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Internet Purchases in European Union Countries: Multiple Linear Regression Approach

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***Abstract*—**This paper examines economic and Information and Communication Technology (ICT) development influence on recently increasing Internet purchases by individuals for European Union member states. After a growing trend for Internet purchases in EU27 was noticed, all possible regression analysis was applied using nine independent variables in 2011. Finally, two linear regression models were studied in detail. Conducted simple linear regression analysis confirmed the research hypothesis that the Internet purchases in analyzed EU countries is positively correlated with statistically significant variable Gross Domestic Product *per capita* (GDPpc). Also, analyzed multiple linear regression model with four regressors, showing ICT development level, indicates that ICT development is crucial for explaining the Internet purchases by individuals, confirming the research hypothesis.

***Keywords*—**European Union, Internet purchases, multiple linear regression model, outlier

I. Introduction

INTERNET purchasing is a new way of conducting business and according to preliminary findings of OECD [3], it has a great potential to radically change economic activities and the social environment. Already, it affects large sectors as communications, finance and retail trade, where the largest effects may be associated not with impacts that attract the most attention, but with less visible routine business activities. Along with the continuous development of modern information technology and global economic integration, Internet purchasing comes along. According to [2] it can be defined as the sum of commercial activities and non-profit business or service activities with the application of modern computer, network technology and modern information communication technology. Thus, it can be considered as new form of trade arising from the application of electronic information technology in trade field.

Therefore, the main goal of this paper is to explore the impact of selected IT development and economic variables on Internet purchases for the European Union member states. The research hypothesis is that the Internet purchases in analyzed countries is mostly influenced by individual`s computer skills and also that gross domestic product (GDP) in analyzed countries influences Internet purchases by individuals.

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II. Literature Review

The Internet has transformed many aspects of life, but perhaps mostly our shopping habits. While it's still nice to stop by a store to see the actual product, the convenience of online shopping is still unbeatable. For some services, such as booking a travel or buying a concert ticket, the ability to do so online has made the process much easier and more efficient [6].

According to [22], in 2012 Wijnand Jongen, the chairman of the Executive Committee of e-commerce Europe, stated that Eurostat figures show that e-commerce in Europe is booming. However, he pointed out that there is still much to be done before European e-commerce reaches its full potential even though there are enormous opportunities, still there are many barriers that inhibit the growth of e-commerce, due to the differences in legislation, payments and logistic systems in Europe. More uniformity is crucial, in order to avoid restrictions related to European digital boundaries. The development has only just begun, and the coming years will be incredibly important.

Back in 2007 a report for the Office of Fair Trading [4] by Europe Economics showed that Internet shopping still only had accounted for just over three per cent of total retail sales although this share is higher in certain sectors. In that report nearly two-thirds of consumers are shown to be Internet users and over half of these used the internet to make purchases. Convenience of use is shown to be an important factor in purchasing decisions while concerns about security of payment and delivery arrangements are seen as negative aspects of the Internet. Moreover, the report stated that the growth of broadband access is an important driver of change both for consumers and for business. The speed of response available is shown to be an important factor in the growth of search engines and price comparison sites.

Nielsen Company conducted a survey in March 2010 [6] and polled over 27,000 Internet users in 55 markets from Asia, Europe and America to look at how consumers shop online: what they intend to buy, how they use various sites, the impact of social media and other factors that come into play when they are trying to decide how to spend their money. They found that there are some products bought online that are universal, and others that still have yet to build a significant share of trade.

Furthermore, according to McKinsey report [7], which studied the digitally based purchasing behavior of 40000 Europeans in eight countries in 2012, online channel is expanding in all product categories, particularly for consumer electronics and digital/mobile products. Consumers

increasingly research products online via computers and mobile devices prior to making any purchase decisions, especially regarding mobile phones. The analysis of Internet purchasing is very important for business sector. Companies should address the new segment of online buyers as they could be a strategic source of growth and savings.

