Functioning characteristics of construction companies in Ukraine under the influence of macroeconomic factors

Características funcionales de las empresas constructoras en Ucrania bajo la influencia de factores macroeconómicos

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Abstract
The article substantiates the significant importance of the construction enterprises development for the country economy . The dynamics of the construction enterprises development and features of their current state are characterized. Multivariate dynamic regression modeling method was used to identify the dependence of functioning of enterprises providing basic types of construction on a number of different macroeconomic indicators during the years 2013-2018 to evaluate quantitatively their impact. The current stage of development in the construction sector enterprises is characterized by compliance with macroeconomic trends in the state, which is reflected by dynamics of the main indicators of their functioning.
Key words: economy, construction sector, construction enterprises, macroeconomic factors influence

Resumen
El artículo confirma la importancia significativa del desarrollo de las empresas de construcción para la economía del país. Se caracteriza la dinámica del desarrollo de las empresas de construcción y las características de su estado actual. Se utilizó el método de modelado de regresión dinámica multivariante para identificar la dependencia del funcionamiento de las empresas que proporcionan tipos básicos de construcción en una serie de diferentes indicadores macroeconómicos durante los años 2013-2018 para evaluar cuantitativamente su impacto. La etapa actual de desarrollo en las empresas del sector de la construcción se caracteriza por el cumplimiento de las tendencias macroeconómicas en el estado, que se refleja en la dinámica de los principales indicadores de su funcionamiento.
Palabras clave: economía, construcción, empresas constructoras, influencia.

1. Introduction

Construction is one of the basic sectors of the economy of all countries. Its level of development has a considerable influence on economic security. Due to the construction enterprises, the primary physiological needs of society in housing and protection are fulfilled, the fixed assets (buildings and structures) are provided to subjects of different forms of ownership and different spheres of activity, which in turn is connected with the formation of capital markets, goods and services, manpower; causes the development of commercial, transport and socio-cultural infrastructure. However, on the other hand, the functioning of construction enterprises

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depends on the influence of a number of external and internal factors that can both provide opportunities and pose real threats to their development.

2. Research study and problem statement

The results of research on the characteristics of the construction sector enterprises development were examined by A. Asaul [1], V. Bazylevich, J.Burka [2], Z. Varnalii [12], N.Verkhogladova [13], A. Goiko, O. Ilyashenko, V. Kravchenko [3], M. Kyzym, O. Lajko [4], L. Lipych, A. Mokii [5], V. Pavlov, K. Palyvoda [3], L. Prodanova [8], T. Pushkar [9], R. Tian and other scholars. Despite the significant scientific achievements of the researchers, a number of issues regarding the development of residential, commercial, industrial and infrastructural construction enterprises under the influence of macroeconomic factors remain undisclosed. This actualizes the need to identify the features of the construction sector enterprises functioning in Ukraine, which motivated to choose this direction of research.

Methodology

In order to reveal the dependence of the operation of enterprises providing the basic types of construction (dependent variables, which is considered as a function of some independent variables) on a number of different macroeconomic indicators (independent variables) [6; 7] during 2013-2018 and to estimate their quantitative influence, the method of multivariate dynamic regression modeling was applied:

$$C = a_0 + a_1 b_1 + a_2 b_2 + \dots a_n b_{n'}$$

where $a_1, \dots, a_n$ – are the proportionality coefficients; $b_1, \dots, b_n$ – regressors.

3. Results

After a slight post-crisis recovery of the construction sector in 2010-2011, a period of stagnation began in 2012 which grew into an acute phase of the crisis in 2014, and continued until the end of the year 2015. Since 2016, the construction companies have shown a gradual increase in volumes for all types of construction (residential, non-residential, engineering structures). In general, during the period 2010-2019, the deformation of the structure in the construction work carried out by the companies took place. During the year 2019, Ukrainian enterprises have completed in total the construction works worth about 177 billion UAH. The index of construction products in comparison with the previous year was 120%, namely the index of construction of buildings - 116.3%, engineering structures - 123.3% [6].

The use of dynamic cross-sectional balance regression made it possible to form a large-scale overall sample (6768 observations – 47 indicators for six years concerning of 24 regions of Ukraine) for each dependent variable (C_1 – the volume of contract works by enterprises specializing in housing construction; C_2 – the volume of contract works by enterprises specializing in non-residential construction; C_3 – the volume of contract works by enterprises specializing in construction of engineering structures). A software environment Statistica 10.0 was used to perform the calculations. Before loading the data set, all metrics were logarithmized.The calculation results for the first dependent variable are displayed in table 1.

