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Statistical Analysis of the Development Indicators' Impacts on E-Commerce of Individuals in Selected European Countries

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Abstract

The aim of this paper is to analyse the influence of the development level indicators on the e-commerce, i.e. on the online purchase by individuals, in selected European countries in 2013. In the analysis, the main variable under study and all the independent variables are included as standardised. Based on nine variables, the principal component analysis with varimax rotation was performed and the two extracted factors were used as the regressors in the multiple regression analysis. In the regression model both components, Factor 1, which includes seven variables, called Prosperity, Investing in Education and IT Infrastructure, and Awareness, and Factor 2, comprised of two variables, called IT Skills, are statistically significant at the significance level of 1%. Both factors show a positive correlation with the online purchase of individuals. Inclusion and analysis of distributions and impacts of even nine independent variables, which make up two distinct factors affecting the e-commerce, make a new contribution of this work.

Keywords: e-commerce, broadband access to the Internet, factor analysis, multiple regression analysis.

Introduction

Electronic commerce (e-commerce), in simple terms, implies trade using information technology. In order to be able to understand what e-commerce encompasses, one should look at its core components: a business process, a business process object and the technology a business process involves. A business process includes purchase, sale, transfer or exchange. The object of a business process can be a product, a service or information. From the technological perspective, a

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business process can be conducted by a partial or total use of a computer or other electronic devices and equipment, as well as computer networks, including the Internet. The synthesis of the named components results in the following wider definition of e-commerce: "*Electronic commerce is the process of buying, selling, transferring or exchanging products, services and / or information via computer networks, including the Internet*" (Turban, King and Lee, 2008).

The main aim of the paper is to inspect the impact of chosen economic and information and communications technology development level variables on e-commerce developments. In accordance with the aim, the following research hypothesis has been set: the chosen economic and information and communications technology development level variables have a positive impact on e-commerce developments, which is observed as the Internet purchases conducted by individuals.

The paper is organised as follows. After the brief introduction, the second chapter brings literature review whereas the third chapter explains and divides variables used in the analysis into groups of development indicators. In the fourth chapter, a descriptive and exploratory statistics analysis of the observed variables has been conducted. In the fourth chapter the results of the conducted factor analysis have been shown as well. After selecting an appropriate number of factors, checking the assumption of a factor analysis application and conducting a factor analysis, a regression analysis based on results from a factor analysis has been made. The final, fifth, chapter concludes the paper and provides recommendations for further research.

Literature Review

E-commerce would be impossible without information technology. However, it would be unsuccessful without strategic management of business operations through the named processes. Electronic commerce has become an increasingly significant and profitable component of the global commerce. It has been increasing constantly and experts forecast that the increase is to continue in the years to come (Babić, Krajnović and Radman Peša, 2011; Delić and Knežević, 2012; European Commission, 2013). The main reasons for switching to e-commerce include the reduction of business operation costs, time-effectiveness, and the access to a large market, i.e. the whole world (Laudon and Traver, 2010). Therefore, this paper presents the analysis of the online purchase by individuals as one of the most important segments of e-commerce in selected European countries.

Business-to-Consumer (B2C) e-commerce or e-retail is a business transaction between a company (business entity) and an individual consumer, usually conducted through a webshop. This is the most well-known type of e-commerce. Its significance is not high if one considers only the revenue it creates (although it has an exponential increase), but considering the number of realised transactions it excels all other e-commerce models (Laudon and Traver, 2010). Contemporary e-commerce is unimaginable without intermediaries, which have recognized the need for additional service (reintermediation). Before purchasing a product in a brick-and-mortar shop, a growing number of consumers search for information on the product online (prices at other suppliers, the product's characteristics etc.). This type of purchase is denoted by the acronym ROBO (Research Online, Buy Offline), or occasionally the acronym ROPO (Research Online, Purchase Offline) (Knežević, Jaković and Strugar, 2014).

