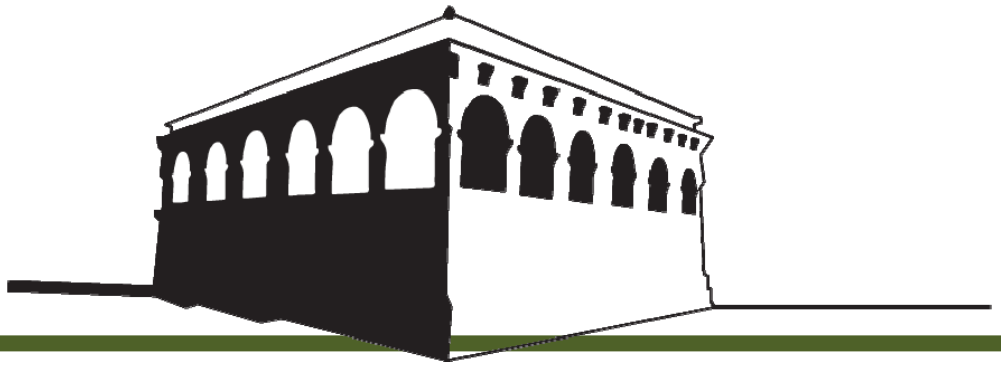

GESTÃO DE BENS COMUNS
E DESENVOLVIMENTO REGIONAL SUSTENTÁVEL
BRAGANÇA – ZAMORA 29 JUNHO A 02 JULHO 2011

17.º CONGRESSO DA APDR
5.º Congresso de Gestão e Conservação da Natureza
Congresso Internacional da APDR/ AECR

ACTAS
Proceedings

ISBN 978-989-96353-2-6

COMISSÃO ORGANIZADORA

Ana Pardo Fanjul (AECR/ Universidad de León)
Angel Prieto Guijarro (AECR/ CSIC Salamanca)
Ángeles Marín Rivero (AECR/Univ. de León)
António Fernandes (Inst.Politéc.de Bragança)
Antonio Maya Frades (AECR/ Univ.de León)
Elisabete Martins (APDR)
João Azevedo (Inst. Politéc.de Bragança)
Jose Jorge Nogales García (AECR/ Univ. de Valladolid)
José Manuel Díez Modino (AECR/ Univ. de León)
Juan Carlos Gamazo Chillón (AECR/ Junta de Castilla y León)
Natividad Gonzaler (Fundación Rei Afonso Henriques - Zamora)
Orlando Rodrigues (Inst. Politéc. de Bragança)
Sílvia Nobre (Instituto Politéc. de Bragança)
Tomaz Ponce Dentinho (APDR/Universidade dos Açores)

COMISSÃO CIENTÍFICA

A. Idrissa Embalo (Univ. Amilcar Cabral); Adolfo Rodero Franganillo (AECR/ ETEA Córdoba); Adriano Pimpão (Univ. do Algarve); Alfredo Marvão Pereira (College of William and Mary in Williamsburg); Ana Lúcio Sargento (Inst. Polit. de Leiria); Ángel Prieto Guijarro (AECR/ CSIC Salamanca); Ángeles Marín Rivero (AECR/ Univ. de León); António Almeida (Univ. da Madeira); Cássio Rolim (Univ. Federal do Paraná); Conceição Rego (Univ. de Évora); Eduardo Castro (Univ. de Aveiro); Eduardo Haddad (ABER/ Univ. de S. Paulo); Emilia Pepeka (Inst. Sup. de Ciências da Educ. do Huambo); Francisco Carballo-Cruz (Univ. do Minho); João Azevedo (Inst. Polit. de Bragança); Jorge Sousa Brito (Univ. Jean Piaget de Cabo Verde); José Pedro Pontes (Univ. Técnica de Lisboa); José Silva Costa (Univ. do Porto); Juan Cuadrado Roura (AECR/ Univ. de Alcala);Livia Madureira (APDEA/ Univ. de Trás-os-Montes e Alto Douro); Luis Fonseca (Univ. do Algarve); Luis Moreno (SPER/ Univ. de Lisboa); Luis Quinta Nova (Inst. Polit. de Castelo Branco); Mário Fortuna (Univ. dos Açores); Miguel Marquez (AECR/Univ. da Extremadura); Miranda Miguel (Inst. Sup. De Ciências da Educ. do Huambo); Nuno Martins (Univ. Católica Portuguesa); Orlando Rodrigues (Inst. Polit. de Bragança); Paulo A. L. D. Nunes (Cà Foscari Univ. of Venice); Paulo Carvalho Tomás (SPER/ Univ. de Coimbra); Paulo Guimarães (Univ. of South Carolina); Pedro Ramos (Univ. de Coimbra); Rita Anastácio (Inst. Polit. de Tomar); Rosalina Gabriel (Univ. dos Açores); Rui Baptista (Inst. Sup. Técnico); Teresa Vaz de Noronha (Univ. do Algarve); Tomaz Ponce dentinho (Univ. dos Açores); Xavier Vence (AECR/ Univ. de Santiago de Compostela).

