

UDC 338.2

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## **DIGITAL ECONOMY AS A FACTOR OF ECONOMIC DEVELOPMENT OF THE STATE**

**Abstract.** The article examines the role of the digital economy as a factor in the economic development of the state. It is established that the impact of the digital economy on the economic development of the state can be assessed based on its impact on macroeconomic indicators. To assess the impact of the digital economy as a factor in Ukraine's economic development, regression models of the impact of the digital economy on gross domestic product, inflation and the hryvnia exchange rate against the US dollar were built.

It is established that the development of IT services in Ukraine has an upward trend, the reliability of which is 96%. It is proved that the correlation between the growth dynamics of the volume of IT services provided in Ukraine and the gross domestic product is 79%. This proves the existence of a connection between the growth of gross domestic product and the development of the digital economy in Ukraine. The inverse influence of the development of the digital economy on the inflation rate in Ukraine is proved. The correlation between them is 67% and is negative, as the development of IT services helps to reduce inflation and maintain price stability. A low level of correlation between the volume of IT services in Ukraine and the dynamics of the hryvnia exchange rate against the US dollar was revealed. This is due to the fact that IT services are consumed by residents and lead to a direct inflow of foreign currency into Ukraine.

Testing of the models of the impact of the digital economy represented by IT services on the indicators of Ukraine's economic development has shown that IT services have a statistically significant impact on the inflation rate. It is established that the low impact of the digital economy on the gross domestic product in Ukraine is due to the small share of the digital economy. It is proved that with the increase of the share of digital economy its influence on the economic development of the state grows. Forecasting the trend values of economic development parameters showed that in the future the volume of IT services in Ukraine will increase, which will help maintain price stability and increase the volume of gross domestic product. Given the export of IT services, the digital economy will have a positive impact on the strengthening of the hryvnia against the US dollar.

**Keywords:** digital economy, economic development, GDP, inflation, exchange rate.

**JEL Classification** O33, O40, O44

Formulas: 4; fig.: 4; tabl.: 3; bibl.: 15.

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## ЦИФРОВА ЕКОНОМІКА ЯК ФАКТОР ЕКОНОМІЧНОГО РОЗВИТКУ ДЕРЖАВИ

**Анотація.** Досліджено роль цифрової економіки як фактору економічного розвитку держави. Установлено, що вплив цифрової економіки на економічний розвиток держави можна оцінити виходячи з її впливу на макроекономічні показники. Для оцінки впливу цифрової економіки як фактору економічного розвитку України побудовано регресійні моделі впливу цифрової економіки на валовий внутрішній продукт, темп інфляції та обмінний курс гривні щодо долара США.

Установлено, що розвиток ІТ-послуг в Україні має висхідний тренд, надійність якого становить 96 %. Доведено, що кореляція динаміки зростання обсягу наданих ІТ-послуг в Україні та валового внутрішнього продукту становить 79 %. Це доводить існування взаємозв'язку зростання валового внутрішнього продукту і розвитку цифрової економіки в Україні. Доведено обернений вплив розвитку цифрової економіки на темпи інфляції в Україні. Кореляція між ними становить 67 % і має від'ємне значення, оскільки розвиток ІТ-послуг сприяє зменшенню темпів інфляції та забезпечує підтримання цінової стабільності. Виявлено низький рівень кореляції між обсягом ІТ-послуг в Україні та динамікою обмінного курсу гривні щодо долара США. Це зумовлено тим, що ІТ-послуги споживаються резидентами і призводять до безпосереднього припливу іноземної валюти в Україну.

Тестування моделей впливу цифрової економіки, що представлена ІТ-послугами, на показники економічного розвитку України показало: статистично значимий вплив ІТ-послуги мають на темп інфляції. Установлено, що низький вплив цифрової економіки на валовий внутрішній продукт в Україні зумовлений малою часткою цифрової економіки. Доведено, що зі збільшенням питомої ваги цифрової економіки її вплив на економічний розвиток держави зростає. Прогнозування трендових значень параметрів економічного розвитку показало, що в майбутньому в Україні зростатиме обсяг ІТ-послуг, а це сприятиме підтриманню цінової стабільності та зростанню обсягу валового внутрішнього продукту. За умови експорту ІТ-послуг цифрова економіка здійснюватиме позитивний вплив на укріплення гривні щодо долара США.