The Executive Agency for Health and Consumers report [5] analyzed the consumer welfare changes implied by the price difference between buying a good online versus offline, and the consumer welfare aspects of increased online choice. Their analysis encompasses consumer welfare gains under the current share of Internet retailing for each country and consumer welfare gains under a hypothetical situation in which the share of Internet retailing would be 15% of total retailing. In scrutinizing this hypothetical situation which serves as an indicator for the "missing potential", they also consider to which extent welfare gains would be affected by a continuation of the current fragmented national consumer markets of the EU27 Member States, compared to a situation where a Single EU consumer Market in the e-commerce of goods exists, all other things unchanged. Their key findings regarding consumer welfare are that consumer welfare gains in domestic markets from lower online prices with the current share of Internet retailing in the EU (3.5%) are 2.5 billion Euro, and total welfare gains resulting from lower online prices under a hypothetical situation of a 15% share of Internet retailing and a Single EU consumer Market are 70.4 billion Euro per year (equivalent to 0.6% of EU GDP).

According to [8] socio-economic differences within a country are more important than differences between countries in explaining Internet access. In part, differences in access are explained by differing levels of GDP per capita. But even after accounting for this effect, significant differences between countries remain to be explained by other factors, unspecified in their analysis. However, when they turn to Internet usage, given access to the Internet, they find differences in individual characteristics to be less important than differences between countries.

The results of a first attempt to explore the micro data of the community survey on the use of information and communication technologies in households and by individuals at the level of the European Union are presented in [9].The frequency of Internet use and of downloading of audiovisual content are analyzed using logistic regression models in order to isolate the influence of different explanatory variables. Socio-economic background characteristics such as age, gender, educational attainment, employment situation, geographic location, household income and composition, as well as the type of connection or place of internet access are used to explain differences in frequency of internet use and downloading.

Research of [8] gives an insight to what extent Internet sales by individuals is influenced by the barriers people perceive to buying/ordering over the Internet, using of Internet, and level of computer/Internet skills they poses. For investigating the research question the multiple linear regression models are applied. The dependent variable of their analysis is the percentage of individuals who used Internet for buying goods and/or services within last 3 months. The percentage of the individuals who bought goods/services over the Internet within last 3 months and factors: giving personal details over the Internet, level of necessary computer usage skills, and lack of necessary computer usage skills are found to be statistically significant. Therefore, buying over the Internet in EU countries is influenced both by the level of individuals' skills and the level of perceived barriers.

E-commerce is the most common form of distance shopping and has been growing steadily since it was first measured in 2004. More than four out of ten EU consumers (43 %) have purchased goods and services over the Internet in the past year. This represents an increase of 3 percentage points compared to 2010. Since 2004 the proportion of Internet shoppers has risen by 23 percentage points from 20 %. The use of other distance channels (19 % for telephone and 12 % for post) remains almost unchanged compared to last year and has tended to decline since 2006. The corresponding figures for retailers confirm that Internet is the most common distance sales channel [11].

III. Data

The EUROSTAT data for Internet purchases by individuals is given for different periods, but the dependent variable analyzed here is Internet purchases by individuals in the last 12 months, expressed as % of individuals which is denoted as Y_{Pu}.

In initial exploratory analysis, 10 different regressors were used, namely: X_{Access} (level of Internet access expressed as a percentage of households who have Internet access at home), X_{BB} (fixed broadband penetration rate, which indicates the percentage of broadband connections per 100 inhabitants), X_{CSkill} (individuals' level of computer skills expressed as % of the total number of individuals aged 16 to 74), X_{ExpEdu} (public expenditure on education expressed as a percentage of GDP), X_{GDPpc} (GDP per capita in Purchasing Power Standards (PPS), EU27=100), X_{Inform} (individuals using the Internet for finding information about goods and services expressed as a percentage of individuals aged 16 to 74), $X_{IntSkill}$ (individuals' level of Internet skills expressed as a percentage of the total number of individuals aged 16 to 74), $X_{OrderBuy}$ (individuals having ordered/bought goods or services for private use over the Internet in the last three months expressed as a percentage of individuals aged 16 to 74) and X_{Secure} (concern about possible problems related to Internet usage, activities via Internet not done because of security concerns expressed as a percentage of all individuals). The data source for all variables except fixed broadband penetration rate is EUROSTAT database available online [13]-[21]. The data source for fixed broadband penetration rate is Croatian Post and Electronic Communications Agency [12].

