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MODELLING THE DEVELOPMENT OF EU DIGITAL BUSINESS

Abstract. *The article deals with identifying and studying factors influencing the formation and development of digital business according to correlation analysis in order to simulate its development. It proves the relationship between digital business, imports of goods and services and employment rate. The model of digital business development is created. Excluding factors with low correlation based on Pearson's coefficient and multicollinear factors, the authors create a two-factor model of digital business development. Using trend forecast values of the chosen factors, digital business development forecast is carried out. Autocorrelation of residuals is detected and the simulation modelling is performed.*

Keywords: *digital business, electronic business, electronic trading, electronic commerce, the Internet*

Introduction. Nowadays, digital business is still in an active phase of its development. Financial and economic transactions are mostly conducted via the Internet. All business processes have become an integral part of the virtual sphere. There is an increase in the competitiveness of the company by reducing costs for business organization, advertising and promotion of goods (services), customer services, communication support, reducing time spent on interaction with customers and business partners, expanding pre- and after-sales support. Small and medium-sized enterprises compete successfully in the global market, and consumers have an opportunity to get wider access to goods and services without any obstacles, like geographical boundaries, time constraints, weekends or holidays. Furthermore, the cost and speed of access to the information does not depend on the distance to its source. Today, personalization of interaction through information networks is also widespread. Enterprises receive detailed information from each client and automatically offer goods and services at

mass market prices. Digital technologies cause changes in infrastructure by decreasing a part of material infrastructure (buildings, structures) or its complete elimination, reducing number of staff or intermediaries. One of the important and topical issues is creating new digital products and services, such as electronic communication, digital advertising, cybersecurity, etc.

In the European Union digital business plays an important role in its citizens' lives. Thus, electronic sales (e-sales) increased by 31%[1] during the Covid 19 pandemic. The development of digital business has become an important deterrent factor to the epidemic, as it has allowed the population to refrain from social contacts and get all necessary goods online.

The increase of online sales in terms of selected countries of the European Union in 2016 and 2020 is considered and presented in Figure 1.

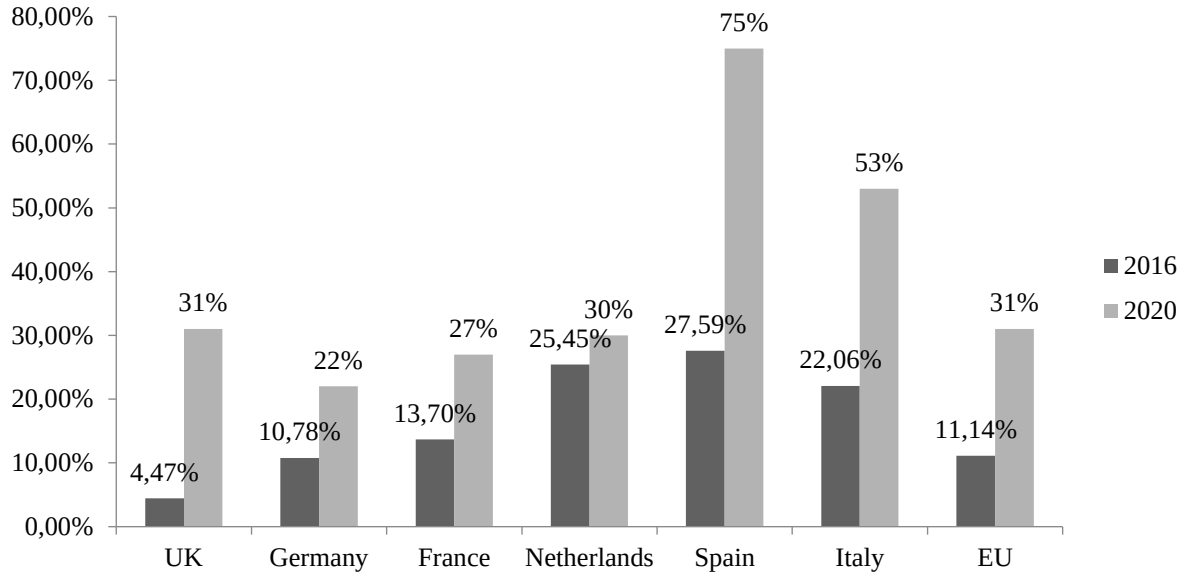

Figure 1. Growth of e-sales in the European Union countries in 2016 and 2020, %.
Note: based on data from [11]

Being among the countries the most affected by the virus, Spain with a growth rate of e--sales of 75% and Italy with a rate of 53% are the leaders in the region. The data proves that Covid 19 has become a natural factor in the development of digital business under European integration conditions. It is necessary that the factors of sustainable development of digital business in the context of European integration be identified.

