GDP per capita of 0.367018 % is assumed, under the Ceteris Paribus assumption.

LnAEC: For an increase of one additional percentage unit in the area actually constructed, GDP per capita would decrease by 0.0937357%, while all other variables remain constant.

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LnIUC: For each additional percentage unit of imports per unit of capital, GDP per capita increases by 0.209792%, as long as all variables remain constant.

Model validation

Table 2
Model validation with global and individual hypotheses

Hipótesis	Valor p
Hipótesis global β i	0.0000000311
Hipótesis individual β0	0.0001
Hipótesis individual β1	0.0010
Hipótesis individual β2	0.0824
Hipótesis individual β3	0.0465

Source: own elaboration estimated in Gretl 1.6.5.

Table 3.
Validation of MCO model assumptions

Supuestos	Validación
Normalidad de los residuos	Valor de P= 0.195554
Especificación del Modelo Test Ramsey	Valor de P== 0.0636
Contraste de Chow de cambio estructural	Valor de P= 0.250345
Contraste de Heteroscedasticidad de White	Valor de P = 0.250345
Contraste de Autocorrelación	Valor de P = 0.952
Estabilidad de parámetros CUSUM	Valor de P = = 0.1984
Contraste de Colinealidad	Valores VIF Asegurados INSS construcción: 7.272 Área efectivamente construida: 1.502 Importaciones capital construcción: 7.776

Source: own elaboration based on data from Gretl 1.6.5.

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Discussion

The estimated model provides a guideline for identifying neoclassical theories on economic growth and the construction industry, specifically taking as a reference the economic growth models based on construction proposed by Galindo and Sosvilla (2012) with theoretical foundations in Solow (1956), Swan (1956), and Lucas (1988), as well as in Wi- lkinson et al. (2016), the contribution of physical and human capital in the construction sector is confirmed as an important factor in achieving economic growth, particularly to Nicaraguan GDP per capita, since it generates both direct and indirect employment, generating an increase in per capita income. However, it should be noted that the variable, effectively constructed area, instead of contributing, decreases the growth of per capita GDP, a result that is undoubtedly undesirable, but this phenomenon is explained by the theory of Cass (1965), Ramsey (1928) and Koopmans (1965) where they demonstrated that, in the presence of diminishing returns on factors, long-term sustained growth based on capital accumulation was not possible.

However, it is necessary to clarify that in Nicaragua there is a housing deficit of 957,000 homes, which has generated state efforts to alleviate this situation (Prensa-Asamblea Na- tional, 2020), with financing through the National Program for the Construction of Housing of Social Interest. In addition to this effort, private enterprise through the Chamber of Developers of Nicaragua (CADUR) presents offers "of houses of social interest, as well as medium and high end with prices ranging from $70,000 to $200,000" (SWI, 2022). As a result, many Nicaraguans tend to go into debt in order to have access to housing or to carry out small remodeling work on their homes.

Conclusions

With the analysis of the outstanding results that we have obtained through the process that we have elaborated throughout the research, the following conclusions must be drawn:

The study variable GDP per capita declined during 2008 due to the international real estate crisis. In the 2009-2017 period, it was able to maintain an upward trend. In the INSS insured variable, there was a growing trend during 2006-2007, with a decrease in the following years, generating a reduction in personnel and costs in the companies. In the following period of 2010-2017, a growing trend was reflected. Regarding the variable of imports per unit of per capita, it was observed that from 2006 to the end of 2008, there was an increasing trend, with a brief decrease in 2009. Thus, for the 2010-2014 period, it continued to grow steadily, and for 2015-2017 it showed its maximum growth in this variable. On the other hand, during the following year 2018, all variables showed a decline due to the socioeconomic crisis.

Through the estimation carried out with the OLS model, it is observed that the contribution of private building construction to GDP-per capita. It is being explained with 96.27% by

The variables that constitute it, such as INSS insured construction, effective constructed area and imports per unit of capital.

Based on the econometric estimation with theoretical foundations, the variable, effectively constructed area, instead of contributing decreases the growth of GDP per capita, but this phenomenon is not explained by economic theory.

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