**Ключові слова:** цифрова економіка, економічний розвиток, ВВП, інфляція, обмінний курс.

Формул: 4; рис.: 4; табл.: 3; бібл.: 15.

**Introduction.** The digitalization of social life inevitably affects economic transformations. The development of telecommunication technologies and the Internet makes it possible to significantly reduce the transaction costs of businesses to conduct their activities. In addition, the digital transformation of business processes makes it possible to increase the efficiency of their execution and reduce the number of errors resulting from the human factor. The issue of digital transformation became especially relevant in the context of the coronavirus pandemic when the established restrictions had a significant impact on the possibility of direct contact between people. Under these conditions, the digital economy, represented by various types of transactions, which, however, take place in an electronic environment, began to actively develop. In this aspect, the question of the role of the digital economy as a factor in the economic development of the state requires more detailed attention and study.

**Study analysis and problem statement.** The study of the impact of the digital economy on the economic development of the state is relevant, and therefore there are many studies devoted to this issue. For example, Afonasova, Panfilova, Halichkina and Sliusarchuk [1] argue that the economic system of the state can benefit from the development of the digital economy only with wide access to quality Internet. Therefore, in order to obtain a positive effect, it is first necessary to invest resources in the formation of quality infrastructure.

Kravchenko, Leshchenko, Marushchak and Vdovychenko [2] conclude that the degree of digitalization and development of the digital economy have different options for evaluation. On this basis, it is difficult to objectively assess the degree of development of the digital economy, but this does not cast doubt on the positive effect on the development of the state economy as a whole. The authors found that there is a positive relationship between the level of investment in the development of the digital economy and the macroeconomic indicators of state development.

Interesting is a study by Sausen [3] on the challenges and opportunities of digitalization of the economy in Africa. It was found that digitalization in the banking sector is being implemented at a fast pace, while in the industrial and agricultural sectors, the process is lagging far behind. Arsakaiev and Khatsiieva [4] argue that the development of the digital economy should be based on the development of digital platforms. The use of common digital platforms at the level of the national economy will reduce the cost of business to develop digital solutions and unify consumer access to the consumption of digital services. As a result, the efficiency of the state economy and business in particular will increase significantly.

Separately, it should be noted about the study of the impact of the digital economy on sustainable development [5]. The development of the digital economy requires a significant amount of computer technology, but as a result of improving the efficiency of business processes, the quality of economic life is also increasing. According to the authors of the study, the development of the digital economy can ensure the sustainable development of all mankind. The most dynamically developing digital economy in the countries of the Eurasian Economic Union, where, according to the authors of the study [6], the need for the convergence of the economies of the member countries of the Union determines the super-fast development of the introduction of information technologies in economic life. As a result, the cumulative effect of the impact of the digital economy on the development of the countries, which in turn more actively stimulate the development of the digital economy.

The digital economy significantly stimulates business development by reducing transaction costs, as noted in the study [7]. This ensures the formation of an institutional environment in which cost optimization reaches its maximum positive effect. The analysis of studies has shown that the digital economy is the subject of many scientific studies. However, the impact of the digital economy on the economic development of the state does not have a certain established approach to definition. This issue is extremely important for understanding the effects of the impact and assessing the development of the national economy as a whole.

Nachit and Belhcen [10] note that during the pandemic there is a transition to the digital environment. This is also relevant for Ukraine, because it was during the pandemic that the provision of IT services in Ukraine continued to grow, and companies massively implemented

digital platforms for their activities. Latin American countries also saw a decrease in GDP, exports, and other macroeconomic indicators during the pandemic [11].