Since 2007, the portion of individuals in the Internet business operations has been on a constant rise (Eurostat, 2017a). In 2013, almost half of the EU population ordered goods or services via the Internet (Eurostat, 2017b). The increase in the number of individuals who participate in the e-commerce anticipates an increase in the e-commerce, which is thus becoming an increasingly significant factor in the economy. In 2013, e-commerce amounted to 2.2 % of the European GDP (Nagelvoort et al., 2014). The named industry nowadays employs 2 million people (Nagelvoort et al., 2014), which does not come as a surprise since retail in general has become a highly important type of trade in the EU due to the significant workforce it employs (Knežević, Renko and Knego, 2011).

When comparing specific European countries, it can be seen that online purchase is more common in more developed countries. According to the report published by E-commerce Europe (Nagelvoort et al., 2014), in 2013, B2C e-commerce realized turnover of 363.1 billion euros, out of which EU28 countries realized 317.9 billion euros. The ten leading countries make 83% of the total B2C e-commerce. However, the first three leading countries (Great Britain, Germany and France) make 61% of the total e-commerce in Europe. E-commerce Europe research has also shown that the most commonly purchased products in the EU include clothes and shoes, books, house appliances and electronics. Therefore, in the top three countries (Great Britain, Germany and France), more than 40% of consumers have bought clothes or shoes via the Internet, more than 32% have bought books, and more than 29% house appliances and electronics. In other countries only 4-10% of consumers buy such products via the Internet (Nagelvoort et al., 2014).

In Dumičić, Žmuk and Čeh Časni (2015, 2016), the purchases by individuals, defined as Internet booking for travel and holiday accommodation and Internet banking, were analysed in details for different selections of European

countries by variety of multivariate analysis methods. The scientific contribution of this particular paper, as compared to the previous research on similar topic, is represented by inclusion of more variables that comprised clear components influencing the e-commerce.

According to Liu (2013) gross domestic product (GDP) is considered to be the economic indicator, which shows relatively well the development level of a certain economy (Liu, 2013). GDP reflects the value of all final goods produced in a certain country during a year. It does not include products or services used in the production process, nor are those produced abroad (domestic investments abroad). The most favourable GDP growth is the one resulting from investment, i.e. investment into new production (Kolaković, 2008). Investment into traffic infrastructure has a positive impact on e-commerce since logistics is one of the main preconditions of successful e-business (Laudon and Traver, 2010). Investment into network infrastructure as well as into marketing and advertising can also incite the e-commerce growth. In addition to investments, other components can also have a positive impact on e-commerce. The prosperity of a country also facilitates an increase in personal consumption and government expenditure. One of the ways of increasing export is through e-commerce. Therefore, the GDP growth has a positive impact on e-commerce (Dumičić et al., 2014).

Investment into education creates workforce with better skills. Persons with a higher educational level have better employment opportunities and in general better salaries. This leads to consumption, while employment reduces social expenditure, which results in further investments and ultimately the GDP growth (Terzi, 2011).

Skills as a development indicator refer to the ability to use a computer and the Internet. The ability to use a computer seems to be a skill necessary for purchases via the Internet. Online purchase nowadays can be conducted using mobile devices, and due to that, a lack of computer skills does not seem to be an obstacle anymore. Consequently, the Internet use skills could have a more significant impact on e-commerce (Chen, Tarn and Han, 2004, Dinu and Dinu, 2014). Information-communication technology has an increasing influence on everyday lives of common people (Wirthmann, 2009). The Internet access, especially the broadband access, plays an important role in the development of an economy (Bahovec, Dumičić and Čižmešija, 2013). Due to its speed and being always on, the broadband access presents advancement in comparison to the dial up Internet access. According to European Commission (2013), the broadband access implies access to the Internet with access speed of 144 Kbit/s. It enables exchange of richer content, and a faster and more advanced communication. Being widespread and affordable, the broadband Internet access results in an informed society based on knowledge (Eurostat, 2014). Therefore, providing basic information on goods and services, and enabling a comparison of products' characteristics, availability, delivery options and similar can lead to an increase in the online purchase (Peltier and Youssef, 2015).