APDR

Universidade dos Açores
Rua Capitão João D'Ávila
9700-042 Angra do Heroísmo
www.apdr.pt

AECR

C/ Viladomat, 321 entresuelo
08029 Barcelona
www.aecr.org

INSTITUTO POLITÉCNICO DE BRAGANÇA

Escola Superior Agrária de Bragança
Campus de Santa Apolónia - Apartado 1172
5301-855 Bragança
http://esa.ipb.pt/

FUNDACIÓN REI AFONSO HENRIQUES

Avda. Nazareno de San Frontis, s/n
49027 Zamora (Espanha)
http://www.frah.es/

INDÍCE

ANALYSIS OF THE CAUSAL RELATION BETWEEN CONSTRUCTION ACTIVITY AND THE GROSS DOMESTIC PRODUCT OF TWO NEIGHBOURING ECONOMIES: PORTUGAL AND SPAIN

Alcina Nunes[1], Jorge Lopes[1], Carlos Balsa[1]
[1] Polytechnic Institute of Bragança, Bragança, Portugal

ABSTRACT
It has long been recognised that the role of the construction industry in a country's national economy goes beyond its share in national output. Using time–series data drawn from the United Nations national accounts databases, this study applies the econometric Granger causality methodology to investigate the relationship between construction activity, measured by the construction value added, and the Gross Domestic Product (GDP) of two neighbouring economies – Portugal and Spain. In a comparison basis, the paper intends to identify the existence of a causal relation between the construction sector and each one of the aggregate economies. In particular, it tries to verify if the construction activity contributes to economic growth and/or economic growth contributes to the dynamics of the construction industry activity in these two countries. For both countries is find evidence that GDP growth leads the growth in the construction sector, in the short and medium-run. The opposite is not observed.
Keywords: *Portugal, Spain, Construction sector, GDP, Unit root tests, Granger causality*

1. INTRODUCTION
Research requires a systematic approach by the researcher, irrespective of what is investigated and the methods adopted. This is particularly true when the research is applied to a special subject as the one addressed in this research work [1]. Indeed, if "pure" research is undertaken to develop knowledge as a way to contribute to the body of existing theory, the applied research seeks to address issues of applications that help solve real everyday problems. Generally, in applied research, the different approaches focus on collection and analysis of data rather than assessment of theory and literature [2] even if the related literature drives the development of the methodology used in empirical applications.
Construction is an important sector in world economies. Construction firms are of core importance at a microeconomic level due, for example, to the amount of construction firms, its generated turnover and the number of sector employees. In the European Union (EU), in 2007, the construction sector accounted for, approximately, 3.1 million firms, employed just less than 14.8 million persons and presented a turnover of around 1.665 trillion Euros [3]. According to the same statistical source, and for the same year, the construction sector in Spain employed 2.881 million persons and had a turnover of 304.645 billion Euros. The figures for Portugal were, respectively, 515 thousand persons and 33.204 billion Euros. The importance of the construction sector is also evident at a macroeconomic level. In 2009, construction valued added contributed to 5.06% of the gross domestic product (GDP) in Portugal and 9.78% of GDP in Spain. These values reflect, however, a decreasing trend in the relative economic importance of the sector when data for the period 1970-2009 are analysed (see Figures 1 and 2). Before proceeding with the analysis of the development pattern of the construction industry and its sectoral share in GDP, a brief detour is in order to compare the relative clout of the industry between Portugal and Spain. Leaving aside that Spain is the fifth largest economy of the EU and has a population about 4.3 times as high as that of Portugal, the number of people employed in the construction industry in Spain, in 2007, was about 5.5 times as high as that of Portugal, an in terms of turnover and value added, the absolute number for the former was about 11 times as high as that for the latter. Moreover, the Spanish construction industry contributed about to 18% of the total turnover in construction, and represented 19.5 % of the construction workforce in the EU. The apparent labour productivity of the construction sector in Spain, in 2007, was 35,000 EUR per person employed compared to 18,400 EUR for that of Portugal [3].

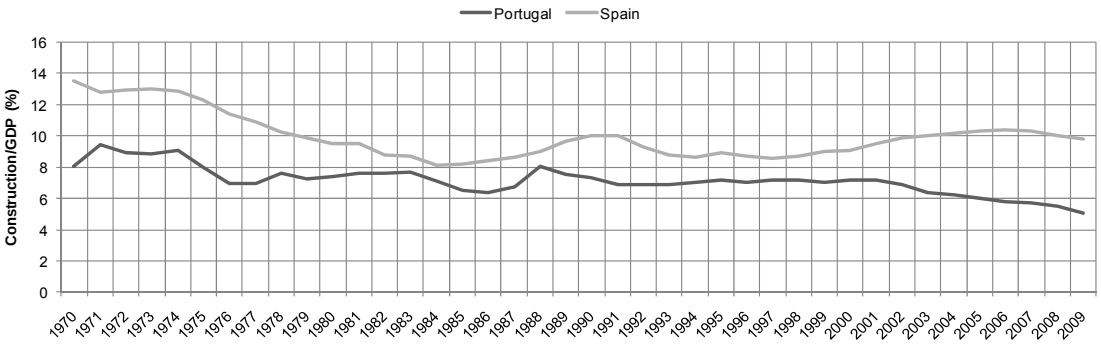

Figure 1: Share of Construction flows in the Portuguese and Spanish GDP (1970-2009)

Figure 2: Evolution of GDP and Construction flows in Portugal and Spain (1970-2009)

Figure 1 depicts the share of construction value added (CVA) in the Portuguese and Spanish GDP using internationally comparable data collected from the United Nations National Accounts- Main Aggregates Database from 1970 to 2009, covering a period of 40 years (values are presented in constant prices with 2005 as the base year). Figure 2 presents the evolution of construction value added (CVA) and GDP of Portugal and Spain for the same period, both measured at constant 2005 US dollars. It can be seen that these countries have distinct patterns as regards the relative clout of the construction industry, as measured as the share of CVA in GDP. The most distinguishing feature is that this indicator of this economic activity in Spain is higher than that of Portugal throughout the period analysed. Since the entry of these countries in the then European Community, in the mid-1980, the share of CVA in GDP in Spain presented an upward trend until 2006, of course with inter-temporal fluctuations, and reached a peak of 10.3%. From then on, the decline is evident in relative terms. In Portugal, the construction industry activity increased relatively in the period from 1986 to 1988 (about 8% of GDP), declined until the early 1990s and presented a slightly upward trend until 2001. In terms of construction volume, an upward trend is apparent for both countries until the early years of the last decade. From 2001 to 2009, the construction industry in Portugal decreased not only relatively but also absolutely. In Spain, the construction volume decreased in the last two years of the period.