Analysis of the recent research. Leading foreign and national scientists studied the development of digital business. The nature of digital business is considered as the Internet--interactive and network connection among producers, consumers and service providers

[1] https://www.statista.com/topics/3792/e-commerce-in-europe/ [Access: March 28, 2021]

[Castells 2001, p. 58]. In accordance with the definition of Gartner Inc, that is a leading global research and advisory firm, digital business is the creation of new business designs by blurring the digital and physical worlds [Gartner Inc 2014]. Additionally, digital business is considered as changing the ways of organizing and designing technology, its transition from a supporting player to a leading one in the field of innovation, revenue and market growth. On the other hand, digital business is a rapid change in the business world caused by the Internet providing new and diverse ways of trading [Cunningham, Fröschl 1999, p. 48]. Increasing competitiveness by implementing innovative digital technologies in an organization and beyond it, through linking to partners and customers and promoting via digital mass media is also a digital business [Chaffey 2001, p. 36].

The leading and prominent Ukrainian scientists have studied the modelling of digital business impact on economic growth indicators. It is defined that the growth of Internet sales per capita affects the development of countries and GDP growth, as well as fosters unemployment reduction in Ukraine and Poland [Zatonatska 2018, p. 52]. Regarding the risks which are in the digital market, the circulation of crypto currencies is considered as a source of fictitious capital; it is necessary to define the model of market regulation at the legislative level [Zahorodnii, Partyn 2018, p. 65].

Economists are increasingly applying simulation modelling as a method which allows us to create process models that describe how these processes would actually take place. Simulation modelling is based on the game theory and is a series of numerous experiments by which it is possible to obtain an empirical estimation of the degree of various factors (initial values) impact on some dependent results [Havrylenko, Shumeiko 2007, p. 211]. Regarding the rapid development of digital technologies and the digital transformation of the economy as a whole, we believe that implementation of simulation modelling of digital business development is one of the important and urgent tasks for today.

The aim of the article is to define factors of digital business development, to create a digital business model depending on the chosen factors, to make forecast of this development and simulation of the results.

Methodology of the given research is based on the scientific and verification principles, comparative, structural and systems analysis. Applying economic and mathematical methods, we have studied the correlation between digital business and the main factors influencing it. Using Excel and SPSS Statistic, the strength of the correlation between the feature of the result and the impact factors by the Pearson, Kendall and Spearman coefficients is conducted and

estimated. The software is used to create a model and evaluate its adequacy. Research proves that factors influence the development of digital business.

Results of the research. For modelling the development of EU digital business[2], it has been analyzed 19 social and economic factors[3,4], that may have influence on digital business (Table 1).

Table 1

The set of social and economic factors of the development of EU digital business

Indicator	Name of indicator
Y	Volume of EU e-commerce in the B2C segment, billion euros
X_1	The level of Internet accessibility of households, %
X_2	Using the Internet by individuals, %
X_3	Individuals using the Internet for selling goods or services, %
X_4	Individuals using the Internet for Internet banking, %
X_5	Individuals using the Internet for ordering goods and services, %
X_6	Individuals using the Internet for ordering goods and services from other EU countries, %
X_7	Individuals using the Internet for taking online-courses, %
X_8	Businesses received orders via the Internet (at least 1%), %
X_9	The share of business turnover in the field of e-commerce, %
X_{10}	Businesses using software solutions like CRM analyze customer information for marketing goals, %
X_{11}	EU GDP, trillion dollars
X_{12}	Exports of goods and services in % GDP
X_{13}	Imports of goods and services in % GDP
X_{14}	Employment rate, %
X_{15}	Gross domestic expenditure on R&D
X_{16}	Resource productivity
X_{17}	Real GDP per capita, euros
X_{18}	Convergence indicators
X_{19}	Population size, million people

Note: own authors' analysis

Establishing correlations is the first step in analyzing the factors influencing the volume of EU digital business. We have to consider the indicators of correlation between the independent factors and the volume of digital business (Table 2).

