THE ECONOMETRIC ANALYSIS OF THE DEPENDENCE BETWEEN THE CONSUMER, GDP AND THE INTEREST RATE USING THE EVIEWS PROGRAM

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ABSTRACT: *In this paper is performed an econometric analysis of the dependence between of consumption, GDP and interest rates of 15 European Union countries over a period of three years. The main purpose of this paper is to show how this can be done using the Eviews program, the steps that we must go through this program and to forecast achievements of the phenomenon studied.*

KEY WORDS: *Gross Domestic Product (GDP); Method of Least Squares (MLS); Ordinary Least Squares (OLS); Eviews Program*

JEL CLASSIFICATION: *C24, E20, E43*

1. INTRODUCTION

The subject refers to the dependency analysis at European level between the consumption per capita, GDP per capita and the interest rate, from the Keynesian theory of consumption function, interpreted as a linear dependence between private consumption and disposable income. Theoretically, this dependence is positive and can be measured by the marginal propensity to consumption which shows how much of each additional monetary unit perquisite will be spent on consumption. Typically, the economies of developed countries are characterized by lower values of BMI.

For this econometric analysis were used as data sources 15 Member States of the European Union for a period of three years and has as endogenous variable the consumption per capita and as exogenous variables the GDP and interest rate.

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The measuring unit used for all the data is Euro per capita made at current prices. For this reason, data have been restated with the Consumer Price Index to provide comparable prices in 2000 and to ensure comparability of data. The data to be processed are given in Table 1.

Table 1. The data to be processed

	2000			2001		
	GDP / CAPITA	CONSUM/ CAPITA	INTR./ RATE	GPD / CAPITA	CONSUM/ CAPITA	INTR./ RATE
Bulgaria	1700,00	1500,00	0,00	1780,69	1593,25	0,00
Czech Republic	6000,00	4400,00	7,50	6482,36	4671,12	5,75
Denmark	32500,00	23700,00	5,40	32682,93	23804,88	3,60
Estonia	4500,00	3400,00	0,00	4843,30	3608,74	0,00
Cyprus	14500,00	11700,00	7,00	14893,62	12088,97	5,50
Latvia	3600,00	3000,00	5,50	3933,14	3244,84	5,50
Lithuania	3500,00	3100,00	10,38	3915,66	3413,65	5,50
Hungary	5000,00	3700,00	13,75	5272,73	4000,00	11,25
Malta	10800,00	9100,00	5,30	10551,79	9196,52	4,80
Poland	4900,00	4000,00	23,00	5410,63	4444,44	15,50
Romania	1800,00	1600,00	35,00	1451,38	1233,67	35,00
Slovenia	10800,00	8200,00	11,00	10487,58	8003,68	12,00
Slovakia	4100,00	3100,00	9,25	4190,48	3238,10	9,00
Sweden	30000,00	22700,00	4,75	27663,73	20821,11	4,50
United Kingdom	27200,00	22900,00	6,00	27228,21	23114,59	4,00

	2002		
	GDP / CAPITA	CONSUM/ CAPITA	INTEREST RATE
Bulgaria	1885,19	1705,65	0,00
Czech Republic	7233,13	5378,48	3,75
Denmark	32806,43	24127,98	2,95
Estonia	5240,18	3953,12	0,00
Cyprus	15003,71	12423,45	5,00
Latvia	3986,29	3321,91	5,00
Lithuania	4308,65	3707,44	10,00
Hungary	5897,72	4465,41	9,50
Malta	10599,82	8817,55	4,30
Poland	5199,62	4443,31	8,75
Romania	1301,15	1123,72	20,40
Slovenia	10506,54	7858,55	10,50
Slovakia	4399,84	3483,20	8,00
Sweden	28478,84	21743,98	4,50
United Kingdom	27359,50	23464,57	4,00

Data Source: Eurostat

Next is presented the mathematical model of these applications what's next to being solved using Eviews 7.0 software package.

2. THE MATHEMATICAL MODEL

In this econometric model the following notations are used for the variables that enter into its composition:

- C_t is the total consumption per capita;
- GDP_t is Gross Domestic Product per capita;
- $RATA_t$. is the interest rate.