Data Definition and Description

The analysis presented in the paper included all 28 European Union member states, the Former Yugoslav Republic of Macedonia (FYROM), Serbia and Turkey. The main variable

Table 1. Classification of the independent variables according to development indicators categories

Development indicators	Variable	Description
Economic	$X_1 = X_{GDPpc}$	GDP per capita in Purchasing power standards (EU-27 = 100)
Economic	$X_2 = X_{ExpEdu}$	Public expenditure on education, percentage of GDP, direct expenditure on educational institutions
Skills	$X_6 = X_{CSkill}$	Individuals' level of computer skills, individuals who have carried out 1 or 2 of the 6 computer-related activities, percentage of the total number of individuals aged 16 to 74
Skills	$X_7 = X_{IntSkill}$	Individuals' level of the Internet skills, individuals who have carried out 1 or 2 of the 6 Internet-related activities, percentage of the total number of individuals aged 16 to 74
ICT/skills	$X_9 = X_{InfoG\&S}$	Individuals using the Internet for finding information about goods and services, percentage of individuals aged 16 to 74
ICT	$X_3 = X_{IntAccessHH}$	Level of the Internet access, percentage of households which have the Internet access, all forms of the Internet use are included, the population considered is aged 16 to 74
ICT	$X_4 = X_{BBAccessHH}$	Households having broadband access to the Internet, percentage of all households, having at least one member in the age group 16-74
ICT	$X_5 = X_{BBPenet}$	Fixed broadband penetration, subscriptions as a percentage of population
ICT	$X_8 = X_{IntUse}$	Internet users (per 100 people), Internet users are people with access to the worldwide network

Source: Eurostat, 2016a-g, World Bank, 2016.

under the study, also observed as the dependent variable, is the variable the Internet purchases by individuals (Y_{PU}), which is defined as a share of individuals who made a purchase by using the Internet in the last 12 months in the total population of a country. List of included independent variables, carefully selected based on the conducted literature review and their availability, is provided in Table 1. The independent variables are classified into following three categories of development indicators: economic development indicators, skill development indicators and ICT development indicators.

Data for the observed variables have been taken from secondary sources (Eurostat, 2016a-g, World Bank, 2016). Furthermore, the analysis will be made by using data related to 2013. Unfortunately, it has to be emphasized that data for some variables and for some countries were not available. In such cases the most recent data has been used as an approximation of 2013 data.

Results

Exploratory Data Analysis

In order to inspect and look more closely at the observed data, to detect outliers, to estimate data variability and similar,

exploratory graphical and numerical statistical methods can be applied (Azcel and Sounderpandian, 2009). The basic exploratory analysis of the dependent variable, the Internet purchases by individuals (Y_{PU}), is shown in Figure 1.

If the Internet purchases by individuals are observed in all selected European countries, it can be concluded that on average 38.81% of individuals made a purchase by using the Internet in the last 12 months. However, the average absolute deviation from the calculated average is 22.35%, which amounts 57.58% relatively. The great data dispersion led to the conclusion that the calculated mean here has a weak representativeness level (Dumičić and Palić, 2011). Despite a high data variability, all data can be found inside the two standard deviations interval of the mean. So, it can be concluded that outliers are not present for the main variable under the study. The outlier analysis has been conducted for all, the main and the independent, variables by using the multiple box-plots chart, too, as it is shown in Figure 2.