[2] https://ecommerce-europe.eu/ [Access: March 28, 2021]
[3] https://ec.europa.eu/eurostat/data/database [Access: March 28, 2021]
[4] https://datacatalog.worldbank.org/ [Access: March 28, 2021]

Table 2

Indicators of correlation between the volume of EU digital business and investigated factors

Factor	Pearson's correlation	Kendall's tau-b	Spearman's rho
	Y		
X1	0,986	1,000	1,000
X2	0,992	1,000	1,000
X3	0,814	0,744	1,000
X4	0,986	0,991	0,858
X5	0,993	1,000	0,998
X6	0,989	1,000	1,000
X7	0,207	0,117	1,000
X8	0,971	0,867	0,005
X9	0,922	0,828	0,938
X10	-0,062	0,062	0,929
X11	0,058	0,164	-0,057
X12	0,907	1,000	0,227
X13	0,843	0,807	1,000
X14	0,861	0,574	0,902
X15	0,486	0,917	0,763
X16	0,960	0,855	0,980
X17	0,945	0,927	0,955
X18	-0,401	-0,200	0,973
X19	0,975	0,964	-0,345

Note: finalized by authors on the basis of data [4, 5, 12]

According to the results of the correlation analysis, there is a strong relationship between the digital business and most of the chosen factors. The factors X_1, X_2, X_4, X_5, X_6, X_8, X_9, X_{12}, X_{16}, X_{17}, X_{19} are characterized by the highest correlation coefficient with Y. Considering the Pearson's correlation indicator, there is no correlation between the dependent variable and the X_{10}, X_{11} factors. Consequently, these factors can be excluded from the research. The further task is to study the correlation between the independent variables (Table 3).

Table 3

Correlation matrix

X	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}	X_{18}	X_{19}
X_1	1,00																
X_2	0,99	1,00															
X_3	0,88	0,85	1,00														
X_4	0,98	0,99	0,79	1,00													
X_5	0,99	0,99	0,83	0,99	1,00												
X_6	0,97	0,99	0,77	0,99	0,99	1,00											
X_7	0,20	0,19	0,34	0,25	0,23	0,17	1,00										
X_8	0,94	0,95	0,75	0,93	0,95	0,95	0,11	1,00									
X_9	0,93	0,93	0,78	0,92	0,93	0,92	0,22	0,94	1,00								
X_{12}	0,96	0,94	0,94	0,91	0,93	0,89	0,25	0,86	0,91	1,00							
X_{13}	0,90	0,89	0,91	0,87	0,88	0,83	0,29	0,78	0,88	0,98	1,00						
X_{14}	0,78	0,82	0,55	0,82	0,83	0,84	0,22	0,89	0,83	0,66	0,60	1,00					
X_{15}	0,54	0,53	0,35	0,55	0,55	0,58	-	0,39	0,42	0,50	0,50	0,12	1,00				
X_{16}	0,96	0,95	0,83	0,95	0,95	0,92	0,26	0,94	0,90	0,90	0,82	0,80	0,37	1,00			
X_{17}	0,93	0,95	0,70	0,97	0,96	0,97	0,15	0,90	0,91	0,86	0,85	0,83	0,60	0,85	1,00		
X_{18}	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1,00	
X_{19}	0,95	0,96	0,74	0,96	0,97	0,98	0,13	0,96	0,91	0,84	0,77	0,87	0,52	0,91	0,93	-	1,00

Note: finalized by authors on the basis of data [4, 5, 12]

The results to emerge from the correlation analysis enabled us to state that most of the factors are characterized by a high degree of correlation:

1) X_1 has a strong correlation with X_2, X_4, X_5, X_6, X_8, X_9, X_{12}, X_{13}, X_{16}, X_{17} and X_{19}, indicating the relationship between these factors and their influence on each other;
2) X_2 has a strong correlation with X_4, X_5, X_6, X_8, X_9, X_{12}, X_{16}, X_{17}, X_{19};
3) a high correlation is observed between X_3 and X_{12}, X_{13};
4) there is a high degree of correlation between X_4 and X_5, X_6, X_8, X_9, X_{12}, X_{16}, X_{17}, X_{19};
5) regarding X_5, it is observed a strong correlation with the factors X_6, X_8, X_9, X_{12}, X_{16}, X_{17}, X_{18};
6) X_6 depends on factors X_8, X_9, X_{16}, X_{17}, X_{19};
7) X_8 significantly correlates with X_9, X_{16}, X_{17}, X_{19};
8) there is also a strong correlation between factors X_9 and X_{12}, X_{16}, X_{17}, X_{19};
9) it is found out a close correlation between factors X_{12} and X_{13}, X_{16};
19) a high correlation reveals between such factors as X_{19} and X_{16}, X_{17};
11) X_{18} factor correlates with all investigated indicators;
12) inverse correlation is characteristic of such pairs of factors as X_{14} with X_{16}, and X_{15} with X_7.

Further investigation of the model for collinearity shows that most of the factors are multicollinear with each other. For creating the model we have chosen X_{13} and X_{14} factors. The results of regression analysis can be seen in Tables 4 and 5.

Table 4
Regression analyses results

Model	R	R-square	Standard error	F	Regression	Residual	Durbin–Watson
Linear	0,954	0,910	0,12668	40,559	2	8	2,212

Note: based on authors' calculations

The presented regression model has a high correlation and determination coefficient that confirms the factors chosen for creating the model. As far as Fisher's correlation coefficient is higher than the critical value, it has been confirmed that the model is adequate. The Durbin--Watson autocorrelation indicator is within limits [2; 2,396] at a significance level of d = 0.05, which indicates that there is no autocorrelation in the model.

Table 5
Regression analyses results

	Coefficients	*Standard error*	*t-statistics*	*P-value*	*Lower 95%*	*Upper 95%*
Y-intercept	-9,15984	1,422261	-6,44033	0,0002	-12,4396	-5,8801
Goods and services imports, X_{13}	2,85873	0,736557	3,881206	0,004667	1,160226	4,557234
Employment rate, X_{14}	7,301105	1,731515	4,2166	0,002929	3,308225	11,29398

Note: based on authors' calculations

It is crucial to note that the value of the t-criteria exceeds the t-critical and this finding lets us assume with a probability of 95% that the parameters of the model are statistically significant. The P-value is below 0,005, so if we accept the previous assumption, we risk making a mistake of less than 0,5%. At a significance level of 95%, the confidence interval for the free regression parameter is [-12,44; -5,88], for X_{13} [1,16; 4,56], for X_{14} [3,31; 11,29].

As a result, we obtain the dependence described by the following equation:

$$Y=-9,16+2.86\ X_{13}+7,30X_{14.}$$

An increase of EU imports by 1% leads to an increase in the volume of EU digital business in the B2C segment by 2,86%, and an increase in the employment rate of the EU population by 1% leads to an increase in the volume of EU digital business in the B2C segment by 7.3%.

The collinearity diagnostics is presented in Table 6.

Table 6

Collinearity diagnostics results

X	Correlation			Collinearity statistics	
	Zero-order	Partial	Component	Tolerance	VIF
X_{13}	0,843	0,808	0,411	0,645	1,550
X_{14}	0,861	0,830	0,447	0,645	1,550

Note: based on authors' calculations

The collinearity diagnostics indicates the absence of multicollinearity in the model, because VIF<10, therefore, the regression model is acceptable for further interpretations. Additionally, in the model the correlation between Y and X_{13}, X_{14} is approximately the same and it is 0,843 for X_{13}, and 0,861 for X_{14}.

The further part of our paper deals with studying dynamics of imports of EU goods and services in % to GDP[3] in the period from 2009 to 2019 that is presented in Fig. 2.