With the purpose of capturing the trend of dependent variable (Internet purchases by individuals, Y_{Pu}) the linear plot as shown in Fig. 1, was constructed. From Fig. 1, it can be seen that, Internet purchases by individuals, expressed as % of individuals who purchased goods through Internet in the last

12 months, has a growing trend in the period from 2004 to 2012 in all analyzed countries (EU27).

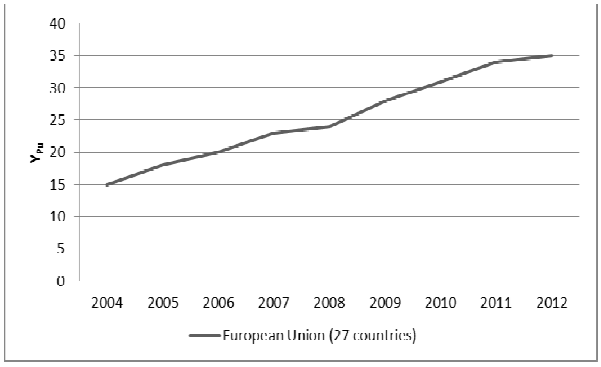

Fig. 1 Internet purchases by individuals (Y_{Pu}) in EU27

Fig. 2 shows Internet purchases by individuals in EU27 countries and Croatia in 2011 and 2012. According to this figure, Internet purchases by individuals increased in 2012 in all countries except Poland and Cyprus, where Internet purchases remained unchanged, and the Netherlands and Romania, for which a decrease in Internet purchases is recorded.

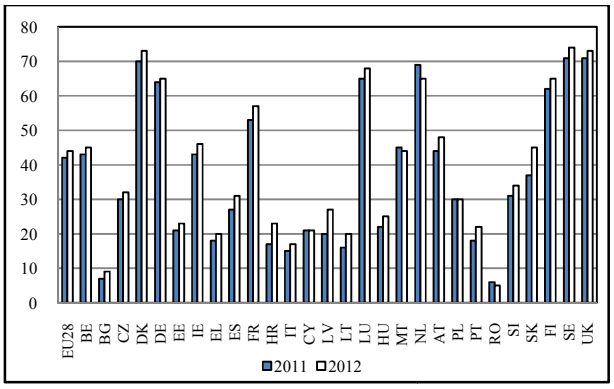

Fig. 2 Internet purchases by individuals in EU28 countries and Croatia in 2011 and 2012

After initial data exploration, Luxembourg appeared to be an outlier for the variable Gross Domestic Product *per capita* in PPS (EU28=100), as shown in Fig. 3.

The Box Plot created using standardized values for each of ten variables for EU28 member states in 2011, given in Fig. 3, describes that the dependent variable Y_{Pu} data range within ±2 standard deviations around the mean, so, there are no outliers for it. Among initially proposed independent variables only the variable Y_{GDPpc} has showed the serious outlier with the maximum value for Luxembourg (standardized value is z=4.02), and therefore Luxembourg was not included into the following regression analysis.

Also, the correlation matrix of all variables was explored (Table I) showing that all ten analyzed variables have positive correlations with the regress and Y_{Pu} for Internet purchases. The variables that showed to be statistically significant at 5% significance level or less were selected for further analysis[1]. Namely, there is a positive correlation between Internet purchases and level of individual`s Internet and individual`s computer skills as well as fixed broadband penetration rate and Individuals using the Internet for finding information about goods and services, with correlation coefficients ranging between 0.54 and 0.86.