Time is an important element of any research design both at a micro and a macroeconomic scenario. Concerning the construction sector, the analysis of the past values of the Construction Cost Index (CCI), which is a weighted aggregate index of prices of construction raw materials and labour, is of crucial importance to compute accurate bids for contractors and engineering estimates for owner organizations, for instance. The ability to predict construction cost trends can avoid under- or over-estimation of construction costs [4]. This is the ability to forecast the CCI can determine a successful business management strategy. The recent development of longitudinal methods has become an important branch in quantitative analysis research methodology. The uncertainty about future trends in construction costs is a significant risk factor

in cost estimating and, consequently, budgeting. So, the development of more robust prediction models, using time series analysis, can help reduce uncertainty about future costs in an economic activity that is essential and a dominant part of economic development. Moreover, if it is a fact that is very difficult to estimate the degree of price variations in construction labour and material costs, due to the uniqueness of tasks and materials in each construction project, it is also a fact that these difficulties are stressed by the overall environmental changes and dynamic variations at a macroeconomic level [5].

At a more general level, public policy makers rely on a variety of techniques to estimate the possible costs and benefits of a public policy. If this is observed for the generality of public policies, it is particularly true for the ones that affect an important relative sector as the construction industry. The analysis of historical data to find trends is the base for forecasting future outcomes of a policy measure. Time series analysis is a popular technique for assessing trends and forecasting. This statistical quantitative method becomes also essential to compute causal relations between micro and macroeconomic economic variables as the causal relation between construction value added and the growth of national economy. The present paper is concerned essentially with the macroeconomic scenario faced by the construction industry in an economy where it seems that the construction sector is losing its relative economic importance but not its social and financial weight in the national business framework.

The paper is presented as follows. Next section shows how the research methodology applied to analyse the relationship between GDP and construction flows has evolved in the research literature. Then, the methodology of the Granger causality is presented. The results of the study are elaborated and discussed in the fourth section. Some concluding remarks finalise the analysis.

2. EVOLUTION OF THE RESEARCH METHODOLOGY APPLIED TO ANALYSE THE RELATIONSHIP BETWEEN GDP AND CONSTRUCTION FLOWS

The relationship between construction flows and the development of a country, measured throughout Gross Domestic Product (GDP) per capita, has received great attention in the specialized literature.

In particular, it is possible to mention several studies that analysed the above relationship in samples of countries covering all stages of economic development [6-12]. Lopes [13] provided an extensive review of the literature concerning the study the construction industry at the macroeconomic level, for both developed and developing economies. A brief summary of the research approach adopted to analyse the underlying relationship is provided in this section.

Earlier studies on the role of the construction sector in the process of economic growth and development [6, 8], based mainly on cross sectional data, found a positive association between national income and several measures of the construction industry activity. An important feature of Wells' 1986 work was the establishment of a mathematical model (through the ordinary least squares technique) relating different measures of construction activity- construction value added, gross construction output, and employment in construction- to the level of GDP per capita. Wells [8] main findings can be stated as follows: i) the construction output as a percentage of GDP is related to GDP per capita in an increasing form of income level; ii) and if the relationship between countries at different income levels at a fixed point in time also occurs within any country over time, then construction output increases relatively with increasing per capita GDP in any country over time. The changes of this ratio would be faster for countries in the middle- income range [8]. Further development on the analysis of the relationship between the measures of construction output and GDP made use of correlation techniques, using time-series data pertaining to developing countries [14-15].

With the availability of long and more reliable time-series data and the development of econometric methodology related to the study of economic relationships between variables a new set of studies has emerged. Some of these studies [16-20] have applied econometric analysis within the Granger's 1969 framework to test the causality link between construction output and GDP. For example, Yiu et al. [19] found that, for Hong Kong, the real growth of the aggregate economy leads the real growth of the construction output and not vice versa, at least in the short-term. On the other hand, Wong et al. [20], using more recent data covering a longer period of Hong Kong's high income status, concluded that the direction of the causality is from the construction sector, particularly the civil engineering subsector, to GDP. In the same line,

Anaman and Osei-Amponsah [21] analysed the relationship between the construction industry and the macroeconomy in Ghana, based on time series data from 1968 to 2004, and found that the construction industry leads the economic growth in Ghana. Chen and Zhu [22] analysed provincial data on housing investment in three main regions of China, and found that there was a bi-directional Granger causality between GDP and housing investment for the whole country, while the impact of housing investment on GDP behaves differently in the three regions.

3. GRANGER CAUSALITY METHODOLOGY

The methodology chosen in this research work is justified by the nature of the object of study and intends to demonstrate how the development of quantitative applied research analysis is crucial to implement an effective research design in a short- and medium-run.

To analyse the causal relation between two variables, Granger [23] developed a test to check it. Granger causality examines to what extent a change from past values of a variable affects the subsequent changes of the other variable testing the direction of causality between two variables. Granger implemented the causality test by testing the null hypothesis that $\alpha_{2i} = 0$ or $\beta_{2i} = 0$ in the following bi-variable (X and Y) regressions:

$$Y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} Y_{t-i} + \sum_{i=1}^{n} \alpha_{2i} X_{t-i} + \nu_t \quad (1)$$

$$X_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} X_{t-i} + \sum_{i=1}^{n} \beta_{2i} Y_{t-i} + \mu_t \quad (2)$$