Researchers on the impact of the digital economy on economic development in Thailand [12] concluded that the degree of influence depends on the size of the digital economy, which will grow over time, and therefore the direct impact of the digital economy on economic development will grow. This position is confirmed by the results of a study on the impact of the digital economy on the economic development of the G20 countries [13]. The authors of the study argue that the digital economy simplifies and increases the flow of data and information. This, in turn, has a positive impact on the economic activity of business through the development and implementation of appropriate policies at the state level. In addition, as the team of authors [14] emphasizes, outsourcing is becoming a key business model for non-core tasks in the future. This will become a defining feature of the digital business environment in the dynamic development of the digital economy [15].

The purpose of the article is to investigate the impact of the digital economy on the economic development of the state. The study will be conducted on the example of the economy of Ukraine. The article plans to: investigate the role of digital economy as a factor of economic development of the state; establish the factors of influence of digital economy on the economic development of the state, define them; simulate the model / models of the influence of digital economy the main economic indicators: gross domestic product, inflation rate and the exchange rate of the hryvnia against the US dollar; test models of the influence of digital economy, represented by IT services of Ukraine.

**Study methodology and methods.** In our study, we assume that the development of the digital economy contributes to the reduction of transaction costs for businesses and the population. As a result, the economic activity of business increases, which leads to an increase in the volume of the produced aggregate product. Economic growth increases the volume of exports, which has a positive impact on the exchange rate and the inflation rate. The development of the digital economy is directly linked to an increase in IT services in the economy. To achieve the goals of our study, we consider the following model:

$$ED = f(GDP, IR, ER_{UAH/USD}), \quad (1)$$

where  $ED$  — economic development of the state;  $GDP$  — gross domestic product;  $IR$  — inflation;  $ER_{UAH/USD}$  — exchange rate of hryvnia to US dollar.

In turn, we consider the main indicators of economic development of the state depending on the development of the digital economy:

$$GDP = f(DE), \quad (2)$$

$$IR = f(DE), \quad (3)$$

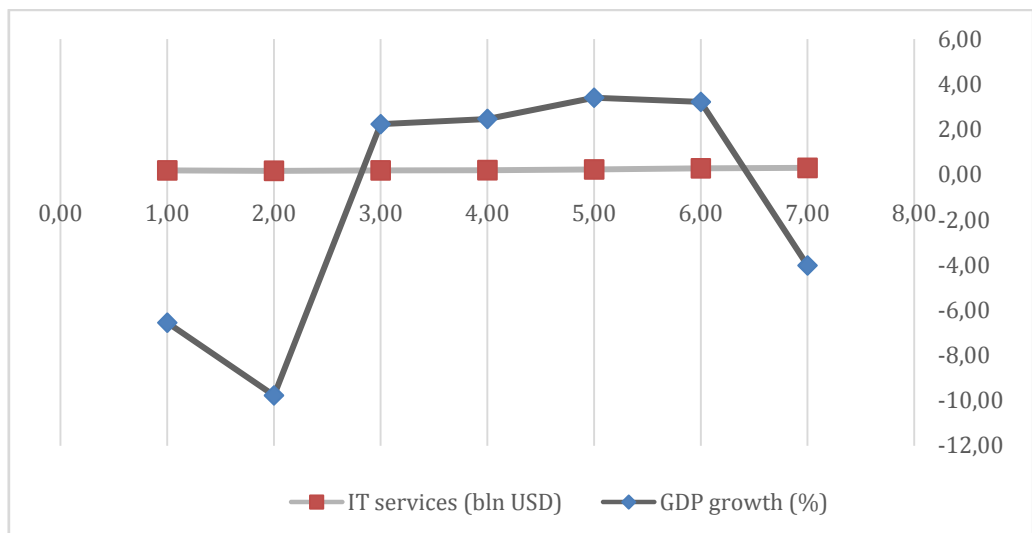
$$ER_{UAH/USD} = f(DE), \quad (4)$$

where  $DE$  — digital economy.

To determine the impact of the digital economy on the indicators of economic development of the state, we use the method of correlation and regression. Because the values of all parameters of the models in the current period depend on their values in the previous period, all data will be presented as a time series. Information about the development of the digital economy in Ukraine as the volume of IT services, obtained from the Report on the development of the IT industry [8]. Data on the parameters of economic development are taken from the World Bank public data [9]. All calculations and graphs construction will be made in Microsoft Excel software product.