According to Figure 2, two outliers can be detected. Here the term outlier refers to a value that deviates more than three standard deviations from the mean of the observed variable. The first outlier is detected at the variable GDP per capita in Purchasing power standards. The outlier is represented by Luxembourg which has GDP per capita considerably higher

Figure 1. Exploratory analysis of the variable the Internet purchases by individuals, 31 European countries, data for 2013

Anderson-Darling Normality Test	
A-Squared	0,64
P-Value	0,085
Mean	38,806
StDev	22,346
Variance	499,361
Skewness	0,29876
Kurtosis	-1,03492
N	31
Minimum	5,000
1st Quartile	25,000
Median	32,000
3rd Quartile	59,000
Maximum	77,000
95% Confidence Interval for Mean	
30,610	47,003
95% Confidence Interval for Median	
25,675	46,650
95% Confidence Interval for StDev	
17,857	29,870

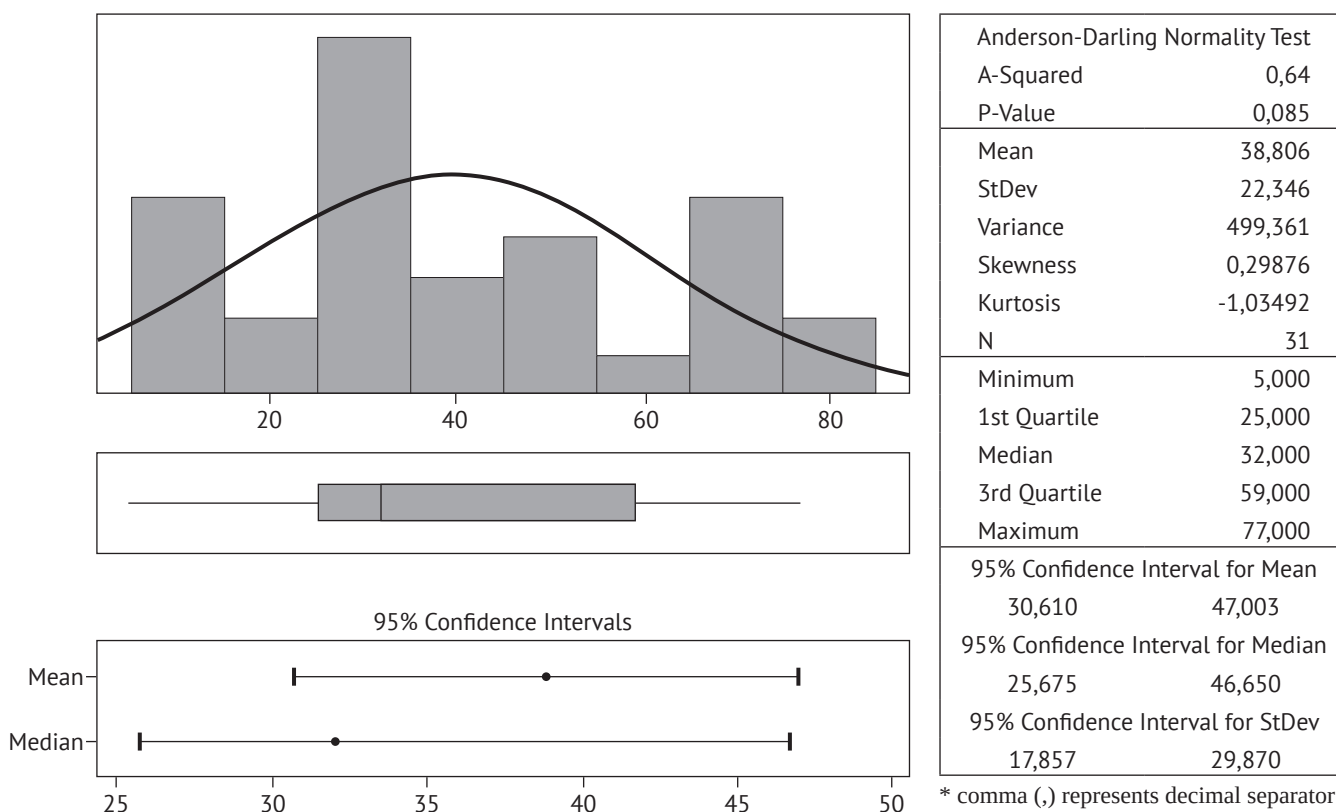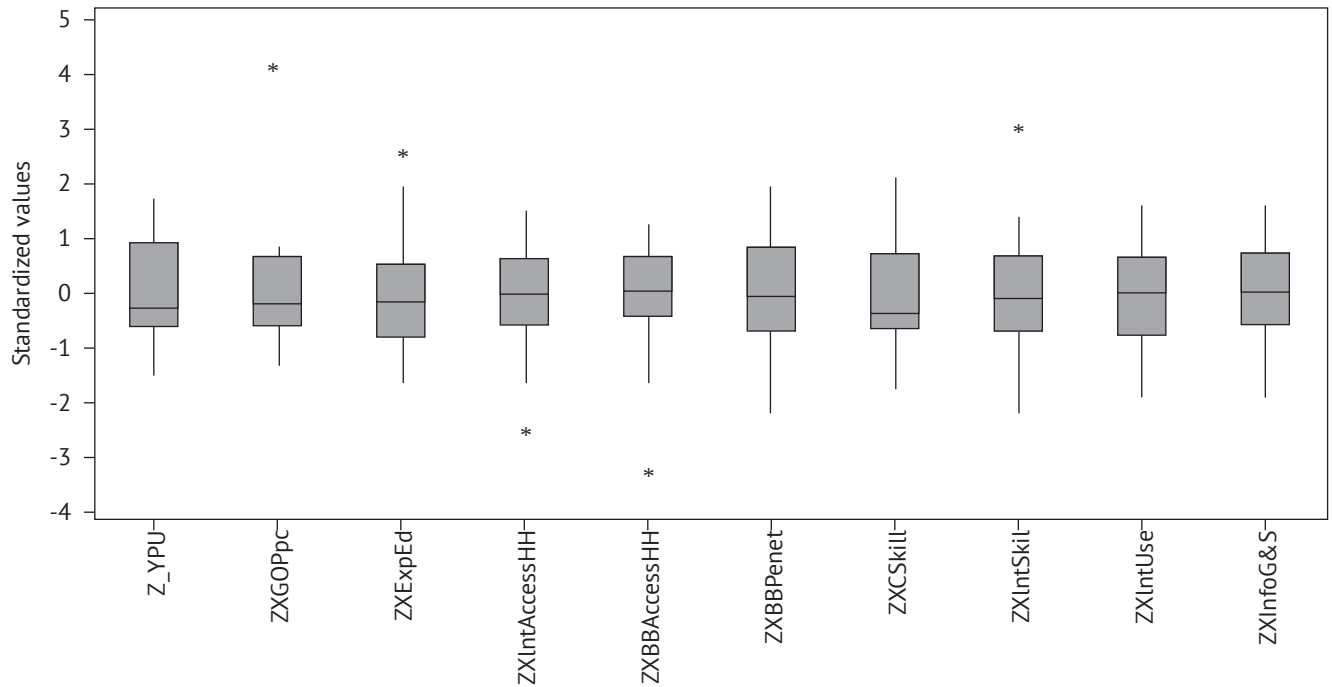* comma (,) represents decimal separator