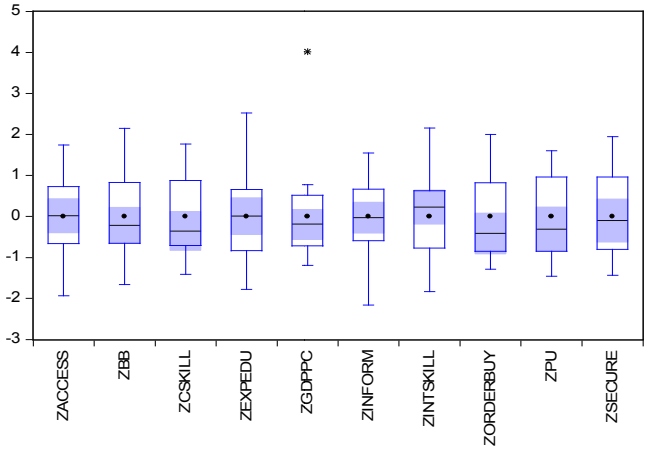

Fig. 3 Box plot diagram of standardized values of selected variables in EU28 in 2011

[1]Detail variable description and sources are given in Table A in Appendix.

TABLE I
CORRELATION MATRIX AND P-VALUES OF SELECTED VARIABLES IN EU 28 WITHOUT LUXEMBURG FOR 2011

	X_{Access}	X_{BB}	X_{CSkill}	X_{ExpEdu}	X_{GDPpc}	X_{Inform}	$X_{IntSkill}$	$X_{OrderBuy}$	X_{Secure}	Y_{Pu}
X_{Access}	1									

X_{BB}	0,83	1								
	0,00	---								
X_{CSkill}	0,46	0,29	1							
	0,02	0,14	---							
X_{ExpEdu}	0,64	0,67	-0,04	1						
	0,00	0,00	0,85	---						
X_{GDPpc}	0,80	0,77	0,25	0,64	1					
	0,00	0,00	0,21	0,00	---					
X_{Inform}	0,91	0,82	0,28	0,65	0,74	1				
	0,00	0,00	0,15	0,00	0,00	---				
$XI_{ntSkill}$	0,68	0,53	0,61	0,30	0,79	0,57	1			
	0,00	0,00	0,00	0,13	0,00	0,00	---			
$X_{OrderBuy}$	0,90	0,83	0,51	0,63	0,82	0,82	0,76	1		
	0,00	0,00	0,01	0,00	0,00	0,00	0,00	---		
X_{Secure}	0,37	0,45	-0,04	0,37	0,53	0,39	0,27	0,37	1	
	0,06	0,02	0,84	0,06	0,00	0,04	0,18	0,06	---	
Y_{Pu}	0,94	0,83	0,54	0,62	0,82	0,86	0,76	0,99	0,39	1
	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,05	----

Source: Author`s calculation

It is worth stressing that in the initial analysis for 27 European countries, more precisely EU28 without Luxembourg, all ten regressors were taken into account and *all possible regressions* analysis was applied. The vast majority of the estimated models were either not statistically significant, or with small coefficient of determination R^2, based on *a priori* defined criteria for model selection. Therefore, only the models described in Section IV were examined in detail.

IV. METHODOLOGY AND RESULTS

A. Multiple Linear Regression Analysis of IT Development Variables Influence on Internet Purchases

In order to model the influence of selected IT development independent variables on Internet purchases by individuals (Y_{Pu}), the multiple linear regression models were used. For explanation of the model, see for example [10]. Before performing regression analysis, descriptive analysis was conducted. Some of the results are shown in Table II.