**Study results.** Let us analyze the dynamics and development trend of the main indicators of our model.

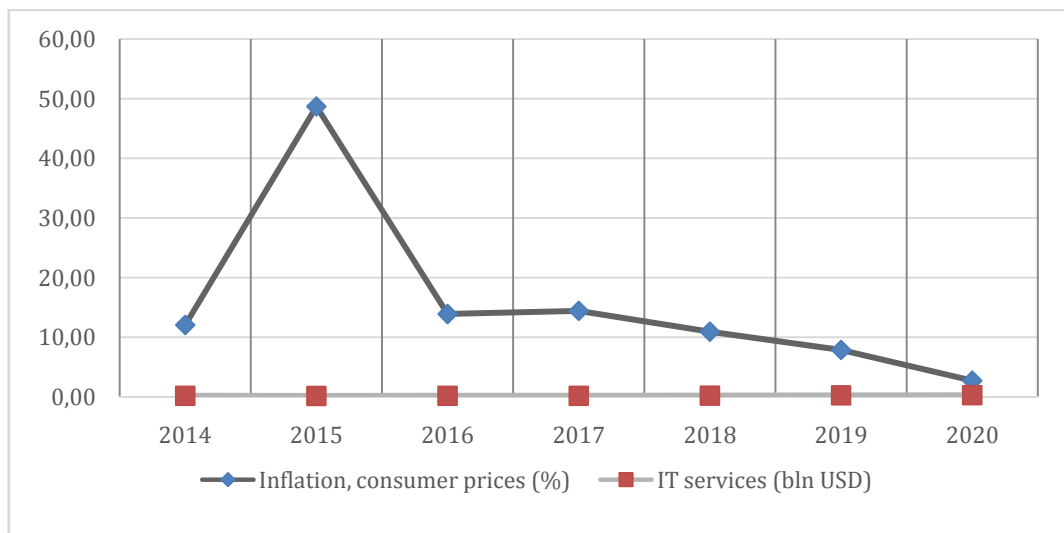
*Fig. 1* shows the dynamics of GDP in Ukraine and the development of IT services in the period 2014—2020.



**Fig. 1. Dynamics of GDP and volume of provided IT services in Ukraine**  
 Source: the author(s)' own calculations.

The development of IT services in Ukraine has a clear upward trend. The reliability of the trend is 96%, which is a high value. In turn, the dynamics of GDP values of Ukraine has an upward trend in the period 2015—2019, after which there is a negative trend due to the global economic downturn due to the coronavirus pandemic. Taking this into account, the reliability of the trend is 67%. The analysis showed that the correlation between the development of IT services and the dynamics of GDP is 31%. In general, this is a rather low value, but if we exclude from the calculations the period of 2014, which accounts for the annexation of Crimea and eastern regions of Ukraine, and 2019—2020, which accounts for the global economic downturn due to lockdowns, the correlation coefficient is 79%. This figure is quite high and indicates a direct link between the development of the digital economy and the economic development of the national economy of Ukraine.

Fig. 2 shows the dynamics of the development of IT services in Ukraine and the inflation rate.



**Fig. 2. Dynamics of inflation and volume of provided IT services in Ukraine**  
 Source: the author(s)' own calculations.

The data in Fig. 2 indicate an upward trend in the volume of IT services provided and a downward trend in the rate of inflation. The downward slope of the inflation rate curve is positive and characterizes the reduction of inflation in Ukraine, which indicates the achievement of price stability. The reliability of the trend of inflation values is 36%, but this is due to the peak of inflation in 2015. Starting from 2016, there is price stability. The correlation coefficient of the

volume of provided IT services and inflation in Ukraine has a negative value and is -67%. This indicates a positive impact of the development of the digital economy on price stability.

Fig. 3 shows the data on the volume of provided IT services and the exchange rate of the hryvnia against the U.S. dollar.

