EFFECTS OF CONSTRUCTION ACTIVITIES ON THE CZECH ECONOMY

Lucie Kozumplíková[1]*, Jana Korytárová[1]

[1] Brno University of Technology, Faculty of Civil Engineering, Veveří 95, Brno, 602 00, Czech Republic

Abstract

The paper deals with the development of the Czech civil engineering production and the Czech economy, measured by the macroeconomic indicator called gross domestic product (GDP). Research results were processed using data from 1995-2014 period in current prices at the national level and with data from 2008-2014 period in current prices at the regional level (NUTS3). Regression analysis and correlation coefficient have been applied in order to determine the dependence between GDP and construction activities. The level of dependence of the performance of the entire economy of the Czech Republic on the construction production is significant. However, from the regional point of view, the dependence is not so straightforward. It can be concluded that construction activities have a very strong influence on GDP, but in case of smaller areas, it couldn´t be clearly proved by the correlation analysis.

Key words

correlation analysis; construction activities; Gross domestic product; regression analysis

To cite this paper: *Kozumplíková, L., Korytárová, J. (2016). Effects of construction activities on the Czech economy. In conference proceedings of People, Buildings and Environment 2016, an international scientific conference, vol. 4, Luhačovice, Czech Republic, pp. 176-184, ISSN: 1805-6784.*

*Corresponding author: Tel.: +420-54114-8136Fax: +420-54114-8632
E-mail address: kozumplikova.l@fce.vutbr.cz

1 INTRODUCTION

The main aim of the paper is to analyse relationship between the construction activities and the macroeconomic indicator GDP at the national level in the Czech Republic. In the Czech Republic as well as in other economically developed countries, construction industry forms one of the main pillars ensuring economic development. Construction industry contributes to GDP by a ratio of about 6-7% and employs nearly 9% of people working in the civil sector. It is a sector which can be classified by its importance as one of the major economic sectors, such as energy sector, manufacturing industry and transportation. Construction industry tends to be the first affected sector during the crisis period and vice versa. Improvement in the outcomes of construction industry indicates improvement of the entire economy of the country. Slowdown in construction investments brings immediate reflection in the country's economy because construction industry represents a high multiplier effect, a large number of manufacturers and suppliers from other industries are related to it and the completion of objects brings additional employment. Construction industry and capital investment construction associated with it contributes to the balanced development of the territory in the long term horizon, affects the environment, creates the conditions for doing business in other economic sectors and fields as well as helps to maintain social stability. An essential precondition for increasing economic development of regions is connection of the area to the transport infrastructure which always presents large-scale construction activities. Construction projects with rapid social development as well as large-scale construction of infrastructure have become one of the driving forces of the national economy which energy consumption, environmental emissions and social impacts are significant [1].

2 LITERATURE REVIEW

Generally it is possible to conclude that building production plays one of the most important roles in the economy. The relationship between construction output and economic growth has been discussed in detail by construction economists. Most of the previous studies found a positive correlation between gross domestic product (GDP) per capita and various measures of construction production [2]. Construction production is undoubtedly very important as a quality factor of economic development and it is advisable to follow it because it belongs to the group of predictive indicators that can foretell the future situation: how will the production, investments and economy as a whole continue to develop. Data on the number of building permits or commencements of construction also belongs among the indicators with the ability to anticipate the development trends [3]. The productivity of the construction industry has a significant effect on the national economic growth. Gains from higher construction productivity flow to the economy, as all industries rely on construction industry to some extent as a part of their business investment. Contractions and expansions of economic activities are common phenomena in economy [4].

Support of building industry itself leads to significant support of the domestic economy. It is widely known that the construction industry has one of the highest multiplier effects in terms of economic benefits and also the impact on employment [5]. This fact is important for finding the ways to overcome the economic crisis. State can directly stimulate the domestic economy through public investments, because construction industry proves to have a relatively low dependence on imports.

Public contracts for construction work also play a significant role in the domestic economy. Through it, it is possible to significantly affect the economic growth and employment and this role of the construction industry should be used within the economic policy [6].

One of the main functions of the state is to stabilize the economy. The following characteristics are used to evaluate whether governments actually help to stabilize the economy through controlled investments, particularly in civil engineering:

- standard deviation of annual development of civil engineering,
- correlation of annual GDP development and civil engineering (time series of development of civil engineering is delayed by two years).