Using the variables above, we define the following econometric model:

$$C_t = b + a \cdot GDP_t + c \cdot RATA_t + \varepsilon_t \qquad (1)$$

where a ,b and c are the parameters to be determined after applying the method of least squares.

Next we analyze descriptively the data sets used in this model.

Therefore, after processing the two data sets, we obtain information on the statistical indicators that are contained in the graphs below:

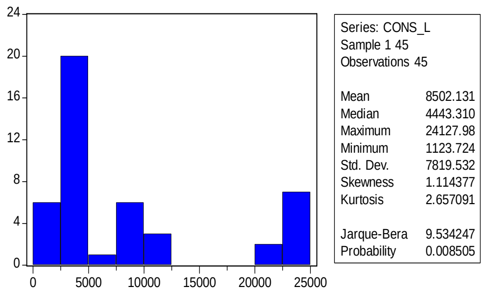


Figure 1. The descriptive statistics for Consumption per capita

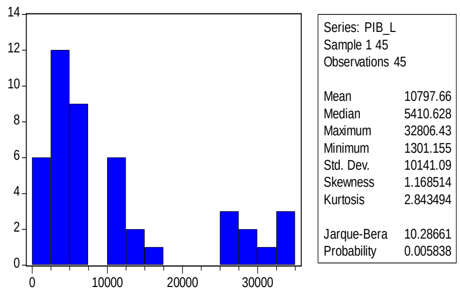


Figure 2. The descriptive statistics for GDP per capita

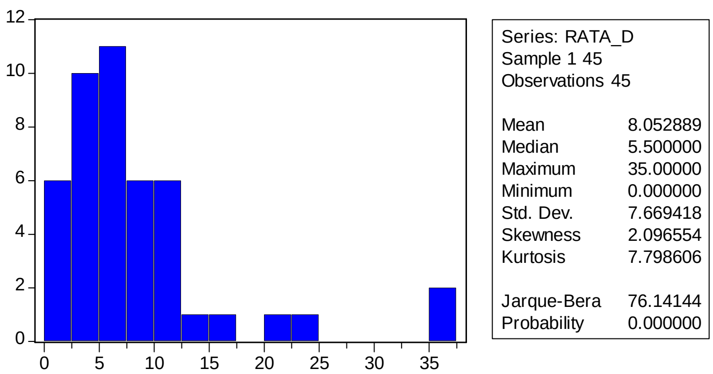


Figure 3. The descriptive statistics for the benchmark interest rate

To test the normal distribution of the three data sets, we present the histogram of the three series in which is observed the mean, median, minimum and maximum values, standard deviation, coefficient of asymmetry, kurtorica, and Jarque-Bera test.

In the histograms presented above, we see that the distributions of consumption, GDP and interest rates are platikurtotic (kurtotica <3). In a leptokurtotic distribution, the probability of occurrence of an extreme event is higher than the probability of occurrence of that event, implied by a normal distribution. Therefore, the evaluation models can cause errors assuming a normal distribution of GDP. The Jarque-Bera coefficient, is testing if a distribution is normally distributed. The test measures the difference between the coefficient of asymmetry and the kurtotica of distribution analyzed with the normal distribution. The test has the null hypothesis: the series is normally distributed. Thus, if the probability associated to the test is superior to the relevant level (1%, 5% or 10%), then the null hypothesis is accepted. In the example above, as the probability value is less than 10%, we can say with certainty that the null hypothesis is rejected.

From the analysis of the corelograms it is seen that between the two variables (consumption and GDP) is a direct link and type of link is one linear, this can be seen in the graphic representation of the cloud data.

