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MODELING OF THE IMPACT OF THE E-COMMERCE ON INDICATORS OF ECONOMIC DEVELOPMENT OF UKRAINE

Abstract

This paper investigated the impact of e-commerce on indicators of economic development of Ukraine. The time period was chosen from 2007 to 2019 year. The economic-mathematical models were constructed on the basis of Cobb–Douglas production function, regression analysis was performed using the computer program Excel.

Key words: e-commerce, Cobb–Douglas production function, economic development, economic-mathematical modeling, internet penetration.

Introduction

Today, the rapid development of information technology is leading to significant digitalization and digital transformation in the world, which contributes to the development and spread of e-commerce in many countries. This process contributes to the complete modernization of most business processes and trade and economic relations in society. That is why e-commerce as a new progressive phenomenon in the world needs to be studied in detail in order to clearly understand the impact of e-commerce on the economic development of countries.

The purpose of this paper is to build economic-mathematical models to study the impact of e-commerce on economic development in Ukraine.

Scientific hypothesis of this paper - the development of the e-commerce market will decrease unemployment rate and increase GDP per capita in Ukraine. Thus, the spread of e-commerce will help improve certain indicators of Ukraine's economic development.

Literature overview

The issue of e-commerce development and its impact on the economic development of countries is popular in Ukrainian and foreign scientific circles. Many scientific articles are devoted to the study of the peculiarities of the functioning of e-commerce and its diverse impact on economic indicators of countries.

In particular, Rana Deljavan Anvaria and Davoud Norouzib (2016) [3] investigated the relationship between e-commerce costs, research and development costs, health care costs, government size and economic development (GDP per capita based on purchasing power parity) in 21 selected countries. The results of their research showed that spending on e-commerce and research and development had a positive and long-term impact on GDP per capita based on the results of cointegration tests, but e-commerce had a stronger effect, contributing to economic development. In addition, other variables, such as government size and health care costs also had a positive impact on GDP per capita, which is effective for improving and growing the economies of the countries studied.

Elvis Mwenda KITHINJI and Perez A. ONONO (2020) [2] investigated the impact of e-commerce on output and overall factor productivity in Kenya. The results showed that e-commerce has had a positive impact on production in the country. The results suggest that continued investment in e-commerce in terms of capital and mobile payment technology will be important for Kenya to support output growth and factor productivity growth, which in turn will contribute to the country's economic development.

Tianqi Wang and Lijun Huang (2018) [4] conducted an empirical study of the relationship between investment in agricultural science and technology and economic growth in agriculture based on the e-commerce model. The results of the analysis showed that with the improvement of the level of agricultural e-commerce, the total factor productivity of agriculture will increase simultaneously. Thus, based on research, the authors believe that China still needs to adhere to the construction of agricultural informatization, improve the management mechanism of agricultural informatization, increase investment in agricultural science and technology, thereby further improving the level of economic development in China.

In addition, Jamal Hasan, Attila Póya and Pavol Kita (2016) [1] studied the impact of e-commerce on the economy, labor market and labor productivity in the Slovak Republic. The results of the study showed that e-commerce has a significant impact on the country's economy. On the one hand, it saves costs for consumers who buy online, as well as those companies that operate in this sales channel, it has been confirmed that e-commerce has a comprehensive economic impact on the economy. Another impact is the undeniable impact on employment. The authors thought that the use of e-commerce deploys the labor market, which also helps save labor costs. Increased productivity is another undoubted advantage of e-commerce for a company that uses this sales channel, according to a survey published by the authors.

Ukrainian scientists Zatonatska T. and Novosolova V. (2017) [6] also comprehensively studied the impact of e-commerce on economic development and economic growth in Ukraine and Poland. As a result, it was found that the spread of e-commerce reduces unemployment in Ukraine. In addition, the spread of e-commerce in Ukraine contributes to GDP growth per capita. It was proved that the parameters representing e-commerce in Poland have a greater impact on the economy of the studied European country compared to Ukraine. The comparison of the models confirmed the fact that e-commerce in Poland has reached the highest level of development.