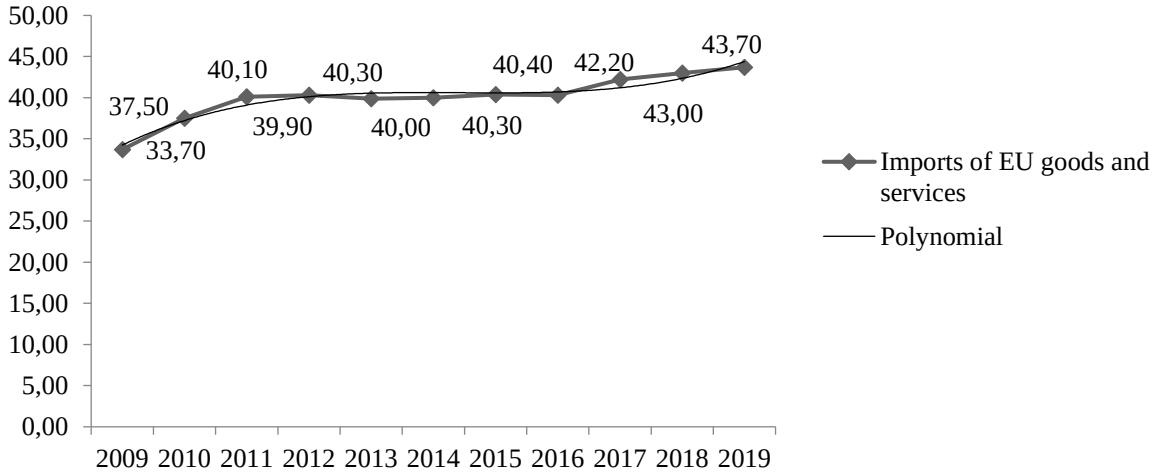

Figure 2. Dynamics of EU goods and services imports in % to GDP from 2009 to 2019

Note: data are from [5]

The imports of EU goods and services have increased by 29.67% during the analyzed period that shows goods and services market openness to the neighbouring countries of the European Union. The dynamics of changes in imports of goods and services is accurately described by a polynomial function.

The dynamics of employment rate in the EU[3] in % (age group 20-64) in the period from 2009 to 2019 can be seen in Fig. 3.

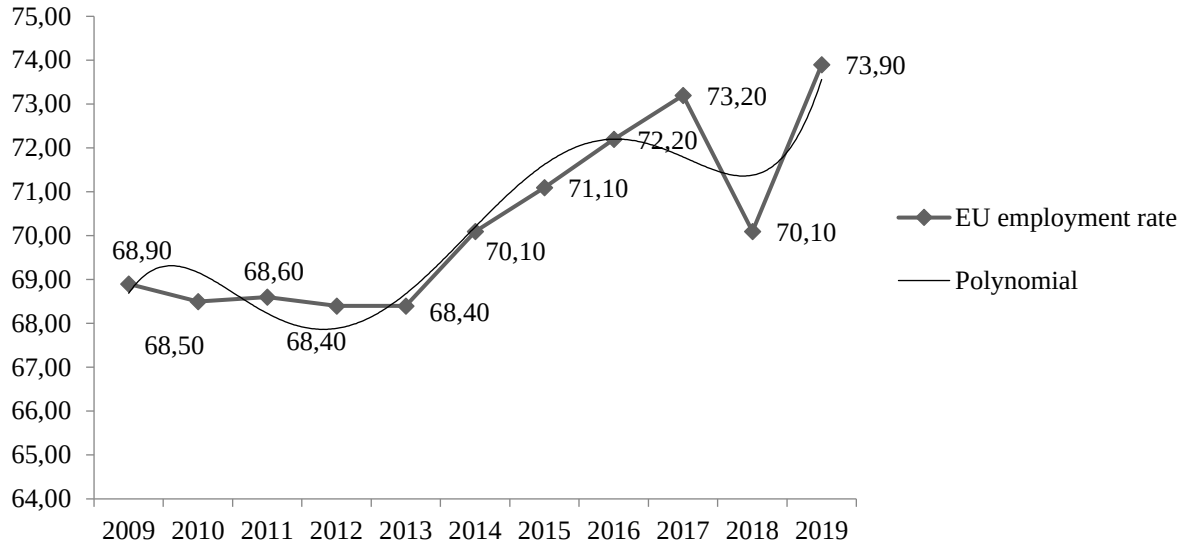

Figure 3. Dynamics of EU employment rate in % (age group 20-64) from 2009 to 2019
Note: data are from [5]

Figure 3 clearly shows that employment rate in the European Union has been changing during the analyzed period. We observe decreasing value of this factor in 2010-2012, which has increased by 2017 and decreased again in 2018. In 2019 employment rate increased by 5,42%. The changes in employment rate in the EU indicate instability in the labour market.

One of our tasks is to make forecast for the imports of EU goods and services and the employment rate in the EU on the basis of trend models that is presented in Table 7.