TABLE II
DESCRIPTIVE ANALYSIS OF SELECTED VARIABLES, EU 28 (WITHOUT LUXEMBOURG) IN 2011 (N=27)

Descriptive statistics	Y_{Pu}	X_{BB}	X_{CSkill}	X_{Inform}	$X_{IntSkill}$
mean	35,96	26,10	13,07	61,07	25,63
sample variance	436,88	44,93	8,15	192,84	57,93
sample standard deviation	20,90	6,70	2,85	13,89	7,61
minimum	6,00	15,22	9,00	31,00	12,00
maximum	71,00	40,63	18,00	83,00	42,00
range	65,00	25,41	9,00	52,00	30,00
skewness	0,48	0,44	0,34	-0,24	0,17
kurtosis	-1,06	-0,34	-1,13	-0,29	-0,69
coefficient of variation (CV)	0,58	0,26	0,22	0,23	0,30

Source: Author`s calculation

The coefficients of variation for all variables show great variability, with dependent variable being the most volatile (CV=58%) and X_{CSkill} being the least volatile (CV=22%). According to kurtosis, all variables have platycurtic distributions and according to skewness they all have positive asymmetric distributions with the exception of X_{Inform} which distribution is negatively asymmetric when compared to the normal distribution.

Since the cross-sectional data are studied, Internet purchases are here modeled in the usual way using the multiple linear regression model. In that sense, the following specification of the population model is examined:

$$Y_{Pu_i} = \beta_0 + \beta_1 X_{BB_i} + \beta_2 X_{CSkill_i} + \beta_3 X_{Inform_i} + \beta_4 X_{IntSkill_i} + \varepsilon_i,\ i = 1, \ldots, 27 \quad (1)$$

where $Y_{Pu\,i}$ is Internet purchases by individuals, expressed as % of individuals who purchased goods through Internet in the last 12 months, X_{BB_i} denotes Fixed broadband penetration rate, expressed as % of broadband connections per 100 inhabitants, X_{CSkill_i} stands for Individuals` level of computer skills, expressed as % of the total number of individuals aged 16 to 74, $X_{Inform_i}$ represents Individuals using the Internet for finding information about goods and services, expressed as % of individuals aged 16 to 74 and $X_{IntSkill}$ is Individuals` level of Internet skills. Error term capturing effects of unexpected shocks to Internet purchases is denoted by ε_i. It is worth noticing that all variables are expressed in percentages and are taken for EU 28 countries (without Luxemburg) for last available year 2011.

The results of estimating (1) via ordinary least squares (OLS) are displayed in (2):

$$\hat{Y}_{Pu_i} = -62.19 + 0.95 X_{BB_i} + 1.35 X_{CSkill_i} + 0.63 X_{Inform_i} + 0.67 X_{IntSkill_i} \quad (2)$$

$$\hat{\sigma} = 7.20\ Adj.R^2 = 0.88\ F = 49.23\ DW = 1.75\ n = 27$$

According to estimated model, a 1% increase in Fixed broadband penetration rate (X_{BBi}), holding other variables constant, would lead to 0.95 percentage points increase in Internet purchases by individuals. This regression coefficient is statistically significant at 5% significance level. The regression coefficient on $X_{CSkill\,i}$ is positive and statistically significant at 5% significance level, suggesting that a 1% change in Individuals` level of computer skills, holding other variables constant, according to the estimated regression model, would lead to a 1.35 percentage point increase in Internet purchases by individuals. Furthermore, a 1% increase in X_{Inform_i} (Individuals using the Internet for finding information about goods and services), holding other variables constant, would lead to 0.63 percentage points increase in dependent variable (Internet purchases by individuals) according to the estimated model. The regression coefficient is statistically significant at 1% significance level. Finally, the regression coefficient of $X_{IntSkill\,i}$ is positive and suggests that a 1% change in Individuals` level of Internet skills, holding other variables constant, would lead to 0.67 percentage points increase in Internet purchases by individuals, according to this model. This coefficient is statistically significant at 5% significance level.