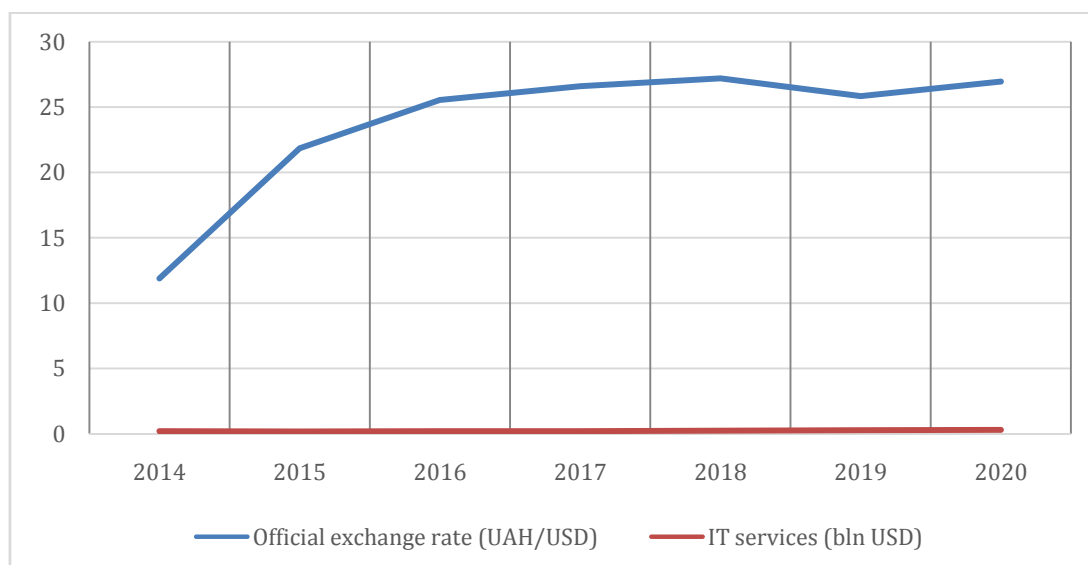


Fig. 3. Dynamics of exchange rate and volume of provided IT services in Ukraine

Source: the author(s)' own calculations.

The data in Fig. 3 shows the consistency of the dynamics of the digital economy and the exchange rate. At the same time, there is a gradual decrease in the growth rate of the exchange rate, which corresponds to the strengthening of the hryvnia and the dynamics of the development of the digital economy. The reliability of the trend of the exchange rate is 91%, and in the development of IT services is 96%. The correlation coefficient is 46%, but such a low value is due to the fact that not all services are exported and as a result cause the receipt of foreign currency. The services consumed by residents do not directly affect the exchange rate but have a positive impact on the economic development of the state.

To determine the extent to which the development of the digital economy affects the economic development of the state, we built and tested regressions of influence. Table 1 shows the results of testing the impact of the digital economy on Ukraine's GDP in the period 2014—2020.

Table 1

**A model of the impact of the digital economy on Ukraine's GDP**

	Coefficient	Std. Error	t-ratio	p-value
const	-8.85152	10.5695	-0.8375	0.4405
IT services	33.9376	46.4525	0.7306	0.4978
Mean dependent var	-1.288290		S.D. dependent var	5.416698
Sum squared resid	159.0635		S.E. of regression	5.640275
R-squared	0.096454		Adjusted R-squared	-0.084255
F(1, 5)	0.533755		p-value (F)	0.497813
Log-likelihood	-20.86445		Akaike criterion	45.72889
Schwarz criterion	45.62071		Hannan — Quinn	44.39181
rho	0.272865		Durbin — Watson	1.264289

Source: the author(s)' own calculations.

The data in *Table 1* indicate that the development of the digital economy on GDP of Ukraine has no statistically significant effect. According to this model, the  $p$ -value is 0.4978, and the reliability of the model is 8%. These results can be explained by the fact that GDP is influenced by many factors, and the development of the digital economy is not the most significant of them. In addition, two types of external shocks influenced the dynamics of GDP during the period under consideration, which significantly distorts the measurement of the effect of the digital economy. The first external shock is the military actions in the east of Ukraine, and the second one is the decline of the world economy as a result of the pandemic, which significantly affected the dynamics of Ukraine's GDP.