The standard deviation expresses the degree of variability of the annual development of civil engineering. It thus refers to the volatility in the volume of civil engineering in individual years. The correlation coefficient between the development of real production and the development of civil engineering is used to evaluate the cyclicality. Due to the relatively long production cycle of civil engineering, time line is delayed by two years [7].

In terms of construction industry the optimal state seems to be a state when the volatility in the annual development of civil engineering is as low as possible not allowing the fast rise or fall in needed capacity. The correlation coefficient should be close to 0 in case of observing the independence of infrastructure investments on the development of the economic cycle or it should be negative in case of implemented anti-cyclical policy [8].

The level of influence of civil engineering on GDP is stable around 4%, but it has been significantly decreasing since 2010. In the period 1995 - 2009 it ranged from 3.6 to 4.4%. The level of around 3% is getting closer to western European countries which, however, have developed the infrastructure of a completely different scale and level both in the area of highway and rail networks. In a period of decreasing dynamics of infrastructural investments, a desirable development cannot appear as well as getting closer to Western Europe, but on the contrary further gap and the loss of competitiveness of the Czech Republic in an international comparison will occur [9]. Significant engineering and construction projects are becoming more and more important, because a lot of states renew and extend their already existing infrastructure, primarily due to their growth [10]. Decisions about infrastructure and its impacts are long term and can last for decades, even centuries. Transport, infrastructure planning and financing represent a controversial political issue at national and increasingly at the international levels [11]. Projects become definitely politically acceptable when they offer a positive impact on regional development. One of the arguments for investing money into infrastructure projects is generating of economic growth [12].

3 METHODOLOGY

Correlation and regression analyses represent statistical methods for determining the type and strength of dependence level between two variables. Type and strength of dependence for a random sample of size n can be indicatively assessed from the dot plot, in which each pair of data (x, y) is graphically shown by one point. Type of dependence determines the shape of the curve, which can be drawn through the points - linear, exponential, logarithmic etc.

When analysing the relationship between two variables x and y, a correlation coefficient is used to determine the degree of linear dependence level. The level of dependence of both variables is determined by the correlation coefficient of two time lines. Generally the values

of the correlation coefficient *r* are assessed in terms of dependence level of the observed variables as follows [9]:

$r < 0.3$	weak dependence to independence
$0.3 \leq r < 0.5$	moderate dependence
$0.5 \leq r < 0.7$	considerable dependence
$0.7 \leq r < 0.9$	strong dependence
$0.9 \leq r \leq 1.0$	very strong dependence

Pearson paired correlation coefficient acquires values in the range -1 to +1, while negative values express inverse relation (with increase in value of one variable, decline in the value of the second variable occurs), positive values then express direct relationship (with increase in the value of one variable, increase in the value of the other variable occurs) and zero correlation means independence [13, 14].

Pearson´s correlation coefficient:

$$-1 \leq r_{x,y} \leq +1 \tag{1}$$

Linear regression function has the form:

$$Y = f(x) = a + b(X) \tag{2}$$

Where:
a, b … regression coefficients
a… shift the y-axis (point, where the regression line crosses the axis)
b … slope of the regression line
y … regressor
x … particular variable

Sometimes it is not clearly determined which variable is independent and which dependent. Linear regression of x on y does not produce the same regression line as regression of y on x. Squared correlation coefficient is called the coefficient of determination R^2, and its value measures the level of linear relation between X and Y regardless of which variable is dependent and which independent. The value of the correlation coefficient can be deduced from the graph of linear regression – the smaller the angle formed by both regression lines (expressing the dependence of x on y and y on x) is, the bigger the absolute value of regression is [15, 16].

4 RESULTS AND DISCUSSION

The relationship between two variables was explored using simple linear regression. Current research has examined 15 regions, data of the whole Czech Republic and data of 14 regions (local government unit, NUTS 3). The investment activities were assessed during different periods. On the national unit level period of 1995-2015 was used, on the regional units level period of 2008-2014 was used. The results of empirical part of the research were processed in the following steps. Firstly, linear regression analysis was performed in order to determine the relationship between particular variable (GDP value) and the regressor (civil engineering output). Regression analysis has the potential to express the relationship between examined variables, while the slope of regress curves may describe the significance of the GDP with respect to the investment activities.