Figure 2. Multiple Box-plots diagram of 10 variables, standardized values, 31 European countries, data for 2013

than the other observed European countries. The second outlier is found for the variable Households with broadband access. For this variable Serbia has convincingly the lowest value. Because of a strong impact of outliers on the statistical factor analysis results, Luxembourg and Serbia have been omitted from the further analysis. The same approach to outliers exploration related to research of Internet usage by individuals in European countries was applied in Dumičić

(2011), Dumičić et al. (2014), Dumičić, Čeh Časni and Palić (2014a, b), Žmuk, Dumičić and Mihajlović (2014).

Factor Analysis

Online purchase by individuals, observed via the variable Internet purchases by individuals, will be inspected by

Table 2. Correlation matrix of nine standardized independent variables, 29 European countries, data for 2013

Standardized variables	ZGDPpc	ZExpEdu	ZIntAccessHH	ZBBAccessHH	ZBBPenet	ZCSkill	ZIntSkill	ZIntUse	ZInfoG&S
ZGDPpc	1	0.661*	0.839*	0.784*	0.788*	0.248	0.539*	0.790*	0.821*
ZExpEdu	0.661*	1	0.647*	0.653*	0.715*	-0.013	0.081	0.623*	0.657*
ZIntAccessHH	0.839*	0.647*	1	0.966*	0.826*	0.397*	0.490*	0.952*	0.907*
ZBBAccessHH	0.784*	0.653*	0.966*	1	0.840*	0.389*	0.420*	0.929*	0.887*
ZBBPenet	0.788*	0.715*	0.826*	0.840*	1	0.203	0.359	0.820*	0.857*
ZCSkill	0.248	-0.013	0.397*	0.389*	0.203	1	0.540*	0.382*	0.356
ZIntSkill	0.539*	0.081	0.490*	0.420*	0.359	0.540*	1	0.410*	0.421*
ZIntUse	0.790*	0.623*	0.952*	0.929*	0.820*	0.382*	0.410*	1	0.961*
ZInfoG&S	0.821*	0.657*	0.907*	0.887*	0.857*	0.356	0.421*	0.961*	1

Note: * Statistically significant correlations at the 5% level.

Source: Authors' work.

using a factor analysis and, after that, by applying a regression analysis. The conducted factor analysis will result in grouping independent variables into a few factors. Those factors will be later used as independent variables in a regression model where the variable the Internet purchases by individuals will be used as the dependent variable.

The aim of the factor analysis is to compress information, which is provided by a large number of original variables, into a smaller number of common factors but with a minimal information loss. Before the factor analysis is applied, the data suitability should be checked, since factors very often seem to be difficult to interpret. Because of that, factors are first rotated and then interpreted. For the purpose of further analysis, factor scores are calculated.

The task of the factor analysis is to explain correlations between quantitative variables by introducing factors. Because of that, it is necessary for original variables to be highly correlated. In that case, the use of the factor analysis is justified. The correlation matrix of the observed standardized independent and original variables is shown in Table 2.

According to Table 2 it can be concluded that each variable has at least one correlation coefficient larger than 0.3 in absolute sense. The value of 0.3 is the minimum for including variables in the factor analysis (Field, 2011; Hair et al., 2008; Härdle and Simar, 2012). Consequently, all nine variables are going to be included in the factor analysis.

Table 3. Kaiser-Meyer-Olkin measure of sampling adequacy, standardized variables, 29 European countries, data for 2013

Variable	Kaiser-Meyer-Olkin measure of sampling adequacy
ZGDPpc	0.882
ZExpEdu	0.894
ZIntAccessHH	0.822
ZBBAccessHH	0.876
ZBBPenet	0.919
ZCSkill	0.748
ZIntSkill	0.716
ZIntUse	0.814
ZInfoG&S	0.829
Overall	0.845

Source: Authors' work.

According to Table 3, the overall Kaiser-Meyer-Olkin measure of sampling adequacy value is 0.845, which can be considered a satisfactorily high level. Furthermore, the Kaiser-Meyer-Olkin measure of sampling adequacy values

at all variables are also large enough. Consequently, it can be concluded that the variable data are suitable for conducting a factor analysis.

Table 4. Eigenvalues, percentages of explained variance and cumulative percentages of explained variance

Factors	Eigenvalues	% of variance explained	Cumulative % of variance explained
F1	6.224	69.151	69.151
F2	1.367	15.186	84.336
F3	0.548	6.094	90.430
F4	0.342	3.797	94.227
F5	0.189	2.095	96.322
F6	0.161	1.793	98.115
F7	0.125	1.394	99.509
F8	0.029	0.317	99.826
F9	0.016	0.174	100.000

Source: Authors' work.