Where μ_t and ν_t are uncorrelated and white noise residuals term series. Causality may be determined by testing the null hypothesis, $H_0 : \alpha_{21} = \alpha_{22} = \ldots = \alpha_{2n} = 0$ and $H_0 : \beta_{21} = \beta_{22} = \ldots = \beta_{2n} = 0$ against the alternative hypothesis that not all the coefficients α_{2i} and β_{2i} are equal to zero in equations (1) and (2), respectively. The range of lagged variables will be chosen according to the specific empirical application. A synthesis of several selection criteria could be used to compute de optimal lag length for the Granger causality equations. These methods comprise the akaike information criteria (AIC), the Schwartz Bayesian information criteria (SBIC), the Hannan-Quinn information criteria (HQIC), the final prediction error (FPE) and a sequence of likelihood ratio tests (LR). The optimal lag length is selected based on the lowest values of AIC, SBIC, HQIC criteria and rejection of the null hypothesis of lag K is equal to zero in LR test. The optimal lag length selection should also consider the Lütkepohl's [24] demonstration that choosing the lag K to minimize the SBIC or the HQIC provides consistent estimates of the true lag order, K. In contrast, minimizing the AIC or the FPE criteria will overestimate the true lag order.

It is worth noting that the term Granger-causality, as Wong et al. [20] put it, is not a true causality concept but a statistical tool which in principle concerns only the predictability between time-series variables.

The implementation of the Granger causality test demands a previous empirical step, however. The presence of a trend in a time series could lead to false conclusions relating the relationship between two variables. In a stochastic process, stationarity means that the statistical characteristics of the process do not change in time. As Granger and Newbold [25] point out, Granger causality on non-stationarity time data might lead to spurious causal relation. The identification of a real causal relation implies the use of stationary time series data. In practice, formal tests for unit root are applied to test the stationarity of the series. The most commonly used unit root test is the Augmented Dickey-Fuller test (ADF) a more complete version of the Dickey-Fuller test [26]. The test is based on the following mathematical formulation:

$$\Delta Y_t = \alpha_0 + \alpha_1 T + \alpha_2 Y_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta Y_{t-i} + \mu_t \quad (3)$$

Where $\Delta Y_t = Y_t - Y_{t-1}$, α_0 is a drift term and T is the time trend with the null hypothesis, $H_0 : \alpha_2 = 0$ and its alternative hypothesis $H_1 : \alpha_2 \neq 0$, n is the number of lags demanded to obtain white noise and μ_t is the error term.

Other test normally applied to examine the existence of unit roots in a data series is the Philips-Perron test [27] that is similar to the Dickey–Fuller statistics. The difference consists in the way the residuals' covariance matrix is estimated. Phillips-Perron test uses the Newey–West [28] heteroskedasticity and autocorrelation consistent covariance matrix estimator.

4. EMPIRICAL APPLICATION AND RESULTS

In this research paper the Granger methodology, presented in the previous section, will be applied to Portugal. This empirical application tries to assess the existence of an economic relationship between the construction flows in Portugal's and Spain's GDP for the short and medium-run using a 40 years (from 1970 until 2009) data set. The longitudinal analysis proposed relies on annual time series data collected in the main national statistics database gathered by the United Nations. The values for each variable are measured in US dollars at constant 2005 prices guarantying its international comparability. Both GDP and construction flows are measured in real values eliminating the bias produced by changes in prices.

The indicators of economic activity which are analyzed in this chapter are: GDP and construction value added (CVA). Unfortunately, data on gross fixed capital formation in construction (GFCFC) are not provided in the UN publication. For this reason, CVA is used as a proxy for analyzing the pattern of evolution of construction investment. It is compared with GDP as both are measures of value added. For a simpler reading of the time series, its values are expressed in natural logarithms. The natural logarithm allows the direct consideration of the elasticity of the relevant variables. Figures 3 and 4 present the annual evolution of the two variables considering their values in logarithms.

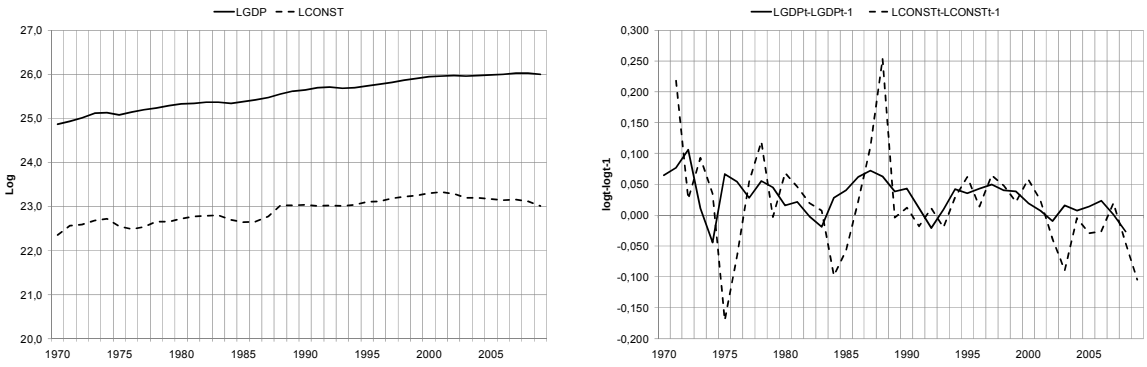

Figure 3: Evolution of GDP and Construction flows, in levels and in first-differences, for Portugal