Secondly, the correlation analysis was carried out in order to determine the existence of dependence between variables as well as its strength (the intensity level of dependence is expressed by Pearson's correlation coefficient r). The quality of the regression model describes the determination index R^2, which indicates appropriateness of the model.

The dependence rate of the performance of the entire economy of the Czech Republic on the civil engineering production is very strong (r = 0.9043). GDP tends to lead the construction industry flow, not vice versa [17]. The following table (Tab. 1) shows the data of civil engineering works and GDP in the Czech Republic.

Tab. 1 Construction activities and GDP in the Czech Republic (index average 1995=100; index of previous period=100; source: Czech statistical Office, authors' own work)

		1996	1997	1998	1999	2000	2001	2002
Civil engineering works	Index average 1995=100	125.19	142.49	138.36	130.02	150.28	160.78	178.15
	Index of previous period=100	25.19	13.82	-2.90	-6.03	15.58	6.99	10.80
GDP	Index average 1995=100	114.71	123.62	135.60	141.59	150.16	162.18	169.27
	Index of previous period=100	14.71	7.76	9.69	4.42	6.05	8.01	4.37

		2003	2004	2005	2006	2007	2008	2009
Civil engineering works	Index average 1995=100	194.58	242.66	276.93	282.54	295.31	342.37	369.94
	Index of previous period=100	9.22	24.71	14.12	2.03	4.52	15.94	8.05
GDP	Index average 1995=100	177.28	193.51	206.19	221.95	242.50	254.12	248.20
	Index of previous period=100	4.73	9.16	6.55	7.65	9.26	4.79	-2.33

		2010	2011	2012	2013	2014	2015
Civil engineering works	Index average 1995=100	375.49	299.40	265.24	254.91	278.69	323.80
	Index of previous period=100	1.50	-20.26	-11.41	-3.89	9.33	16.18
GDP	Index average 1995=100	250.21	254.57	255.78	258.03	269.66	283.04
	Index of previous period=100	0.81	1.74	0.47	0.88	4.51	4.96

The equation of the regression line in this case can be described by:

$$y = 0.5972x + 61.476 \quad (3)$$

Figure 1 shows dot plot of dependence of civil engineering works and GDP in the Czech Republic. Determination coefficient is 0.8178, which indicates tightness of dependence to be very high, and it shows an appropriate choice of this model.

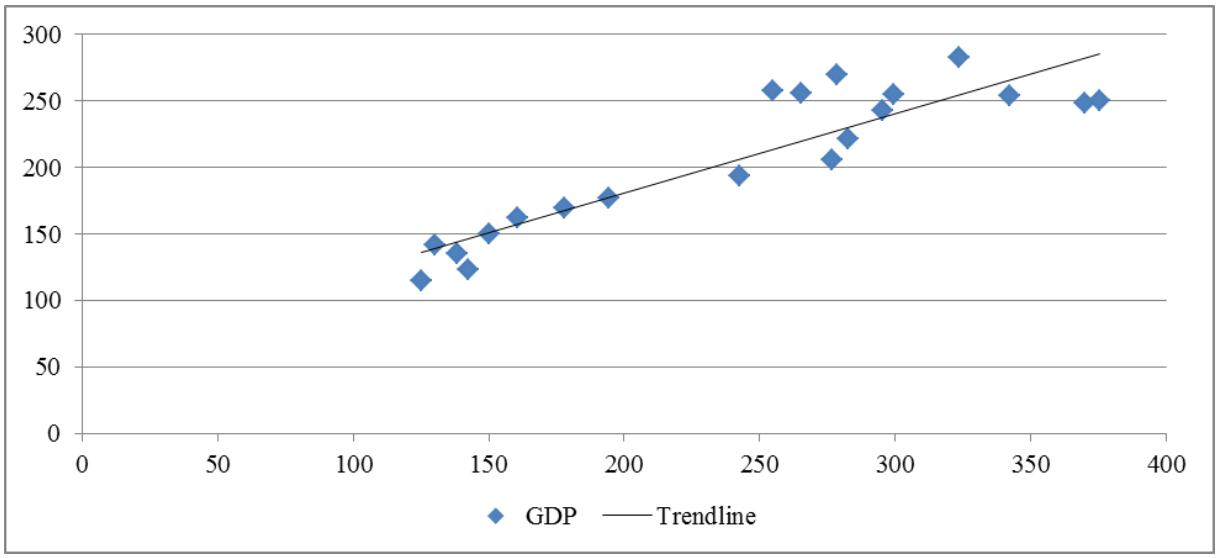

Fig. 1 Graph of civil engineering works and GDP, data for the Czech Republic (source: authors' own work)