Table 1
Main influence factors of macroeconomic indicators on the volume
of contract works of enterprises specializing in housing construction (C_1)

Independent variables	Dependent variable
	Volume of completed contract works of enterprises specializing in housing construction (per capita, UAH) (C_1)
	Correlation coefficient (R=0,9328); Adjusted coefficient of determination (R^2=0,8702); Fisher's test (F(19,124)=43,765) at p<0,0000; Standard error: 0,3392

Free member (*B*)	-3,580
b_3 – volume of sold industrial products (goods, services) per capita (UAH)	-0,51
b_4 – production of agricultural output per capita (UAH)	0,158
b_6 – disposable income per capita per capita (UAH)	0,21
b_7 – employment rate (per 1000 people)	0,143
b_{11} – loans from deposit-making companies to construction companies in foreign currencies, per capita (UAH)	0,184
b_{18} – interest rates on loans by deposit-making corporations to households (annual average weighted interest rates, %)	-0,143
b_{20} – number of employed population in the field of real estate transactions for every 1000 inhabitants in a population (persons)	-0,414
b_{21} – urban housing stock per capita (of total area, m²)	-0,425
b_{22} – rural housing stock per capita (of total area, m²)	0,955
b_{27} – production of prefabricated structural elements for construction works of cement, concrete or artificial stone per 1000 people (t)	-0,212
b_{28} – production of ready-to-use concrete solutions per 1000 people (t)	0,38
b_{30} – pebble, gravel, and crushed stone extraction per 1000 people (t)	-0,346
b_{31} – manufacture of wooden windows, doors, their frames and thresholds per 10000 people (pcs)	-0,132
b_{36} – volume of construction works performed while erecting the non-residential buildings, per capita (UAH)	0,169
b_{37} – volume of construction works performed while erecting the engineering structures, per capita (UAH)	0,156
b_{39} – number of grocery stores with universal assortment (from 400 to 2499 sq.m. retail space) (units)	0,408
b_{41} – number of non-food items stores with a universal assortment (up to 120 sq.m. retail space) (units)	-0,19
b_{46} – natural increase (or decrease) in population (thousand people)	-0,869
b_{47} – migration growth (or decline) in population (thousand people)	0,191

Source: formed by the author's calculations

The regression results are statistically significant, as testified by the relevant indicators: correlation coefficient (0,9328); adjusted coefficient of determination (0,8702); Fisher's test (F(19,124)=43,765); standard error (0,3392); p-level (0,0000).

Accordingly, the equation (1) is represented as follows:

$$C_1 = -3,58 - 0,51b_3 + 0,158b_4 + 0,21b_6 + 0,143b_7 + 0,184b_{11} - 0,143b_{18} - 0,414b_{20} - 0,425b_{21} + 0,955b_{22} - 0,212b_{27} + 0,38b_{28} - 0,346b_{30} - 0,132b_{31} + 0,169b_{36} + 0,156b_{37} + 0,408b_{39} - 0,19b_{41} - 0,869b_{46} + 0,191b_{47} \qquad (1)$$

Significant impact on the volume of contract works of enterprises specializing in housing construction is shown by the indicator of rural housing stock per person (b_{22} = 0,955), which is associated with high volumes of construction by private developers in the countryside. Moderate dependence on housing is traced to the number

of grocery stores with a versatile range (from 400 to 2499 sq.m. retail space (b_{39} = 0,408). In other words, while choosing a plot of land for the construction of residential buildings, developers take into account the availability of near department stores, supermarkets, hypermarkets, which increases demand and affects the cost of apartments in such buildings. Also the production of ready-to-use concrete solutions moderately effects on the volume of housing (b_{28} = 0,38).

Housing is largely dependent on the demographic situation in the state [10], so the downward trend in population has an important reverse effect on housing in Ukraine (b_{46} = -0,869). The research results also display the inverse dependence of the volume of housing construction on the increasing volume of industrial products sold (b_3 = - 0,51). In our opinion, this is due to a bunch of factors, in particular, the current state of the Ukrainian industry requires a rational territorial organization of production, modernization of technologies and updating of funds. The lack of effective industrial clusters that would ensure high production efficiency necessitates a large amount of financial resources for separate production facilities, so the funds withdrawn after the sale of industrial products are involved mainly in production processes and marketing of products, as well as modernization of available industrial facilities, reducing opportunities of investment in housing. Besides, there are shady patterns of production and sales of industrial products, including the construction sector: pebbles, gravel, crushed stone etc. (b_{30} = - 0,346); prefabricated structural elements for construction works of cement, concrete or artificial stone (b_{27} = -0,212); wooden windows, doors, their frames and thresholds (b_{31} = -0,132). The reverse impact on housing is made by number of people employed in real estate transactions as well (b_{20} = - 0,414). Namely, the more people are involved in various "manipulations" with finished construction products in the primary and secondary real estate market, the less dwellings are built. Interest rates on loans by deposit-making corporations to households have a negative effect (b_{18} = -0,143).

The calculation results for the dependent variable C_2 are displayed in table 2.