The overall predictive power of the regression equation is favorable with the adjusted R^2 of 0.88 and significance of overall F-statistic at 1% level. The Durbin-Watson statistic of 1.75 indicates that the residuals are free of first-order autocorrelation at 1% significance level, and further analysis using Breusch-Godfrey Serial Correlation LM Test, suggests the absence of higher-order autocorrelation (Prob. Chi-square (2)=0.9339). Based on Breusch-Pagan-Godfrey heteroskedasticity test, the residuals appear to be homoscedastic (Prob. Chi-Square (4) = 0.5673). According to conducted Jarque-Bera test, the residuals are normally distributed (p-value=0.799). The results of the test are given in Fig. 4.

Given the favorable regression diagnostics and since none of the regression model assumptions is violated, tests of parameter stability were undertaken. Namely, the stability of the regression coefficients is evaluated using cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) of the recursive residual test for structural stability [1]. The CUSUM test is useful for spotting systematic changes in the regression coefficients, whereas CUSUMSQ test is helpful in situations where the departure from the constancy of the regression coefficients is abrupt and sudden. The results of these tests are shown in Figs. 5 and 6, respectively, along with a pair of lines representing the 5% significance level.

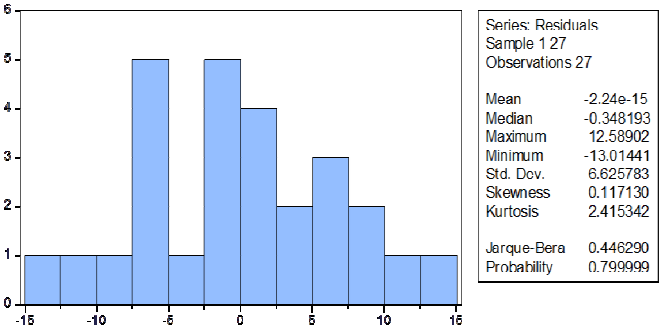

Fig. 4 Histogram of residuals and results of Jarque-Bera test for multiple linear regression model (EViews 7)

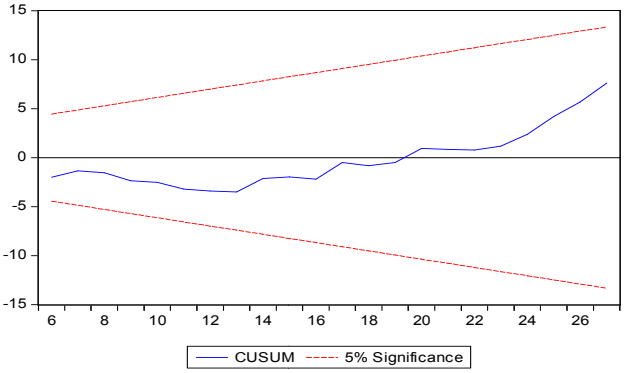

Fig. 5 CUSUM test statistics (EViews 7)

The CUSUM test result given in Fig. 5 suggests that there are no systematic changes in the regression coefficients at 5% significance level.

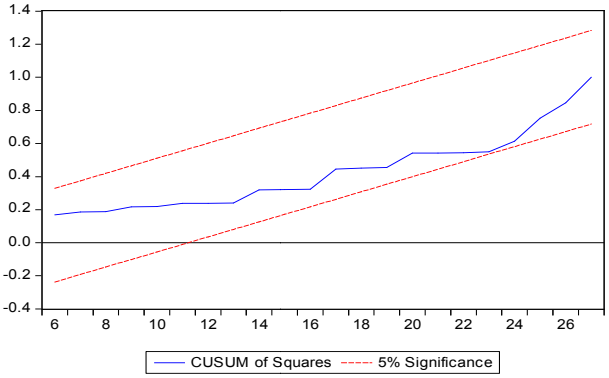

Fig. 6 CUSUMSQ test statistics (EViews 7)

Likewise, CUSUMSQ test results presented in Fig. 6 suggests that there is no departure from the constancy of the regression coefficients which would be abrupt and sudden. So, it can be concluded, on the basic of both test results, that the regression equation is stable, since neither of the conducted test statistics (CUSUM nor CUSUMSQ) exceed the 5% significance level boundaries.