In the case of regions of the Czech Republic (NUTS 3), there is no dependence. In Table 2 there are correlation coefficients, determination coefficients and regression equations for all regions. In the Karlovy Vary region, a strong dependence has been proved, in the Highlands Region and Pardubice Region, a moderate dependence has been proved. In other regions no dependence has been proved.

Tab. 2 Results of regression and correlation analyses in the regions (source: authors' own work)

	Correlation coefficient r	**Coefficient of determination R^2**	**Regression equation**
Capital City of Prague	-0.1880	0.0353	y = -0.0144x + 106.3
Central Bohemian Region	-0.6836	0.4674	y = 0.1074x + 117.88
South Bohemian Region	-0.4064	0.1652	y = -0.1002x + 113.38
Pilsen Region	0.1080	0.0117	y = 0.0291x + 102.34
Karlovy Vary Region	0.7875	0.6202	y = 0,0215x + 97.764
Usti Region	-0.0450	0.0020	y = -0.0031x + 103.59
Liberec Region	-0.4290	0.1839	y = -0.0731x + 112.88
Hradec Kralove Region	-0.3140	0.0985	y = -0.0427x + 109.64
Pardubice Region	0.3062	0.0938	y = 0.0210x + 98.220

Highlands Region	0.4628	0.2142	y = 0.07020x + 94.083
South-Moravian Region	-0.5961	0.3554	y = -0.0897x + 125.41
Olomouc Region	-0.4780	0.2280	y = -0.1791x + 118.11
Zlín Region	-0.4920	0.2418	y = -0.0918x + 119.82
Moravian-Silesian Region	-0.6340	0.4022	y = -0.0842x + 113.22
CR Total	0.9043	0.8178	y = 0.5972x + 61.476

Due to a small number of measurements, correlation coefficient can be distorted, because it overestimated the intensity of dependence.

Strength of dependence has been proved on a certain number of observations. In the case of nationwide perspective, there were 20 monitoring periods (data from 1996 to 2015). The very strong dependence can be confirmed by a 99.9% probability. Correlation coefficient describing the strength of the dependence in the Czech Republic has been 0.9043; therefore it is possible to consider it to be a very strong dependence. In the case of regional perspective, there were 7 monitoring periods (data from 2008 to 2014). In the regions, dependence / independence cannot be proved for sure, because of small number of measurements.

5 CONCLUSION

Regression and correlation analyses were used as research statistical methods. The relationship between civil engineering and performance of the economy was monitored for the Czech Republic and its individual regions.

From a nationwide perspective, it can be confirmed that the relationship between the performance of the national economy and civil engineering is evident. Correlation coefficient describing the strength of the dependence is 0.9043; therefore it is possible to consider it to be a very strong dependence. Determination coefficient (R^2 = 0.8178) indicates appropriateness of this model.

From a regional perspective, however, the dependence is not so clear. Dynamics of construction activity in the regions is so intensive that the relationship between GDP and construction activity cannot be deduced. In relation to the size of the budgets of individual regions, any major investment project financed from national or international sources can cause an enormous fluctuation of the curve of construction activities. Dependence between the performance of the economy, characterized by the GDP and civil engineering has not been confirmed by regression and correlation analyses on the regional level (NUTS 3).

Another important influence on these smaller territorial units is the focus of the investment. It is important whether the building activities are directed to investments into public or private (business) sector. At the regional level, the differences in investment focus play a crucial role. Investment activities have an influence not only on the gross domestic product, but also on other macroeconomic indicators such as unemployment, average gross earnings, profits or other types of value added. Nationwide, all data on the construction activity and the performance of the economy are averaged, so the relationship between construction investment activities and GDP could be confirmed.