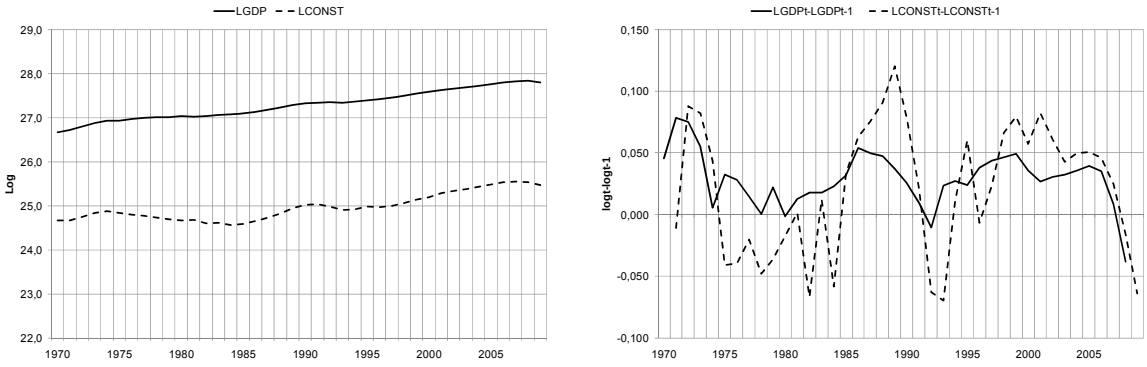

Figure 4: Evolution of GDP and Construction flows, in levels and in first-differences, for Spain

In the left side of the Figure 3, it is shown the evolution of the variables GDP and construction flows in Portugal (LGDP and LCONST, respectively) over time. The right side of the Figure depicts the variable´s first differences (∆LGDP=LGDPt-LGDPt-1 and ∆LCONST=LCONSTt-

LCONSTt-1) which, in this context, can be interpreted as the variables' growth rates. Figure 4 represents the same variables for Spain.

When observing the GDP and the Construction flows in levels it seems clear that a trend exists in both time series, for both countries. It also appears that the evolution of the series is highly correlated. This can also be observed when analyzing the summary statistics for both variables during the 1970-2009 period (Table 1). As the variables are measured in constant prices, the correlation matrix clearly demonstrates that the construction sector and GDP are strongly correlated in these countries during the period 1970-2008.

Table 1: Summary statistics for the variables in levels

Summary Statistics	Portgal				Spain			
	LGDP	LCONST	ΔLGDP	ΔLCONST	LGDP	LCONST	ΔLGDP	ΔLCONST
Number of Observations	40	40	39	39	40	40	39	39
Mean	25,557	22,911	0,029	0,017	27,283	24,967	0,029	0,021
Median	25,626	23,010	0,028	0,019	27,298	24,637	0,034	0,025
Standard Deviation	0,350	0,268	0,031	0,079	0,332	0,305	0,022	0,053
Maximum	26,015	23,325	0,106	0,254	27,836	25,553	0,078	0,120
Minimum	24,862	22,347	-0,044	-0,171	26,671	24,560	-0,038	-0,070
Skewness	-0,260	-0,227	-0,052	0,621	0,103	0,622	-0,401	-0,210
Kurtosis	1,823	1,801	2,989	4,824	1,925	2,158	4,292	1,886

Table 2: Correlation matrix for the variables in levels and in first-differences

Countries	Portugal		Spain	
Variables in levels	LGDP	LCONST	LGDP	LCONST
LGDP	1	0.944**	1	0.909**
LCONST	0.944**	1	0.909**	1
Variables in first-differences	ΔLGDP	ΔLCONST	ΔLGDP	ΔLCONST
ΔLGDP	1	0.6632**	1	0.763**
ΔLCONST	0.6632**	1	0.763**	1

Note: ** Denote 5% level of significance for Pearson correlation

The same conclusion cannot be withdrawn so easily when observing the evolution of the first differences of the variables. The growth rates of both variables are not so strongly correlated. From Table 2 it is possible to observe that the coefficient of correlation decreased from 95%, for the variables in levels, to almost 64%, for the variables presented in first differences. In Spain, we observed the same evolution. However the decrease is less pronounced.

As mentioned above, the presence of a trend in a time series could lead to false conclusions relating the relationship between two variables, that is, to a spurious relation [25]. For example, the previous results could lead us to conclude that there is a statistically significant relationship between a country's GDP and construction flows when, in fact, only a contemporaneous correlation between the variables exists. Declaring a meaningful causal relation is to jump at conclusions. For observing a real causal relation and to avoid a problem of spurious regression it is necessary to use stationary time series data. In practice, the formal unit root Augmented Dickey-Fuller and Phillips-Perron test is applied to test the stationarity of the here present data series. Table 3 and 4 present the results of the ADF and PP unit root tests for each time series, for Portugal and Spain.

Table 3: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for Portugal

Variables	Optimal Lag Length	Augmented Dick-Fuller Test				Phllips Perron Test			
		Variables in levels		Variables in first differences		Variables in levels		Variables in first differences	
		No trend	Trend	No trend	Trend	No trend	Trend	No trend	Trend
LGDP	3	-1,102	-0,837	-3,484**	-4,359***	-2,446	-1,796	-3,411**	-3,814*
		(0,7143)	(0,9624)	(0,0084)	(0,0025)	(0,1291)	(0,7065)	(0,0106)	(0,0159)
LCONST	3	-1,164	-1,128	-4,030**	-4,189**	-2,158	-1,917	-4,731***	-4,746***
		(0,6887)	(0,9242)	(0,0013)	(0,0047)	(0,2219)	(0,6138)	(0,0001)	(0,0006)
Interpolated Dickey-Fuller Critical Values									
1%		-3,675	-4,279	-3,682	-4,288	-3,655	-4,251	-3,662	-4,260
5%		-2,969	-3,556	-2,972	-3,560	-2,961	-3,544	-2,964	-3,548
10%		-2,617	-3,214	-2,618	-3,216	-2,613	-3,206	-2,614	3,209

Note: *, ** and *** denote the rejection of the unit root at 10%, 5% and 1% significance level, respectively. Between brackets is presented the McKinnon approximate p-value for the test statistic.