B. Simple Linear Regression Analysis of Economic Development Level Influence on Internet Purchases

Since the gross domestic product (GDP) is considered to be a relatively good indicator which reflects the economic development level, it was interesting to explore the interrelation between GDP*pc*[2] and Internet purchases by individuals in EU28 (without Luxembourg) in 2011.Having in mind that Internet purchases stimulate economic growth through the consumption and provides people with a wide variety of products as well as meeting their material and cultural needs to a greater extent, according to [2]more and more consumers have been keen in online purchasing, thus increasing the consumption spending.

Taking all previously mentioned into account, the following equation is estimated using Ordinary Least squares (OLS):

$$Y_{Pu_i} = \beta_0 + \beta_1 X_{GDPpc_i} + \varepsilon_i,\ i = 1, \ldots, 27 \qquad (3)$$

The analysis is conducted using statistical software EViews 7 and resulted in estimated linear regression model given in (4):

$$\hat{Y}_{Pu_i} = -21.68 + 0.63 X_{GDPpc_i} \qquad (4)$$

$$\hat{\sigma} = 12.17 \quad R^2 = 0.67 \quad F = 51.66 \quad DW = 1.27 \quad n = 27$$

Based on the estimated model, a 1% increase in GDP *pc* would lead to 0.63 index points increase in Internet purchases by individuals. This regression coefficient is statistically significant on 1% significance level. Also, the coefficient of determination, suggests that GDP*pc* explains 67% of total variation in Internet purchases by individuals. Furthermore, the predictive power of the regression equation is favorable, with significance of overall F-statistic at 1% level. Also, there is no problem of autocorrelation of residuals at 15 significance level, according to both,[Durbin-Watson statistic of 1.27 and Breusch-Godfrey Serial Correlation LM Test, which suggests the absence of higher-order autocorrelation (Prob. Chi-square (2)=0.2306). Furthermore, according to Breusch-Pagan-Godfrey heteroskedasticity test, the residuals appear to be homoscedastic (Prob. Chi-Square (1) =0.0835).Finally, based on conducted Jarque-Bera test, the residuals are normally distributed (p-value=0.709). The results of the test are given in Fig 7.

[2]GDP per capita in Purchasing Power Standards (PPS) (EU27 = 100) - GDP includes goods and services that have markets (or which could have markets) and products which are produced by general government and non-profit institutions [12].

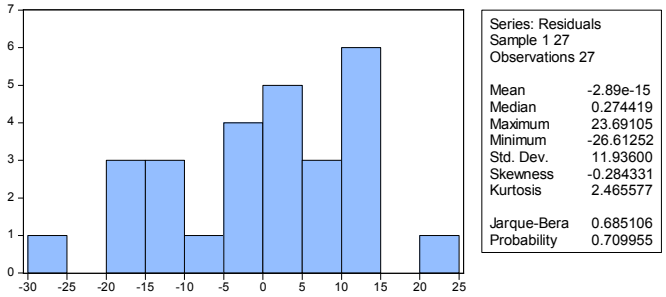

Fig. 7 Histogram of residuals and results of Jarque-Bera test for simple linear regression model (EViews 7)

Since the model passed all diagnostic tests, stability of parameters were further tested. Namely, the stability of the regression coefficients is evaluated using cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) of the recursive residual test for structural stability. The results of conducted tests are shown in Figs. 8 (a) and (b), respectively.