Conversely, in individual regions this dependence has not been confirmed. One of the reasons is the fact that in each region the investments are focused on another direction. While in one region they are investments in the public sector, in another region they may be largely private sector investments. From the general public and private investment perspective, it is obvious that the effect is not always the same and it may show with a time delay. While private sector investments concentrate on the mainly financial aspect (profit), the public sector primarily pursues the common welfare and societal effects.

ACKNOWLEDGEMENT

This paper has been worked out under the project no. LO1408 "AdMaS UP - Advanced Materials, Structures and Technologies", supported by Ministry of Education, Youth and Sports under the „National Sustainability Programme I"

REFERENCES

[1] Chang, Y., Ries, R. J., Wang, Y. (2011). The quantification of the embodied impacts of construction projects on energy, environment, and society based on I–O LCA. *Energy Policy*. Volume 39, Issue 10, pp. 6321–6330.

[2] Yiu, C.Y., Lu, X. H., Leung, M.Y., Jin, W.X. (2004). A longitudinal analysis on the relationship between construction output and GDP in Hong Kong. *Construction Mangement and Economics*, 22, 339–345.

[3] Měšec.cz.(2015) Stavební výroba. Available at: http://www.mesec.cz/dane/ekonomika/pruvodce/stavebni-vyroba/

[4] Chia, F. Ch., Skitmore, M., Runeson, G., Bridge, A. (2014). Economic development and construction productivity in Malaysia. *Construction Management and Economics*, 32(9), pp. 874-887.

[5] Khadaroo, J. and Seetanah, B. (2008). The role of transport infrastructure in international tourism development: A gravity model approach. *Tourism Management*, 29(5), 831–840.

[6] Vlada.cz (2014). *Zpět na vrchol. Strategie mezinárodní konkurenceschopnosti České republiky pro období 2012 až 2020*. Available at: http://www.vlada.cz/assets/media-centrum/aktualne/Strategie-mezinarodni-konkurenceschopnosti-Ceske-republiky.pdf

[7] Ministerstvo průmyslu a obchodu, ÚRS. (2015). *Portál českého stavebnictví*. Available at: http://www.ceskestavebnictvi.cz/

[8] Svaz podnikatelů ve stavebnictví v ČR, Deloitte. *Udržitelné stavební investice v České republice. Studie*. (2012). Available at: http://www2.deloitte.com/content/dam/Deloitte/cz/Documents/survey/udrzitelne_stavebni_investice.pdf

[9] Winkler, O.W. Interpreting Economic and Social Data: A Foundation of Descriptive Statistics. Springer Science and Business Media, 2009. ISBN: 3540687211.

[10] Karst, T., Geurs A., Van Wee, B. (2004). Accessibility evaluation of land-use and transport strategies: review and research directions. *Journal of Transport Geography*, 12(2), 127–140.

[11] Chlaň, A., Stejskal, P. *Tarify a ceny v dopravě: pro kombinovanou a prezenční formu studia*. Pardubice: Univerzita Pardubice, 2008, 170 s. ISBN 978–80–7395–104–7.

[12] Česko. *Zákon č. 13 ze dne 23. ledna 1997 o pozemních komunikacích, ve znění pozdějších předpisů*. In: Sbírka zákonů, Česká republika. 1997, částka 3, s. 47. ISSN 1211-1244.

[13] Mendenhall, W., Sincich, T. *A second Course in Statistics: Regression Analysis*. Prentice Hall, 2012. ISBN: 0321691695

[14] Sen, A.K., Srivastava, M.S. *Regression Analysis: Theory, Methods and Applications*. Springer Texts in Statistics. Springer, 2013. ISBN: 3662250926.

[15] Box, G.E.P., Jenkons, G.M., Reinsel, G.C., and Ljung, M. *Time series Analysis: Forecasting and Control*, Wiley Series in Probability and Statistics. John Wiley and Sons, 2015. ISBN: 111867491X.

[16] Ryan, T.P. *Modern Engineering Statistics*. Published by John Wiley and Sons, Inc., Hoboken, New Jersey. 2007. ISBN 0470128437.

[17] Tse, R.Y.C., Ganesan, S. (1997). Causal Relationship between Construction Flows and GDP: Evidence from Hong Kong, *Construction Management and Economics*, 15(4), pp. 371-376.