Table 7
Forecast for the imports of EU goods and services and the employment rate in the EU on the basis of trend models

Indicator	Imports in % to GDP	Employment rate
Parameter	x13	x14
Type of trend	polynomial	polynomial
Forecast value by years		
2020	47,53	73,92
2021	52,10	75,58
2022	58,3	78,99

Note: based on authors' calculations

According to the presented calculations, during the forecast period imports will increase by 14,6 points and the employment rate will increase by 5,09 points.

The results of the forecast show that the volume of EU digital business based on the model of dependence of digital business on imports of goods and services and employment rate will be 666,44 billion euros in 2020, 693,24 billion euros in 2021, 734,20 billion euros in 2022.

The dynamics of the development of EU digital business in the B2C[2] segment and forecast values can be seen in Fig. 4.

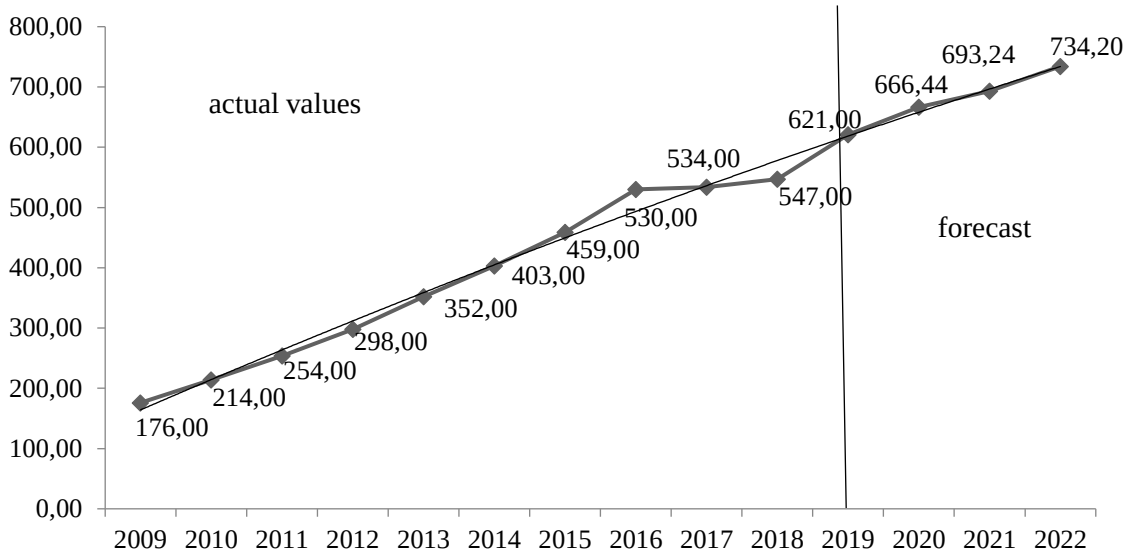

Figure 4. Forecasting the development of EU digital business (B2C segment) based on the model of dependence of digital business on imports of goods and services and employment rate from 2009 to 2022, billion euros.

Note: data are from [4]

We will perform simulation modelling for the obtained result in 2021. It is important to determine the limits for X_{13} and X_{14}, which are equal to the forecast value +/- 10%, i.e. X_{13}(46,89;57,31) and X_{14}(68,022;83,14). Using the random number function, we obtain 100 observations for these arguments and determine Y. The results of simulation modelling are presented in Table 8.

Table 8

Simulation modelling results

Indicators	Value
Average value	688,306
Standard deviation	34,0817
Variation coefficient	0,0495
Minimal value	628,96
Maximum value	756,9
Number of cases Y<693,24	62
Probability Y<693,24	59,93%
Number of cases Y>693,24	38
Probability Y>693,24	40,07%

Note: based on authors' calculations

Considering the results of simulation modelling, we can assume that the average value of digital business in the European Union in 2021 will be almost 688,306 billion euros. In 59,93% of cases the value of digital business will be lower than forecast (693,24) and in 40,07% of cases it will be higher.

The obtained results by frequency are demonstrated in Fig. 5.