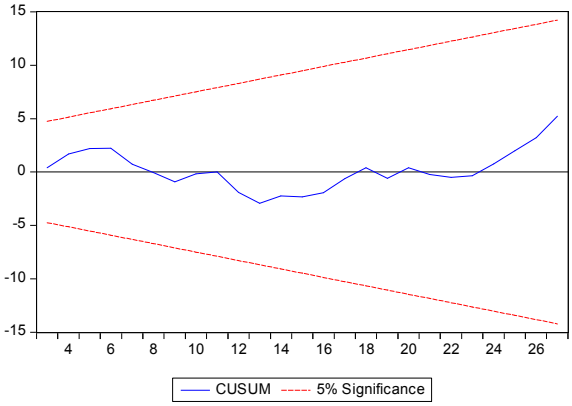

Fig. 8 (a) CUSUM test statistics (EViews 7)

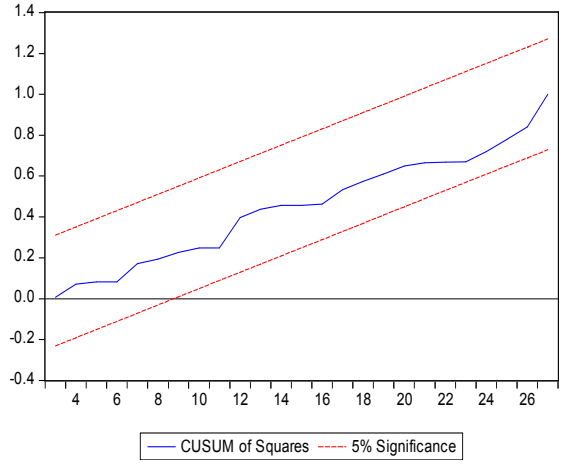

Fig. 8 (b) CUSUMSQ test statistics (EViews 7)

On the basic of both test results, it can be concluded that the regression equation is stable, since neither of the conducted test statistics (CUSUM nor CUSUMSQ) exceed the 5% significance level boundaries.

V. Conclusion

This paper fills the gap in the existing literature by exploring the influence of individual`s level of computer skills, individual`s level of Internet skills, fixed broadband penetration rate and individuals using the Internet for finding information about goods and services on Internet purchases in EU countries. Also, influence of GDP *per capita* on Internet purchases was explored.

When exploring data for each of ten variables, the Internet purchases as the regressand and nine regressors under consideration, it was found that GDP *per capita* has an extremely skewed distribution with a serious outlier for Luxemburg. This was the reason for excluding data for this country from the further regression analysis. So, the further regression analysis was conducted for the last available year 2011 and for 26 EU member states and Croatia.

The estimated multiple linear regression model confirmed the research hypothesis that Internet purchases in EU countries is mostly influenced by individual`s computer skills. Since the model passed all relevant diagnostics tests and since it showed to be stable according to conducted parameter stability tests, it can be used for predicting Internet purchases in EU in the following years, thus helping the decision makers in on-line purchases to reach adequate decisions with smaller risk.

Also, since GDP *per capita* is considered to be a good indicator that reflects the economic development level, it was interesting to explore how Internet purchases in EU28, without Luxembourg, depends on that important economic variable. As expected, GDP *per capita* explained 2/3 of total variation in Internet purchases by individuals, confirming the research hypothesis that the gross domestic product (GDP) in analyzed countries influences Internet purchases by individuals in a statistically significant way.

Finally, it might be concluded that both, the economic and ICT development level indicators, are relevant when explaining the increasing trend of Internet purchases in EU member states.

Appendix

TABLE A
Variables Used in Multiple Linear Regression Analysis of Internet Purchases in EU28 Countries (without Luxembourg)(N=27, K=4) in 2011

Symbol	Definition
Regressand: Y_{Pu}	Dependent variable, Internet purchases by individuals, expressed as % of individuals who purchased goods through Internet in the last 12 months
Regressors:	
X_{BB}	Fixed broadband penetration rate, expressed as % of broadband connections per 100 inhabitants.
X_{CSkill}	Individuals` level of computer skills, expressed as % of the total number of individuals aged 16 to 74
X_{Inform}	Individuals using the Internet for finding information about goods and services, expressed as % of individuals aged 16 to 74
$X_{IntSkill}$	Individuals` level of Internet skills, expressed as % of the total number of individuals aged 16 to 74

Source: Eurostat

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