According to Table 4 two factors fulfilled the eigenvalue criteria ($\lambda_1 > 1$, $\lambda_2 > 1$). If the first two factors are going to be extracted, the explained variance approach will be also respected. Namely, according to Table 4 the first two factors together explain 84.34% of the total variance, which is significantly above the suggested limit of 60% of the total variance for social sciences (Field, 2011; Hair et al., 2008; Härdle and Simar, 2012).

Table 5. Factor matrix after varimax rotation and percentages of explained variance

Variable	F1	F2
ZGDPpc	**0.847**	0.285
ZExpEdu	**0.853**	-0.216
ZIntAccessHH	**0.898**	0.367
ZBBAccessHH	**0.896**	0.322
ZBBPenet	**0.911**	0.135
ZCSkill	0.098	**0.873**
ZIntSkill	0.246	**0.817**
ZIntUse	**0.897**	0.324
ZInfoG&S	**0.908**	0.297
% of variance explained	62.010	22.327
Cumulative % of variance explained	62.010	84.336

Source: Authors' work.

According to Table 5, after the varimax rotation of factors was applied, variables have a high factor loading on only one

factor and a low factor loading on another one. Furthermore, it can be seen that the percentage of variance explained is different than before. However, the cumulative percentage of variance explained stayed the same.

Now it is possible to interpret the extracted factors and give them appropriate names. The Factor 1 includes all economic and ICT variables, whereas the Factor 2 includes skills variables. Consequently, the Factor 1 can be named Prosperity, Investing in Education and IT Infrastructure, and Awareness ($F_{Econ\&Info}$). The Factor 2 can be named IT Skills ($F_{ITSkills}$). The resulting factor scores are used as two input or independent variables in the regression analysis.

Regression Analysis

The aim of the multiple regression analysis is to determine the relation between the variable the Internet purchases by individuals with two independent variables, Factor 1 and Factor 2. For that purpose, the resulting Ordinary Least Squares estimated standardized regression model with two regressors was built, as follows:

$$Z\hat{Y}_{PU} = 0.8768 \cdot F_{Econ\&Info} + 0.3692 \cdot F_{ITSkills} \qquad (3)$$
$$\quad (0.0604) \qquad\qquad (0.0604)$$

$$R^2 = 0.9050 \qquad Adj.R^2 = 0.8977 \qquad R = 0.9513$$
$$F(2, 26) = 123.90 \qquad VIF = 1.0000 \qquad DW = 2.110$$

In the evaluated regression model both independent variables, the variable Prosperity, Investing in Education and IT Infrastructure, and Awareness ($F_{Econ\&Info}$, being the Factor 1) and the variable IT Skills ($F_{ITSkills}$, being the Factor 2) are statistically highly significant (α=0.01) (Härdle and Simar, 2012). Furthermore, both variables seem to have a positive correlation with the dependent variable the Internet purchases by individuals. Because the independent variables are based on extracted factors, they are standardized. In that way, it can be concluded that the first independent variable (Factor 1) Prosperity, Investing in Education and IT Infrastructure, and Awareness ($F_{Econ\&Info}$) has a larger impact on the dependent variable the Internet purchases by individuals (Y_{PU}) than the second independent variable, named IT Skills (Factor 2).

When the regression model quality is observed, according to R-square and Adjusted R-square measures it might be concluded that the model is very good in explaining the variability in online purchases. Furthermore, the F-test statistic value of 123.90 suggests that, at the significance level of 1%, the regression model overall provides a good fit. If partial correlations are observed it can be concluded that there is a stronger correlation between the dependent variable the Internet purchases by individuals (Y_{PU}) and the first independent variable

Prosperity, Investing in Education and IT Infrastructure, and Awareness ($F_{Econ\&Info}$) (correlation coefficient = 0.8768) than between the dependent variable the Internet purchases by individuals (Y_{PU}) and the second independent variable IT Skills ($F_{ITSkills}$) (correlation coefficient = 0.3692).