Table 2
Main influence factors of macroeconomic indicators on the volume
of contract works of enterprises specializing in non-residential construction (C_2)

Independent variables	Dependent variable Volume of completed contract works of enterprises specializing in non-residential construction (per capita, UAH) (C_2)	
	Correlation coefficient (R=0,7223); Adjusted coefficient of determination (R^2=0,5217); Fisher's test (F(21,122)=35,302) at p<0,0000; Standard error: 0,1867	
Free member (*B*)		-1,659
b_6 – disposable income, per capita (UAH)		0,411
b_7 – employment rate (per 1000 people)		-0,184
b_8 – capital investments, per capita (UAH)		0,518
b_{13} – loans granted in foreign currency by deposit-making corporations to households for the purchase, construction and reconstruction of real estate, per capita (UAH)		-1,368
b_{16} – loans provided by deposit-making corporations to households for mortgage loans, per capita (UAH)		1,093
b_{17} – interest rates on loans from deposit-taking corporations to non-financial corporations (the annual weighted interest rate, %)		-0,174
b_{19} – coefficient of accessibility of residential property		-0,24
b_{20} – number of employed population in the field of real estate transactions for every 1000 inhabitants in a population (persons)		0,278
b_{21} – urban housing stock per capita (of total area, m²)		0,465

b_{22} – rural housing stock per capita (of total area, m²)	-0,613
b_{24} – share of capital investment in real estate transactions (%,to total amount investment)	0,137
b_{25} – production of non-refractory ceramic construction bricks, per 1000 people (m³)	0,239
b_{27} – production of prefabricated structural elements for construction works of cement, concrete or artificial stone per 1000 people (t)	0,449
b_{31} – manufacture of wooden windows, doors, their frames and thresholds per 10000 people (pcs)	0,219
b_{32} – export of items made from stone, plaster, cement per 1000 persons ($ USD)	0,104
b_{35} – import of construction services per 1000 people ($ USD)	-0,094
b_{38} – number of grocery stores with universal assortment (from 120 to 399 sq.m. retail space) (units)	-0,275
b_{39} – number of grocery stores with universal assortment (from 400 to 2499 sq.m. retail space) (units)	-0,328
b_{41} – number of non-food items stores with a universal assortment (up to 120 sq.m. retail space) (units)	0,235
b_{46} – natural increase (or decrease) in population (thousand people)	0,376
b_{47} – migration growth (or decline) in population (thousand people)	-0,146

Source: formed by the author's calculations

The equation (2) is represented as follows:

$$C_2 = -1,659 + 0,411b_6 - 0,184b_7 + 0,518b_8 - 1,368b_{13} + 1,093b_{16} - 0,174b_{17} - 0,24b_{19} + 0,278b_{20} + 0,465b_{21} - 0,613b_{22} + 0,137b_{24} + 0,239b_{25} + 0,449b_{27} + 0,219b_{31} + 0,104b_{32} - 0,094b_{35} - 0,275b_{38} - 0,328b_{39} + 0,235b_{41} + 0,376b_{46} - 0,146b_{47} \qquad (2)$$

A significant proportion of commercial real estate is purchased on a mortgage basis, so the largest impact on the volume of contract work of enterprises specializing in non-residential construction is made by mortgage loans provided by deposit-making corporations to households (b_{16} = 1,093). Capital investment (b_8 = 0.518) and people's disposable income also have a significant impact on the development of this segment (b_6 = 0,411).

The inverse dependence of non-residential construction is traced to loans granted in foreign currency by deposit-making corporations to households for the purchase, construction and reconstruction of real estate (b_{13} = -1,368). Using this type of lending, some part of the population, after the rapid increase of the exchange rate since February 2014, crucially reduced their purchasing power, which significantly reduced their consumer opportunities. The reverse impact on the construction of non-residential real estate is also carried out by the rural housing stock (b_{22} = -0.613), which is tied to urbanization processes and the attachment of commercial real estate in urban housing (b_{21} = 0,465).

The calculated results for the dependent variable C_3 are shown in table 3.

Table 3
Main influence factors of macroeconomic indicators on the volume of contract
works of enterprises specializing in construction of engineering structures (C_3)