In this regard, it is reasonable to analyze the effect of the digital economy on other indicators, in particular the rate of inflation (*Table 2*).

Table 2

**Model of the Influence of the Digital Economy on Inflation in Ukraine**

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	61.4380	22.8080	2.694	0.0431	**
IT services	-204.726	100.240	-2.042	0.0966	*
Mean dependent var	15.81340			S.D. dependent var	15.04770
Sum squared resid	740.6867			S.E. of regression	12.17117
<i>R</i> -squared	0.454816			Adjusted <i>R</i> -squared	0.345779
F(1, 5)	4.171213			$p$ -value (F)	0.096579
Log-likelihood	-26.24841			Akaike criterion	56.49681
Schwarz criterion	56.38863			Hannan — Quinn	55.15973
rho	-0.478810			Durbin — Watson	2.790228

*Source:* the author(s)' own calculations.

The data in *Table 2* indicate that the digital economy is a statistically significant regressor of the inflation rate in Ukraine in the 90% confidence interval. At the same time, the growth of IT services leads to a decrease in the rate of inflation, as the coefficient of influence has a negative value. This result is explained by the fact that the development of the digital economy stimulates the growth of aggregate output of the national economy. This, in turn, leads to an increase in the demand for money to service additional output. With the volume of money supply unchanged, the market is counterbalanced by an increase in the velocity of money rotation, which has a positive effect on reducing inflation.

*Table 3* presents the results of testing the model of the impact of the digital economy on the exchange rate of the hryvnia against the U.S. dollar.

Table 3

**A model of the impact of the digital economy on the exchange rate in Ukraine**

	<i>Coefficient</i>	<i>Std. Error</i>	<i>t-ratio</i>	<i>p-value</i>	
const	12.2381	10.0322	1.220	0.2769	
ITservices	51.4204	44.0911	1.166	0.2961	
Mean dependent var	23.69756			S.D. dependent var	5.511856
Sum squared resid	143.3023			S.E. of regression	5.353547
<i>R</i> -squared	0.213849			Adjusted <i>R</i> -squared	0.056618
F(1, 5)	1.360098			$p$ -value (F)	0.296117
Log-likelihood	-20.49923			Akaike criterion	44.99846
Schwarz criterion	44.89028			Hannan — Quinn	43.66138
rho	0.137270			Durbin — Watson	1.008065

*Source:* the author(s)' own calculations.

The results of the conducted regression testing show that the digital economy has no statistically significant effect on the exchange rate. This is due to the fact that IT services are consumed by residents. As a result, there is no inflow of foreign currency into the national economy. However, it has a positive effect on the formation of the digital infrastructure of the national economy, which is converted into increased productivity.

The results of model testing show that the impact of the digital economy on the economic development of the state is still small, but positive. Currently, the volume of digital services is relatively small compared to other sectors of the economy. In order to assess the possible impact of the digital economy in the future, we will conduct modeling of the forecast trends of the digital economy development and indicators of economic development of Ukraine (*Fig. 4*).