The fulfilment of linear regression model assumptions has been inspected for the observed regression model also (Bahovec and Erjavec, 2009; Gujarati and Porter, 2010). Because the varimax factor rotation was applied, the multicollinearity problem by default is not present in the regression model. The absence of the multicollinearity problem is confirmed by the variance inflation factor (VIF) value of 1. In order to inspect whether the problem of heteroskedasticy is present in the regression model, the White heteroskedasticy test was applied. According to the White heteroskedasticy test results, at the significance level of 5%, the conclusion that the heteroskedasticy problem is not present in the regression model can be brought (White test statistic = 1.119, degrees of freedom = 5, p-value = 0.952). Finally, the conducted Jarque-Bera test has shown that, at the significance level of 5%, it can be concluded that residuals are normally distributed (JB test statistic = 2.466, degrees of freedom = 2, p-value = 0.291).

Conclusions

The main variable under study is electronic commerce in Europe, which, defined as online purchases by individuals, as a share of individuals who made a purchase by using the Internet in the last 12 months in the total population of a country, shows a tendency to grow. Consumers can search for goods online and thus obtain information on their characteristics, they can order, pay and determine delivery conditions from anywhere in the world whenever they want. However, there are different impacts of various development indicators on e-commerce representation in different countries.

Data used in the paper come from 31 countries, i.e. the 28 European Union member states and Serbia, the Former Yugoslav Republic of Macedonia and Turkey, for the year 2013. Due to outliers at certain variables, Luxembourg and Serbia data were excluded from the multivariate analysis and the further study included 29 European countries only.

Using the factor analysis, the development indicators have been grouped into common factors. A principal component analysis with varimax rotation was performed and two extracted factors with the respective factor scores were used in the regression analysis. Factor 1 includes seven variables and is defined as the regressand variable named

as Prosperity, Investing in Education and IT Infrastructure, and Awareness, and Factor 2 includes two variables and is named as IT Skills.

The conducted analyses have shown that one standard deviation increase in Factor 1 (Prosperity, Investing in Education and IT Infrastructure, and Awareness), without changing Factor 2 (IT Skills), will lead to 0.88 standard deviations increase in the regression value of the Y_{PU} variable. The regression coefficient close to Factor 2 shows that an increase of one standard deviation in IT Skills, holding Factor 1 constant, will increase the regression value of the Y_{PU} by 0.37 standard deviations. On that way the research hypothesis, that the chosen economic and information and communications technology development level variables have

a positive impact on e-commerce developments, which is observed as the Internet purchases conducted by individuals, can be accepted. However, it has to be emphasized that the research was conducted on a small sample of countries in only one year. In the further research more countries should be observed in longer period.

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Statistična analiza vplivov kazalnikov razvoja na e-trgovino posameznikov v izbranih evropskih državah

Izvleček

Namen tega prispevka je analizirati vpliv kazalnikov ravni razvoja na e-trgovino, tj. na spletni nakup posameznikov v izbranih evropskih državah leta 2013. V analizo vključene spremenljivke so standardizirane. Najprej je bila na podlagi devetih spremenljivk opravljena analiza glavnih komponent z rotacijo Varimax; dobljena faktorja sta uporabljena kot regresorja v multipli regresijski analizi. V regresijskem modelu je pri obeh dobljenih faktorjih – novih spremenljivkah, ki izražata blaginjo, osveščenost in investiranje v izobraževanje in IT-infrastrukturo (faktor 1) in znanje in veščine na področju IT prisotna velika statistična značilnost. Oba dejavnika kažeta pozitivno korelacijo s spletnim nakupom posameznikov. Nov prispevek tega članka sta vključitev in analiza distribucij in vplivov devetih neodvisnih spremenljivk, ki tvorijo dva različna faktorja, ki vplivata na e-trgovino.

Ključne besede: e-trgovina, širokopasovni dostop do interneta, faktorska analiza, multipla regresijska analiza