Table 4: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for Spain

Variables	Optimal Lag Length	Augmented Dick-Fuller Test					Phllips Perron Test			
		Variables in levels		Variables in first differences			Variables in levels		Variables in first differences	
		No trend	Trend	No trend	Trend	Drift	No trend	Trend	No trend	Trend
LGDP	3	-0,441	-2,819	-2,515	-2,425	-2,515***	-1,193	-2,531	-1,945	-2,136
		(0,9031)	(0,1900)	(0,1119)	(0,3663)	(0,0087)	(0,6767)	(0,3125)	(0,3110)	(0,5260)
LCONST	3	-0,319	-2,811	-2,319	-2,48	-2,319**	-0,192	-1,643	-2,888**	-2,76
		(0,9228)	(0,1929)	(0,1658)	(0,3380)	(0,0137)	(0,9398)	(0,7750)	(0,0468)	(0,2119)
Interpolated Dickey-Fuller Critical Values										
1%		-3,675	-4,279	-3,682	-4,288	-2,457	-3,655	-4,251	-3,662	-4,26
5%		-2,969	-3,556	-2,972	-3,560	-1,697	-2,961	-3,544	-2,964	-3,548
10%		-2,617	-3,214	-2,618	-3,216	-1,310	-2,613	-3,206	-2,614	-3,209

Note: ** and *** denote the rejection of the unit root at 5% and 1% significance level, respectively. Between brackets is presented the McKinnon approximate p-value for the test statistic.

The results, in both countries, are presented for the variables in levels and in first differences considering an optimal lag length of 3. Both definitions of variables are computed considering two different assumptions – data series with the presence of a trend, since Figure 3 and 4 point to the existence of a trend, and without the trend. For Spain, it was tested the assumption of the existence of a trend with drift.

Remember that the null hypothesis is the presence of unit root. Thus, when the augmented Dickey-Fuller and Phillips-Perron statistic lies inside the acceptance region at 1%, 5%, and 10% (considering Dickey-Fuller critical values and McKinnon [29] approximate p-value), one cannot reject the presence of unit root at the respective significance level. In this particular case, the ADF test indicates that both series are not stationary in their level form (with and without trend) since the null hypothesis cannot be rejected at none of the critical values. In opposition, the ADF test indicates that both GDP and Construction series are stationary in first differences (with and without trend), since the unit root test was rejected at, at least, the 5% critical value. The PP statistical test confirms the ADF conclusions. Both series are integrated of order one – I(1).

This means that it is now possible to study the dynamic relationship between GDP and construction flows in those countries using first differences data series. Or, in other words, it is possible to analyse the dynamic relationship between the variables' growth rates. Since we have the first differences of logarithm values, the first differences of the variables can be interpreted as the growth rates of the variables.

To test if any feedback effects exist between the two variables' growth rates, the Granger causality test is applied. In practice, the basic assumption of the Granger causality tests is that future values cannot predict past or present values. In fact, the opposite holds. If past values of the construction sector growth rate do contribute significantly to the explanation of GDP growth rate, then the construction sector is said to Granger-cause GDP. This also means that the construction sector is Granger-causing GDP when past values of construction sector have predictive power concerning the current value of GDP even if the past values of GDP are taken into consideration. Conversely, if GDP is Granger-causing construction sector, it would be expected that GDP change would take place before a change in the construction sector.

The results of causality relating the construction sector and GDP growth rates in Portugal are presented in Table 5. The Granger causality test shows that GDP growth leads the growth in the construction sector with a 1-year to 4-year lag (for all the lags model, it is possible to reject, at the 1% significance level, the null hypothesis that the GDP growth does not Granger- cause the growth in the construction sector). Regarding the inverse relationship, it is possible to conclude that the growth rate of the construction sector weakly affects the growth rate of the Portuguese income with a 2 -year lag. For the model with 2 lags, it is possible to observe the rejection of the null hypothesis at a 10% significance level.

Table5: Granger causality Wald test for Portugal

Null Hypothesis	Lags	Chi2	Prob>chi2
The GDP growth rate does not Granger cause the Construction Sector growth rate	1	11,747***	0,001
	2	15,343***	0,000
	3	16,106***	0,001
	4	19,724***	0,001
The Construction Sector growth rate does not Granger cause the GDP growth rate	1	0,044	0,834
	2	4,9625*	0,084
	3	2,772	0,428
	4	1,933	0,737

Note: * and *** denote the rejection of the null hypothesis at 10% and 1% significance level, respectively

The results of causality relating the construction sector and GDP growth rates in Spain are presented in Table 6. The Granger causality test shows that GDP growth leads the growth in the construction sector with a 1-year to 4-year lag. However, the results seem to be less robust than those found for Portugal. Regarding the inverse relationship, it is possible to conclude that the growth rate of the construction sector does not affect the growth rate of the Spanish income.

Table 6: Granger causality Wald test for Spain

Null Hypothesis	Lags	Chi2	Prob>chi2
The GDP growth rate does not Granger cause the Construction Sector growth rate	1	3,0867*	0,079
	2	11,118***	0,004
	3	10,964**	0,012
	4	21,112***	0,000
The Construction Sector growth rate does not Granger cause the GDP growth rate	1	0,151	0,697
	2	3,286	0,193
	3	4,219	0,239
	4	4,7984	0,309

Note: *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level, respectively

In sum, it can be concluded that there is, in the short and medium-run, a uni-directional relationship between the GDP growth rate and the construction sector growth rate in both economies. On the other hand, the results do not show any significant effect of the construction growth on the GDP growth, at least in the short and medium- run. The same conclusion has also been found for other economies [18-19]. However, other writers concluded that the direction of the causality is from the construction sector to GDP [8, 21].

The above conclusion can be stressed by the observation of Figures 5 and 6, which represent the response of each one of the analysed variables to an impulse in the other (or the same) variable.