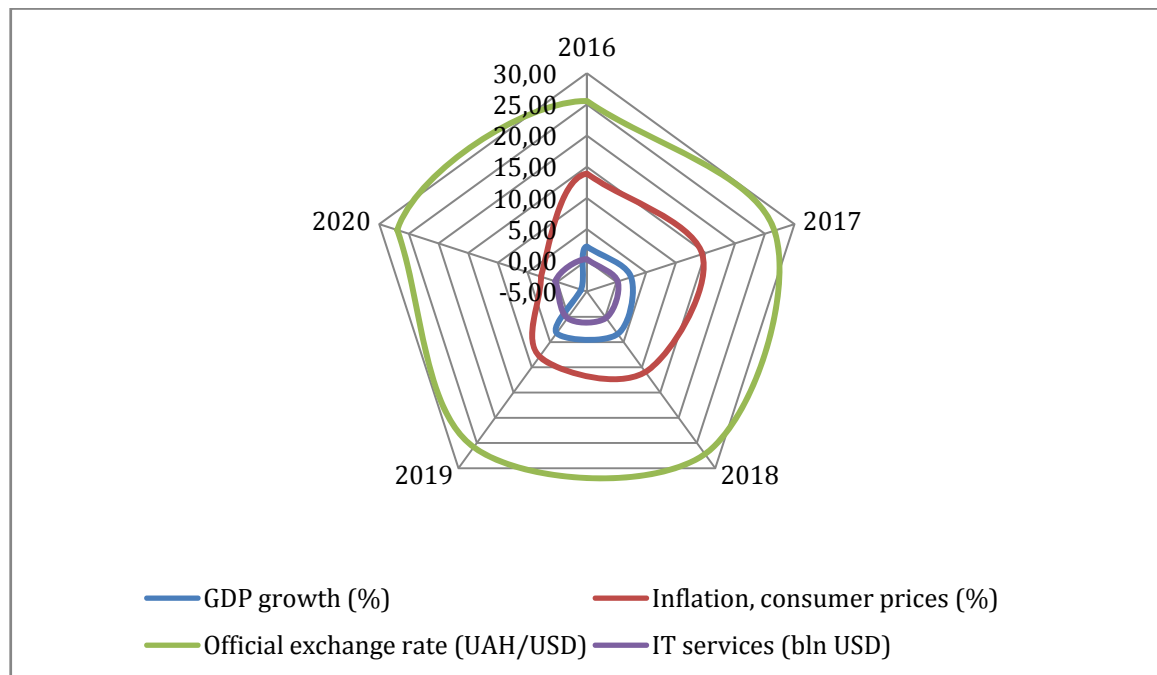


Fig. 4. Forecast dynamics of IT services in Ukraine and economic development of Ukraine  
 Source: the author(s)' own calculations.

The data in *Fig. 4* indicates that the digital economy in Ukraine will continue to develop, as evidenced by the rapid projected growth of IT services. In turn, this will strengthen price stability, which is the main prerequisite for real GDP growth and the strengthening of the hryvnia against the US dollar. It should be noted that economic development depends on many factors and the larger the volume of digital economy will become, the greater will be its impact on the economic development of the state.

**Discussion.** The results of our study indicate the growing role of the digital economy in the economic development of the state. This is confirmed by the forecasted growth trend of IT services in Ukraine. Our results show that the digital economy can help to reduce the rate of inflation, which is the main threat of crisis phenomena. In addition, if the export of IT services is increased, it can have a positive impact on the balance of payments and the exchange rate, which in small open economies are highly dependent on the trends of foreign markets. At the same time, we found that the digital economy has so far had little, though positive, impact on economic development.

Thus, our results confirm the results of other studies. In addition, our study analyzes in detail the impact of the digital economy in the context of the main indicators of economic development — GDP, inflation, and the exchange rate. Our findings open up opportunities for new research, in particular, the impact of the digital economy on labor productivity, which is a determinant of real income growth in the economy.

We predict that rising incomes will lead to a change in the consumption-savings ratio. In turn, savings due to the transformation into investment will ensure the economic development of the

state and will further deepen the digitalization and development of the digital economy. In this context, our study is only a starting point and may be the beginning of a new layer of scientific development, in which we see a further perspective.

**Conclusions.** The study of the impact of the digital economy on the economic development of the state leads to the following conclusions. The development of the digital economy creates prerequisites for the transformation of approaches to doing business and the expansion of companies' presence in the digital environment. Pandemic constraints have intensified the development of the digital sector of the Ukrainian economy, which is manifested in the increase in the volume of IT services.

It is established that the digital economy has a positive impact on the dynamics of inflation in Ukraine. However, the relatively low volume of the IT services market in the structure of the Ukrainian economy does not yet lead to a statistically significant impact on economic development. At the same time, modeling of forecast values showed that the volume of IT services in Ukraine will continue to grow. This will ensure an increase in aggregate output and increase the share of the digital economy in the structure of the national economy of Ukraine. This, in turn, will ensure the strengthening of the influence of the digital economy on the economic development of the state.

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Статтю рекомендовано до друку 15.12.2021

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The article is recommended for printing 15.12.2021

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