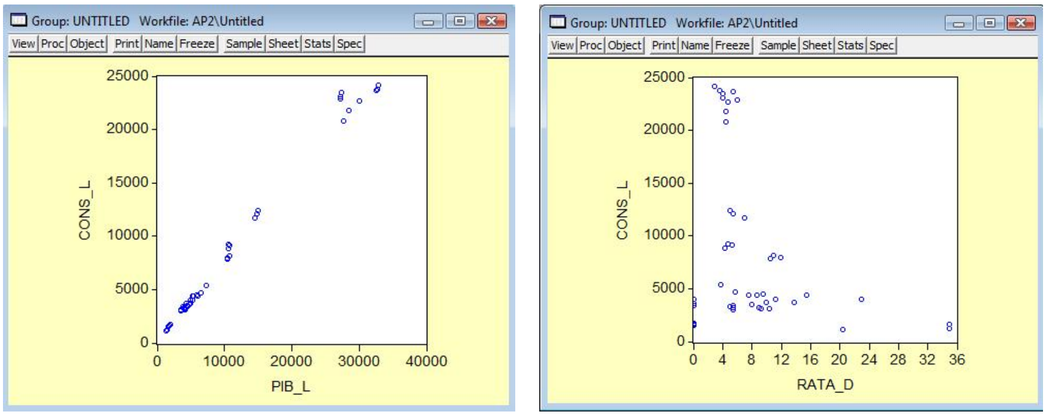


Figure 4. Graphical representation of the cloud data for the two variables

After descriptive analysis of data series, in what follows we will actually solve the econometric model given by (1). To determine those three parameters, we use the method of least squares and we use the following command in EViews: ls cons_l c pib_l rata_d.

The values of the parameters a, b and c are determined using the method of least squares using the Eviews, and are given in Figure 5. Within this, we see that the straight regression given by the equation (1) can be written as following:

$$C_t = 246.0538 + 0.767030 \cdot GDP_t - 3,234870 \cdot RATA_t \tag{2}$$

Also, for each independent and constant variable, EViews reports the standard error of the coefficient (Std. Error), the t- Statistic test and probability associated with it.

Equation: EQ01 Workfile: AP2\Untitled

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: CONS_L
Method: Least Squares
Date: 01/18/10 Time: 20:39
Sample: 1 45
Included observations: 45

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	246.0538	228.0509	1.078942	0.2868
PIB_L	0.767030	0.011538	66.47702	0.0000
RATA_D	-3.234870	15.25678	-0.212028	0.8331

R-squared	0.991448	Mean dependent var	8502.131
Adjusted R-squared	0.991041	S.D. dependent var	7819.532
S.E. of regression	740.1488	Akaike info criterion	16.11592
Sum squared resid	23008448	Schwarz criterion	16.23636
Log likelihood	-359.6082	F-statistic	2434.535
Durbin-Watson stat	1.792076	Prob(F-statistic)	0.000000

Figure 5. Eviews window to determine the parameter values of the mathematical model

Eviews, (also reports R^2 value) (R-Squared) that shows what percentage of the total variance of the dependent variable is due to the independent variable. This coefficient is taking values between 0 and 1 and if it's closer to 1, the regression is well determined. As in this case, R^2 has a value of 0.991448 therefore the above condition is satisfied.

For like the model to be valid, in the following we check the assumptions the model linear regression.

3. THE CHECKING OF THE ASSUMPTIONS OF THE MODEL OF LINEAR REGRESSION

Testing the validity of assumptions made in the linear regression model is similar to autocorrelation analysis, the normality and heteroskedasticity.

31. The average error is zero

To test this hypothesis we perform histogram of errors, highlighting the average of the errors. In the histogram of errors we notice that the average is $1{,}87 \cdot 10^{-12}$, which means that errors are normally distributed, ie normality is checked, so the Mean of the errors is approximately zero.