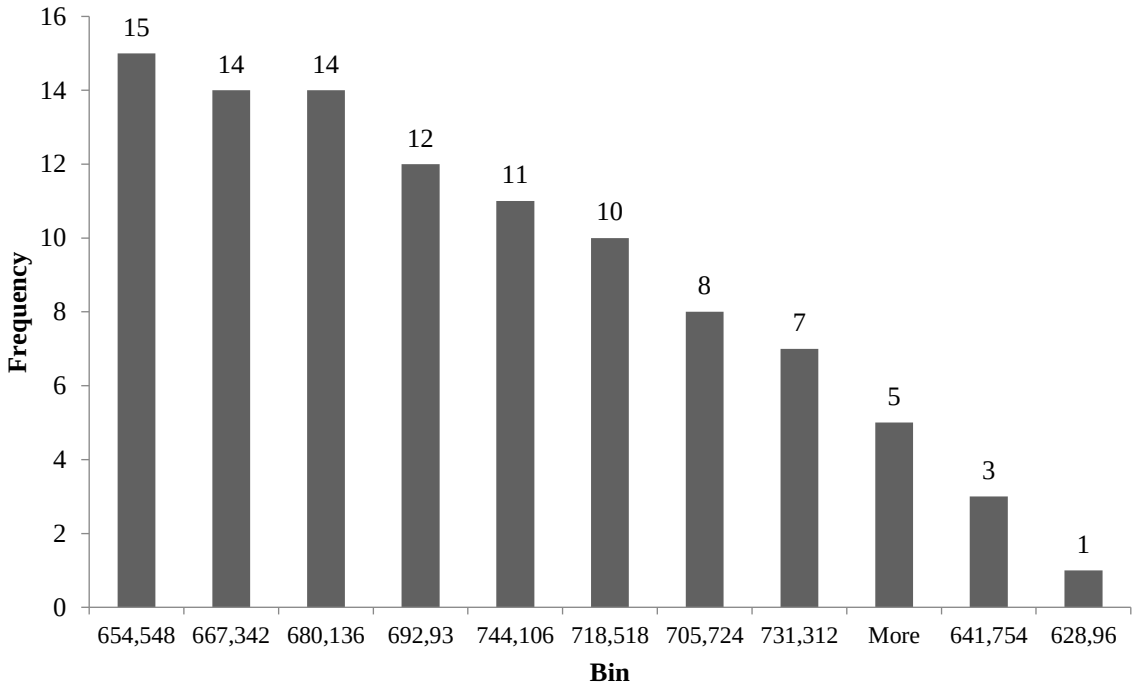

Figure 5. Frequency simulation modelling results
Note: based on authors' calculations

From the above bar chart we can conclude that the probability to get the value of digital business in the amount of 654,548 billion euros in 2021 is 15 cases per 100, 667,342 billion euros in 14 cases, 680,136 billion euros – 14 cases, 692.93 billion euros – 12 cases, 744,106 billion euros – 11 cases, 718,518 billion euros – 10 cases, 705.94 billion euros – 8 cases, 731,312 billion euros – 7 cases, 641,945 billion euros – 3 cases, 628, 96 billion euros – 1 case, other values – 5 cases.

Conclusion. Having analyzed the factors influencing the formation and development of digital business, we state that the closest correlations are between digital business and the level of Internet accessibility of households, the Internet used by individuals, the share of people using the Internet for Internet banking, the share of people using the Internet for ordering goods or services, shares of people using the Internet for ordering goods or services from other EU countries, shares of businesses received orders via the Internet, shares of business turnover in

the field of e-commerce, exports of goods and services, imports of goods and services, employment rate, resource productivity, real GDP and population size.

The strong point of our research work lies on creating the model of digital business development, in order to do it, we have chosen 2 factors, such as imports of goods and services and the employment rate. As a result, the model shows that an increase in EU imports by 1% leads to an increase in EU digital business in the B2C segment by 2,86%, and an increase in EU employment rate by 1% leads to an increase in EU digital business in the B2C segment by 7,3%.

Finally, considering the obtained results, we have simulated the development of EU digital business on the basis of the model of digital business dependence on imports of goods and services and the employment rate. According to the forecast, the volume of EU digital business in the B2C segment will be: 666,44 billion euros in 2020, 693,24 billion euros in 2021, 734,20 billion euros in 2022. Having performed simulation modelling for 2021, we have found out that the probability of digital business volume deviation from the forecast is 40,07% to a higher point, and 59,93% to a lower point.

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