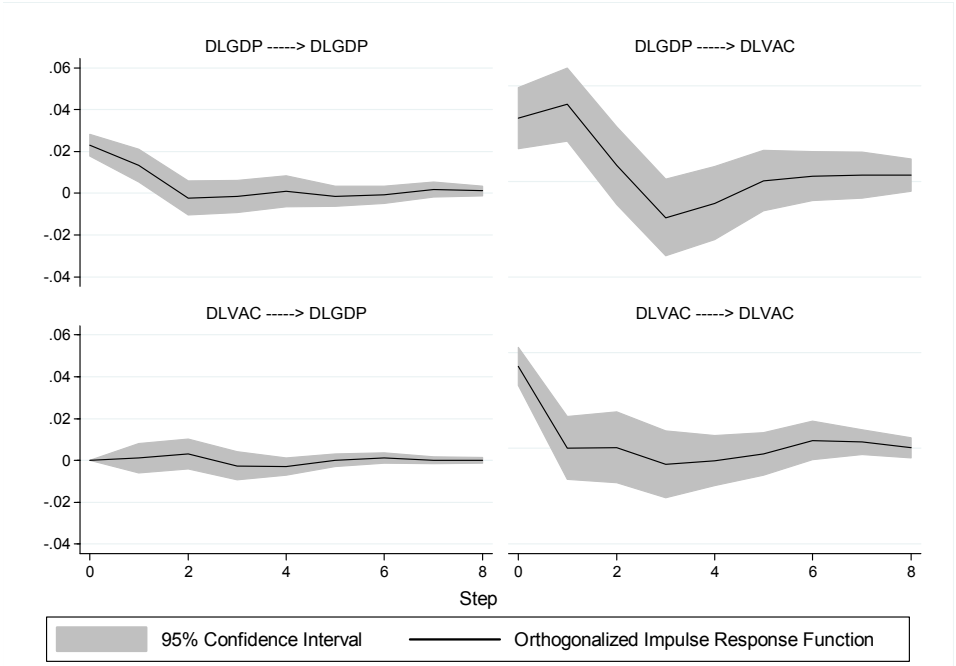

Figure 5: Orthogonalized impulse response functions between Construction and GDP growth rates and themselves, for Portugal

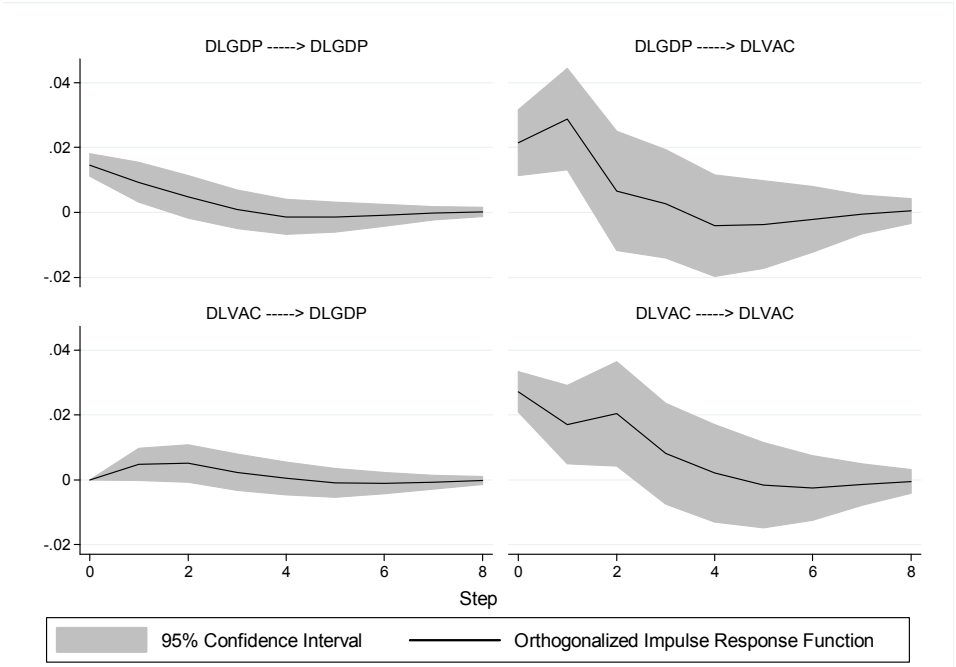

Figure 6: Orthogonalized impulse response functions between Construction and GDP growth rates and themselves, for Spain.

The impulse response function (IRF) analysis, sometimes called multiplier analysis, measures the effect of a shock on a variable on itself or on another variable [24, 30], thus strengthening the Granger causality analysis. If there is a reaction of one variable to an impulse in another variable, it is possible to consider the latter as causal of the former.
Figure 5 shows that one unit increase in Portugal's GDP growth rate influences the growth rate in the construction output up to a five year period. It is also seen that a one percent positive shock in GDP causes an immediate increase of 4% in construction flows. The opposite does not happen.

Figure 6 shows that one unit increase in Spain's GDP growth rate influences the growth rate in the construction output up to a four year period. It also shows that a one percent positive shock in GDP causes an immediate increase of 2% in construction flows. Likewise in the case of Portugal, the opposite does not happen too.

5. FINAL REMARKS

This paper has carried out an empirical investigation on the relationship between the construction output and the national economy in two neighbouring countries: Portugal and Spain. Following previous works, this study has applied an econometric analysis within Granger's 1969 framework to test the causality link between construction output and GDP. The results have shown that, for both Portugal and Spain, there is, in the short and medium-run, a uni-directional relationship between GDP and construction output. This direction of casualty is more pronounced in the former than in the latter country. On the other hand, the results do not show any significant effect of the construction growth on GDP growth, at least in the short and medium run. The analyses have also suggested that the construction industry in those countries has reached the maturity stage. The case of Spain is particularly striking for it has one of the largest construction industries in the European Union, and most recent data point to a significant decrease in all measures of the construction industry activity. Indeed, the relative decrease of the construction sector, in a long-term perspective, is the development pattern that characterizes the most developed countries of the world. Much of the recent literature emphasises the fact that, in the advanced industrial countries, there is a shift away from the new-built segment to the repair and management of the building stock. This aspect has certainly an effect on the organizational structure of the construction enterprises. The main results of this paper might have implications for public policy since they show that this kind of research methodology can be useful not only in a macroeconomic context but also in a microeconomic level. With anticipated knowledge of macroeconomic trends, firms can adjust their market strategy according to the macroeconomic forecasting.