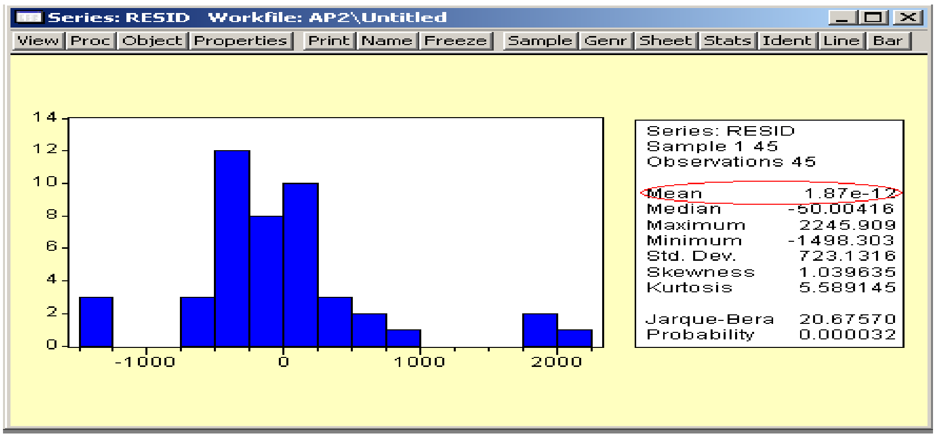


Figure 6. The histogram of the erors

3.2. The series of errors is homoscedastic

The verification of the homoscedastic errors hypothesis for this model will be done using White test.By using Eviews program the following results were optained:

Equation: EQ01 Workfile: AP2\Untitled

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

White Heteroskedasticity Test:

F-statistic	7.576954	Probability	0.000047
Obs*R-squared	22.17363	Probability	0.000485

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/18/10 Time: 22:36
Sample: 1 45
Included observations: 45

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-323123.5	494168.4	-0.653873	0.5170
PIB_L	102.6188	94.53071	1.085560	0.2843
PIB_L^2	-0.000111	0.002168	-0.051318	0.9593
PIB_L*RATA_D	-5.349450	8.327444	-0.642388	0.5244
RATA_D	9326.740	73755.10	0.126456	0.9000
RATA_D^2	147.9055	1804.986	0.081943	0.9351

R-squared	0.492747	Mean dependent var	511298.9
Adjusted R-squared	0.427715	S.D. dependent var	1107696.
S.E. of regression	837966.8	Akaike info criterion	30.23891
Sum squared resid	2.74E+13	Schwarz criterion	30.47980
Log likelihood	-674.3755	F-statistic	7.576954
Durbin-Watson stat	2.415886	Prob(F-statistic)	0.000047

Figure 7. The check of the hypothesis of homoscedasticitate

The White test is a statistical test that is based on the following regression model:

$$r_t^2 = a_0 + a_1 \cdot GDP\_L_t + a_2 \cdot GDP\_L_t^2 + a_3 \cdot GDP\_L_t \cdot RATA\_D_t + \\ + a_4 \cdot RATA\_D_t + a_5 \cdot RATA\_D_t^2 \quad (3)$$

After running the EViews program, parameters are estimated using ordinary least squares (OLS):

$$\begin{aligned} r^2 &= \text{-}323123{,}5 + 102{,}6188 \cdot GDP\_L - 0.000111 \cdot GDP\_L^2 - \\ &\text{-}5{,}349450 \cdot GDP\_L \cdot RATA\_D + 9326{,}740 \cdot RATA\_D + 147{,}9055 \cdot RATA\_D^2 \end{aligned} \tag{4}$$

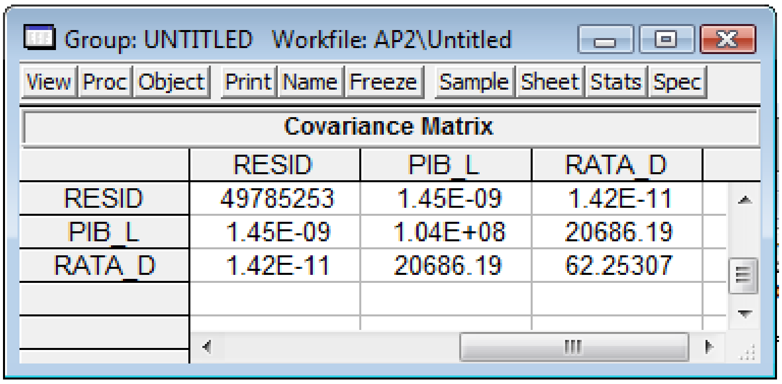
Analyzing the indicators F-Statistic and Obs*R_squared and comparing them with the tabulated values, results: $F_S=7{,}57 > F_{0{,}05;2;10} = 3{,}23$ and $LM = 22{,}17 > \chi^2_{0{,}005;2} = 5{,}99$ that indicates us the existence of heteroskedasticity , therefore we smust use other methods for estimating the parameters.