In addition, Zatonatska T. (2018) [5] studied the models of analysis of the impact of e-commerce on the indicators of economic development of Ukraine, Poland, Austria. The results showed that the growth of online sales per capita contributes to lower unemployment in Ukraine and Poland, and in Austria, on the contrary, this phenomenon will increase this figure. Thus, the development of e-commerce in Ukraine and Poland will help create new jobs and increase employment, while in Austria the rapid growth of Internet transactions and automation of their processing will reduce it. In addition, it was determined that e-commerce affects the development of countries and contributes to the growth of gross domestic product in all three countries.

Methodology

To achieve the objectives set in the work, general scientific methods were used, namely: analysis and synthesis - in the study of input data characterizing the level of economic development of Ukraine and the level of e-commerce in Ukraine; historical and logical - for a comprehensive study and identification of patterns of development

of e-commerce in Ukraine; hypothetical method - for a clearer analysis of the impact of e-commerce indicators on the indicators of economic development of Ukraine, several hypotheses were put forward and tested; methods of statistical analysis - in the study of trends in e-commerce in Ukraine; economic-mathematical modeling (namely regression analysis) - in modeling the impact of e-commerce on economic development in Ukraine. In addition, the Cobb–Douglas production function was used to further analyze the impact of e-commerce on certain indicators of economic development in Ukraine.

Results

To study the impact of e-commerce on economic development in Ukraine, the time period from 2007 to 2019 was chosen. The construction of economic - mathematical models (regression analysis) was performed using the computer program Excel. For a comprehensive analysis there were the following time series: unemployment rate [13], GDP per capita [12], internet penetration rate (calculated as the share of the population using the Internet in the total population of the country) [10] [11], the volume of Internet trade [8] [14], the volume of retail trade [7] [9]. GDP per capita, the volume of Internet trade and the volume of retail trade are presented in million US dollars. Based on the above indicators, an additional indicator was calculated - the share of Internet retail trade. So, the unemployment rate, internet penetration rate and the share of Internet retail trade are presented in percentage. Then, based on the prepared input data, a regression analysis was performed to identify the relationship and interaction between e-commerce and indicators of economic development of Ukraine. The Cobb–Douglas production function was used for this purpose. As a result, two regression models were built to reflect the impact of e-commerce on indicators of Ukraine's economic development. The first economic-mathematical model reflects the dependence of the unemployment rate in the country on the volume of Internet trade and share of internet retail trade in Ukraine. Modifying the Cobb–Douglas production function receives a mathematical representation of the regression:

$$\ln(Unempl) = \ln(A) + \ln(Voit) + \ln(Soit)$$

where

$Unempl$- unemployment rate in Ukraine.

A- a stable indicator that reflects the unemployment rate in Ukraine without taking into account the impact of e-commerce factors.

$Voit$- volume of internet trade in Ukraine.

$Soit$ - share of internet retail trade in Ukraine.

After performing regression analysis in the computer program Excel, the results were obtained, as shown in Figure 1.

SUMMARY OUTPUT

Regression statistics

Multiple R	0,746070261
R square	0,556620835
Adjusted R-square	0,467945002
Standard error	0,103113319
Observations	13

ANOVA

	df	SS	MS	F	Significance F
Regression	2	0,133479235	0,066739618	6,27702967	0,017134696
Residual	10	0,106323566	0,010632357		
Total	12	0,239802801			

	Coefficients	Standard error	t Stat	P-Value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-1,153247725	1,038250958	-1,110760088	0,29266502	-3,466615023	1,16011957	-3,466615023	1,160119572
Volume of internet trade	-0,089199407	0,105822455	-0,842915689	0,41898015	-0,32498653	0,14658772	-0,32498653	0,146587715
Share of internet retail trade	0,187705652	0,081033326	2,31640068	0,04303578	0,007152149	0,36825915	0,007152149	0,368259155

Figure 1. Regression analysis of the impact of e-commerce indicators on the unemployment rate in Ukraine

Source: compiled by the author based on [7], [8], [9], [13], [14]