Independent variables	Dependent variable
	Volume of completed contract works of enterprises specializing in construction of engineering structures (per capita, UAH) (C_3)
	Correlation coefficient (R=0,7143); Adjusted coefficient of determination (R²=0,5102); Fisher's test (F(11,131)=35,435) at p<0,0000; Standard error: 0,3611
Free member (B)	1,497
b_1 – gross domestic product calculated per capita (UAH)	0,825

b_5 – retail turnover of enterprises per capita (UAH)	-0,609
b_9 – volume of innovative products sold, which are new for sale in the market, per capita (UAH)	0,104
b_{11} – loans from deposit-making companies to construction companies in foreign currencies, per capita (UAH)	-0,256
b_{20} – number of employed population in the field of real estate transactions for every 1000 inhabitants in a population (persons)	0,506
b_{21} – urban housing stock per capita (of total area, m²)	-0,598
b_{22} – rural housing stock per capita (of total area, m²)	-0,379
b_{28} – production of concrete solutions ready for use per 1000 people (t)	0,432
b_{30} – pebble, gravel, and crushed stone extraction per 1000 people (t)	0,211
b_{33} – import of items made from stone, plaster, cement per 1000 persons ($ USD)	0,191
b_{42} – the number of non-food items stores with a universal assortment (from 1,000 to 2,499 m2 of retail space) (units)	0,147
b_{47} – migration growth (or decline) in population (thousand people)	0,228

Source: formed by the author's calculations

Accordingly, the equation (3) is represented as follows:

$$C_3 = 1,497 + 0,825b_1 - 0,609b_5 + 0,104b_9 - 0,256b_{11} + 0,506b_{20} - 0,598b_{21} - 0,379b_{22} + 0,432b_{28} + 0,211b_{30} + 0,191b_{33} + 0,147b_{42} + 0,228b_{47} \qquad (3)$$

The erection of engineering structures is provided mainly through public funding, so the largest impact on this segment according to research is the gross domestic product (b_1 = 0,825). Like any construction area, the engineering structures need to use large volumes of concrete solutions (b_{28} = 0,432), pebble, gravel, bricks and crushed stone (b_{30} = 0,211), emphasising the dependence on the production of these types of building materials. Positive influence is evidently due to the number of employed people in real estate transactions (b_{20} = 0,506), which can be explained by the functional features of information support of developers, realtors and other related companies contributing the growth of commercial, transport socio-cultural and road infrastructure.

Chaotic constructions, from the point of view of the master plans of settlements, which are often not approved, do not meet social needs, environmental standards and are often built with numerous violations, leads to an excessive agglomeration of infrastructure [11]. As a result, the inverse effect of urban (b_{21} = -0,598) and rural housing stock (b_{22} = -0,379) is traced. A similar effect is noticed by the volume of retail trade turnover (b_5 = -0.609), which exerts significant pressure on the relevant infrastructure facilities by existing and prospective outlets. Moreover, the financial resources accumulated by retailers are largely invested in furthering their business, which in turn limits capital inflows into the real economy.

4. Conclusions

The current stage of the construction sector enterprises development is characterized by compliance with macroeconomic trends in the state, which is reflected by dynamics of the main indicators of their functioning.

Therefore, the formation of strategic priorities for the development of construction companies should be based on the results of research with regard to the state, trends and macroeconomic factors affecting construction in the context of its segments, depending on regional and institutional features. The results of the study confirm a significant impact of macroeconomic factors on peculiarities of functioning of construction enterprises.

A significant impact on the volumes of contract work by companies specializing in housing construction is an indicator of the rural housing stock, which is associated with significant construction volumes by private developers in rural areas. Housing is mostly dependent on the demographic situation in the state, so the downward trend in population has a significant reverse effect on housing in Ukraine. A large part of commercial

real estate is purchased on a mortgage basis, so the largest impact on the volumes of contract work of enterprises specializing in non-residential construction is made by mortgage loans provided by deposit-making corporations to households. Capital investment and people's disposable income have a significant impact as well on the development of this segment. The inverse dependence of non-residential construction is observed to loans granted by deposit-making corporations to households for the acquisition, construction and reconstruction of foreign currency real estate. The construction of engineering structures is provided mainly through public funding, so the largest impact on this segment in the research data is the gross domestic product.

The strategic priorities for the development of construction companies should aim to strengthen their competitiveness, which ensure formation of a safe and comfortable living environments and of human activities meeting the high standards of quality and efficiency. This will require innovative retrofitting of companies specializing in residential, non-residential and infrastructure construction, as well as training and synchronization of the industry's innovation cycle, which provides:

– necessary conditions for the implementation of innovations in order to increase productivity, to reduce material consumption, energy consumption and construction costs;

– increasing the share of innovative products, developments and technologies in the field of engineering, design, production of building materials, construction technologies and equipment, construction management;

– ensuring the cluster associations development in   industrial construction and infrastructure;

– formation and implementation of programs of innovative development on the national and regional level; implementation of technologies of information and mathematical modeling of full life cycle for construction objects, including assessment and management of investment risks on all aspects of planning, optimizing the processes of design, construction, operation and use;

– development of the system for implementing the next large-scale digital topographic plan of the completed construction and the areas suitable to construction work in Ukraine;

– indusrial implementation of building materials, products and constructions of innovative technologies aimed to solve the problems of import substitution, the reduction of mineral raw materials share and its replacement by industrial wastes.

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