3.3. Non-autocorrelation of the error

The verification of the hypothessis of independence of errors which implies that $\mathrm{cov}(\varepsilon_t, \varepsilon_{t\text{-}1}) = 0$, is performed using the Durbin-Watson test, consisting of calculating the variable d and comparing it with two theoretical values d_1 and d_2,, from the Durbin Watson distribution table, according to a significance threshold α *(*$\alpha = 0.05$*),* the number of explanatory variables k *(*$k = 2$*)* and the number of observations n *(*$n \geq 45$*).*

Observation: the Durbin-Watson table is built for a number of $n \geq 45$ observations; for the lower values will work with the calculated values for $n = 45$, ie $d_1 = 1{,}430$ and $d_2 = 1{,}615$. Because the calculated value $d = 1{,}792076$ ranges between the $d_2 < d < 4 - d_2 = 2{,}385$ results a nonexistent autocorrelation of errors.

3.4. Data series for these features are not stochastic



	RESID	PIB_L	RATA_D
RESID	49785253	1.45E-09	1.42E-11
PIB_L	1.45E-09	1.04E+08	20686.19
RATA_D	1.42E-11	20686.19	62.25307

Figure 8. The Eviews window presenting the covariance matrix

To do this we must show that the variables pib_l and rata_d, are uncorrelated in other words *cov(pib_l,resid)=0* şi *cov(rata_d,resid)=0.* To do this we calculate the covariance matrix and read the values on the secondary diagonal. We note that the values $1.45*10^{-9}$ şi $1.42*10^{-11}$ are approximative 0.

3.5. The explanatory variables are not correlated with residual variables

To test this hypothesis, the following two corelogrames must be created:

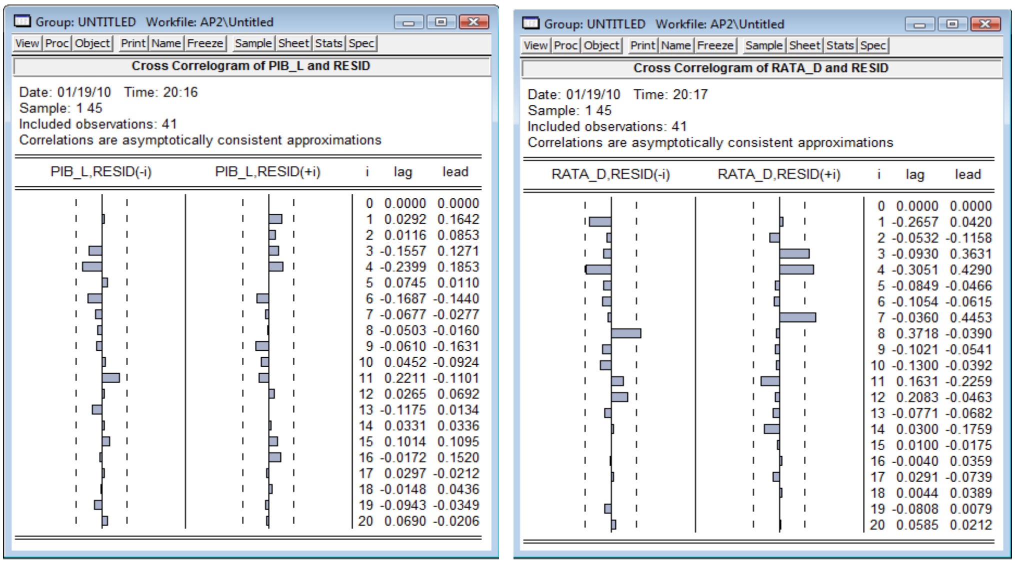


Figure 9. The Eviews window with presenting two corelograme

It is noticed that the values are uncorrelated because they don't exceed the confidence band, except lag 7.