The obtained results indicate the presence of a significant impact of e-commerce on the unemployment rate. Mathematical representation of regression:

$$\ln(Unempl) = -1.153 - 0.089\ln(Voit) + 0.187\ln(Soit)$$

Namely, since the elasticity of the unemployment rate to the volume of internet trade is negative and is -0.089, it means that with the increase in the volume of internet trade there is a decrease in the unemployment rate, so there is an inverse relationship. At the same time, the elasticity of the unemployment rate to the share of Internet retail trade is positive and is 0.187, which means that with the increase in the share of Internet retail trade there is an increase in unemployment rate, so there is a direct relationship. This model is adequate, as evidenced by the value of R-square = 0.5566. The second economic-mathematical model reflects the dependence of the level of GDP per capita on the level of Internet penetration and the volume of Internet trade in Ukraine. Modifying the Cobb–Douglas production function we obtain a mathematical representation of the regression: $\ln(GDP) = \ln(A) + \ln(Intp) + \ln(Voit)$

where

GDP- GDP per capita

A- a stable indicator that reflects the level of GDP per capita in Ukraine without taking into account the impact of e-commerce factors

$Intp$ – internet penetration.

$Voit$- volume of internet trade in Ukraine.

After performing regression analysis in the computer program Excel, the results were obtained, as shown in Figure 2.

SUMMARY OUTPUT

Regression statistics

Multiple R	0,798613863
R square	0,637784102
Adjusted R-square	0,565340922
Standard error	0,140500337
Observations	13

ANOVA

	df	SS	MS	F	Significance F
Regression	2	0,347584907	0,173792453	8,803922	0,006235016
Residual	10	0,197403446	0,019740345		
Total	12	0,544988352			

	Coefficients	Standard error	t Stat	P-Value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	-11,80339711	1,462100109	-8,072906253	1,087E-05	-15,0611592	-8,5456351	-15,0611592	-8,54563505
Internet penetration	-0,658035111	0,158159211	-4,160586712	0,0019469	-1,01043579	-0,3056344	-1,01043579	-0,30563443
Volume of internet trade	0,740379519	0,181615257	4,076637241	0,0022263	0,335715509	1,1450435	0,33571551	1,145043528

Figure 2. Regression analysis of the impact of e-commerce indicators on the level of GDP per capita in Ukraine

Source: compiled by the author based on [8], [10], [11], [12], [14]

The obtained results indicate a significant impact of e-commerce on the level of GDP per capita. Mathematical representation of regression:

$$\ln(GDP) = -11.803 - 0.658\ln(Intp) + 0.740\ln(Voit)$$

Namely, since the elasticity of GDP per capita to the level of Internet penetration is negative and is -0.658, it means that with the increase in the level of Internet penetration there is a decrease in GDP per capita, so there is an inverse relationship. At the same time, the elasticity of the level of GDP per capita to the volume of Internet trade is positive and is 0.740, which means that with the increase in the volume of Internet trade there is an increase in the level of GDP per capita, so there is a direct relationship.

The overall effect of e-commerce factors on the level of GDP per capita can be determined by adding the coefficients of elasticity: $\alpha + \beta = -0.658 + 0.740 = 0.082$ Thus, there is a long-term positive effect of e-commerce indicators on GDP per capita. This model is adequate, as evidenced by the value of R-square = 0.6377.

Conclusions

In this paper, a study of the impact of e-commerce on economic development in Ukraine was carried out for which two economic-mathematical models based on the

Cobb–Douglas production function were built. The obtained results testified to the close interrelation and influence of e-commerce on the indicators of economic development of Ukraine. Namely: with the increase in volume of internet trade in Ukraine there is a decrease in unemployment rate; with the increase in volume of internet trade in Ukraine there is an increase in GDP per capita. Other simulation results are non-consistent with theoretical expectations, namely was discovered the positive relationship between the unemployment rate in Ukraine and the share of internet retail trade and the negative relationship between GDP per capita and the level of Internet penetration. However, these results can be explained by the fact that Ukraine's unemployment rate and GDP per capita are very complex indicators that depend on many factors, so building regression models based on only two independent variables may have some distorted results.

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