BIBLIOGRAPHY

1. Nunes, A., Lopes, J. and Balsa, C., *Is there a causal relation between construction activity and the Portuguese economy? An econometric empirical application*, Book of Proceedings of the 10th European Conference on Research Methodologies for Business and Management Studies, Caen: France (2011).
2. Fellows, R. and Liu, A., *Research Methods for Construction*, Wiley-Blackwell, (2008).
3. Stawińska, A., *The EU-27 construction sector: from boom to gloom*, Eurostat: Statistics in Focus, 7/2010, (2010).
4. Ashuri, B. and Lu, J., *It is Possible to Forecast the Construction Cost Index in the USA", Findings in Built and Rural Environments*. Fibre Series, RICS, (2010).
5. Wang, C. H. and Mei, Y. H., *Model for Forecasting Construction Cost Indices in Taiwan*. Construction Management and Economics, Volume 16, nº 2, 147-157, (1998).
6. Turin, D.A., *The Construction Industry: Its Economic Significance and its role in Development*, UCERG, London, (1973).
7. World Bank, *The Construction Industry: Issues and Strategies in Developing Countries*, The World Bank, Washington D.C., (1984).
8. Wells, J., *The Construction Industry in Developing Countries: Alternative Strategies for Development*, Croom Helm, London, (1986).
9. Bon, R., The *World Building Market 1970-85*, Proceedings of the CIB W65 Symposium: Building Economics and Construction Management, Sydney, (1990).
10. Bon, R., *The Future of International Construction: Secular Patterns of Growth and Decline.* Habitat International. Volume 16, nº 3, 119–128, (1992).
11. Ruddock L. and Lopes J., *The Construction Sector And Economic Development: The 'Bon Curve'*. Construction Management and Economics, nº 24, 717–723, (2006).
12. Lopes, J., Nunes, A. and Balsa, C., *The Long-Run Relationship between the Construction Sector and the National Economy in Cape Verde*. International Journal of Strategic Property Management, Volume 15, nº 1, 48-59, (2011).
13. Lopes, J., *Construction in the economy and its role in social-economic development*, In G. Offori (ed) (forthcoming, 2011).

14. Han, S.S. and Ofori, G., *Construction Industry in China's Regional Economy, 1990-1998*. Construction Management and Economics, Volume 19, 189-205, (2001).
15. Lopes, J., Ruddock, L. and Ribeiro, L., *Investment in Construction and Economic Growth in Developing Countries*. Building Research & Information, Volume 30, nº 3, 152–159, (2002).
16. Green, R. K., *Follow the Leader: How Changes in Residential and Non-Residential Investment Predict Changes in GDP*. Real Estate Economics, Volume 25, nº 2, 253-270, (1997).
17. Lean, S. C., *Empirical Tests to Discern Linkages Between Construction and Other Economic Sectores in Singapore*. Construction Management and Economics, Volume 13, 253-262, (2001).
18. Tse, R. Y. C. and Ganesan, S., *Causal Relationship between Construction Flows and GDP: Evidence from Hong Kong*. Construction Management and Economics, Volume 15, 371-376, (1997).
19. Yiu, C. Y., Lu, X. H., Leung, M. Y. and Jin, W. X., *A Longitudinal Analysis on the Relationship between Construction output and GDP in Hong Kong*. Construction Management and Economics, Volume 22, nº 4, 339-345, (2004).
20. Wong, J., Chiang, Y. and NG, S. T., *Construction and Economic Development: the Case of Hong Kong*. Construction Management and Economics, Volume 26, 815-826, (2008).
21. Anaman, K. and Osei-Amponsah, C., *Analysis of the Causality Links between the Growth of the Construction Industry and the Growth of the Macro-economy in Ghana*. Construction Management and Economics, Volume. 25, nº 9, 951-961, (2007).
22. Chen, J. and Zhu, A., *The Relationship between Housing Investment and Economic Growth in China: A Panel Analysis Using Quarterly Provincial Data*, Working Paper 2008:17, Department of Economics, Uppsala University, (2008).
23. Granger, C. W. J., *Investigating Causal Relations by Econometric Methods and Cross-Spectral Methods*. Econometrica, Volume 34, 541-551, (1969).
24. Lütkepohl, H., *New Introduction to Multiple Time Series Analysis*, Springer, (2005).
25. Granger, C. W. J and Newbold, P., *Spurious Regressions in Econometrics*. Journal of Econometrics, Volume 2, 111-120, (1974).
26. Dickey, D. A. and Fuller, W. A., *Distribution of the Estimators for Autoregressive Time Series With a Unit Root*. Journal of the American Statistical Association, Volume 74, 427-431, (1979).
27. Phillips, P. C. B., and P. Perron, Testing for a unit root in time series regression, Biometrika, Volume 75, 335–346, (1988).
28. Newey, W. K. and West. K. D., *A Simple, Positive semi-definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix*. Econometrica, Volume 55, 703–708, (1987).
29. MacKinnon, J., Critical Values for Cointegration Tests, Long-run Economic Relationships: Readings in Cointegration, Engle, R.F. and Granger, C.W.J. (Eds.), Oxford University Press: New York, 267-276, (1991)
30. Hamilton, J. D., *Time Series Analysis*, Princeton University Press, (1994).