3.6. Among the explanatory variables there is no significant linear dependency

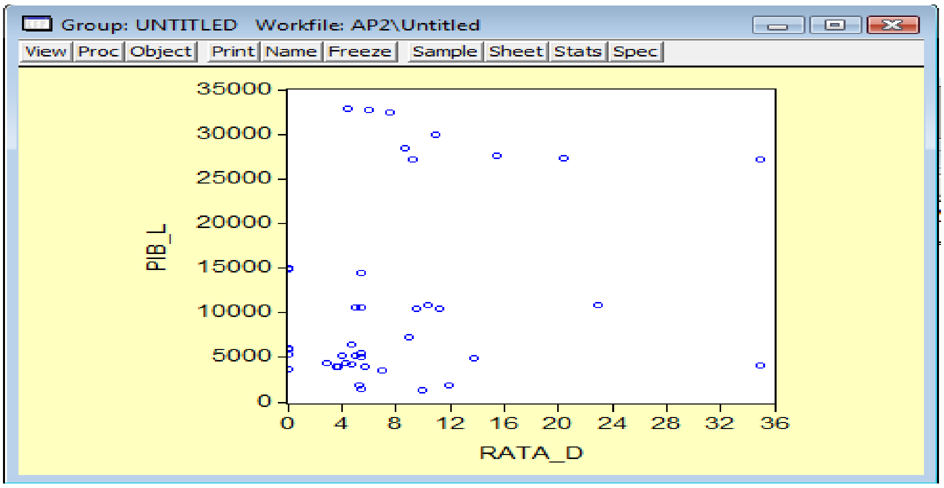


Figure 10. Graphical representation of the data cloud of GDP and interest rate

To test this hypothesis a point cloud is made between explanatory variables rata_d pib_l , where we can observe that between GDP and interest rate there is no linear link, ie a straight line can't go through a data cloud leaving out a smaller number of points, with a smaller error.

3.7. The normality of errors

Normality of errors is seen in the histogram of errors. The Skewness indicator isn't close to 0 and kurtosis is not close to 3, the result is an error for rejecting the null hypothesis (normal distribution of p = 0).

From the assumptions above, we conclude that the linear regression model must be corrected to meet the assumptions of a multiple linear regression model, because the admission of this model may cause errors such as:

- overstatement of the determination raport
- the inefficient estimators in estimation;
- erroneous results after applying the t-Student test indicating a higher significance of the estimators

Given the above, we suggest a model equivalent to the interpretation of elasticities as:

$$\log(CONS\_L)_{ij} = C(1) + C(2)\cdot\log(GDP\_L)_{ij} + C(3)\cdot\log(RATA\_D)_{ij}, \quad (5)$$

Estimating the parameters using OLS we lead to the following relation:

$$\begin{aligned}&\log(CONS\_L)_{ij} = 0.07648345836 + 0.9685414436\cdot\log(GDP\_L)_{ij}\\ &- 0.008151603069\cdot\log(RATA\_D)_{ij},\end{aligned} \quad (6)$$

This econometric model is better than the previous one because of the following reasons:

- errors follow a normal distribution, by the medium 0 and the repartition σ^2
- the hypothesis of the autocorrelation is fulfilled, the Durbin-Watson statistic $DW \in [d_L, 4\text{-}d_U]$, shows no autocorrelation
- the hypothesis of the homoscedasticitate is fulfilled.

4. MAKING FORECAST

Applying this model on the series of known data, ie GDP and interest rates in 2003, we can predict this year's consumption for three countries: Hungary, Poland and United Kingdom.

After running the EViews program, the following prognoses were extracted:

- For Hungary: the consumption is 5441.164895 having an error of approx. 15%
- For Poland: the consumption is 4447.892486 having an error of approx. 8%
- For United Kingdom: the consumption is 23279.98065 having an error of approx. 15%

In making the predictions on this econometric model, we note that this model has to be improved to achieve a probability value under 5%.

5. CONCLUSIONS

Based on the model above can be seen that in Romania the interest rate correlates well with the growth rate of GDP. This rate decreases when the total expenditure increases, due to increased consumption. This conclusion emerges from the annual BNR references from 2000 to 2003 where we can see that between the GDP and the interest rate there is an inverse relation, meaning that as the interest rate decrease (in 2000 the average interest rate decreased from 46.6 to 20.34 in 2003) the macroeconomic variable GDP starts to increase (the GDP regarding the prices raised from 803773 billion in 2000 and 1890778 billion in 2003).

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