

Секция «9. Количественные методы и информационные технологии в финансах и экономике»

Econometric model of Consumption function. Case of Brazil

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Introduction. Nowadays we live in globalized mass production world. Our disposable income has direct influence on our life style, quality of existence and consumption possibility. That is why it is very important to understand the dependence between our purchase power and real income.
1. Description of the economic system. In economics, the consumption function is a single mathematical function used to express consumer spending. John Maynard Keynes developed it. The function is used to calculate the amount of total consumption in an economy [1]. Econometric model is: $C_t = a_0 + a_1 Y_t^d +$

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Where: C_t - total consumption; a_0 - autonomous consumption; Y_t^d - disposable income. Also we have MPC- marginal propensity to consume here it is a_1 . The data collection process was very difficult, but interesting. Unfortunately it is impossible to find data for final consumption per person (US). That is why it was calculated as the ratio between household final consumption and total population. See Table 1. Calculation of the data.
2. Formulation of the problem. In economics, the consumption function is a single mathematical function used to express consumer spending. John Maynard Keynes developed it.
Consumption function depends on disposable income $-Y^d$. If disposable income increases then consumption also rise.
The marginal propensity to consume (MPC) - a_1 , measures the rate at which consumption is changing when income is changing. MPC is actually the slope of the consumption function.
Autonomous consumption - a_0 represents consumption when income is zero. In estimation, this is usually assumed to be positive.
Econometric model: $C_t = a_0 + a_1 Y_t^d +$

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$a_0 > 0, a_1 > 0$

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$\sigma_t = 0$

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$\sigma_t = \text{const}$
3. Determination of endogenous and exogenous variables. Exogenous variables are external variables of a model. They should explain the value of internal variables. Endogenous variables are internal variables of a model. In our econometric model $- Y_t^d$ is exogenous variable; C_t - is endogenous variable.
4. Calculation of the correlation

matrix.par To build matrix of pair correlation we should use Data Analysis, choose- Correlation. At the end we will take matrix of pair correlation. According to our input data of Brazil we have the following results (See table 2).par According to the table 2 corr=0,96 there is a strong positive linear relationship between personal disposable income (US)andfinalconsumptionperp
 On the next section we will understand this results graphically on the scatter diagram.par **5. Plotting of the scatter diagram.**par In order to establish a different kind of dependence we must construct a scatter diagram. To construct scatter diagram we need to use our input data, actually on the y-axis we will put dependent variable and on the horizontal x- axis we put unemployment rate as independent variable.par Also we should chose to build Trend line and according to this trend line choose to build Trend line equation. All coefficients and numbers should be rounded to two decimal places. See the figure 1.par Trend line actually proof that there is positive dependence between two variables: if personal disposable income raise then final consumption per person will also rise . The slope of the trend line is reflected on the coefficient before -0,18x, free coefficient is 1998,59 it is a point where our trend line can intersect y axis; and $R^2=0,93$. Scatter diagrams show this graphically.par **6. Description of statistical data related to the model.**par The statistical data was taken from the websites. Then were done some calculations (see Table 1. Calculation of the data) and next the following table was build. All statistical data are related to Brazil from 2000 to 2009 year.par **7. Construction of the econometric model.**par Model specification:par In economics, the consumption function is a single mathematical function used to express consumer spending. John Maynard Keynes developed it[3] .par Consumption function C_t depends on disposable income Y_t^d . If disposable income increases then consumption also rise.par Econometric model:par $C_t=a_0+a_1Y_t^d+$

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$a_0>0, a_1>0$ par E(

E

σ^2)=0,par σ^2 (

E

σ^2)=constpar Estimation of coefficients in Excel.par To estimate coefficients in excel we should use function - =LINEST(). Than we should math rectangle 2:5 and click SHIFT+ CTRL+ENTER together. If all steps were done correct we will take the table with write values. The result is shown on the Figure 2.par R^2 -Test.par According to our calculations $R^2= 0,93$. So R-square is $> 0,75$, therefore regression model explains values of y with our concrete values of x[4].par F - Test.par For this test we need F crit. To find it we can use =F.INV.RT function. Our probability will be 0,05; Degree of freedom 1 is 1; Degree of freedom1 is 1 and Degree of freedom2 is 8. The result is: F crit= 5,32. As was previously calculated F= 107,65. To sum up F critT - Test. For this test we need T crit. To find it we can use =T.DIST.2T function. Our probability will be 0,05; Degree of freedom is 8.par $|t| > t$ crit so it means that coefficients are significant .par Now we can add some values in our estimated form:par Estimated form:par $C_t=1998,59+0,18Y_t^d+$

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t par (56,75) (0,02) (59,63) par $R^2=0,93$ $F=107,6$ $F_{crit}=5,32$ par Next, we can check our residuals; they should be equal to 0. To do it we should use function =AVERAGE (). So they are equal to 0. par Goldfield-Quant test. par We should do this test to check second condition of Gause-Markov Theorem that the population variance of the disturbance term should be constant for all observations. par Firstly we should use the function =ABS () and then to sort our data from the lowest to the biggest. par Then we should provide the regression analysis for the two parts (they are matched as yellow and orange). We do not take into account the average row (white row), because the number of observation is odd. The result gives us RSS1 and RSS2. To calculate GQ we need RSS1/RSS2. When all calculations are done we can analyse results. See table 3. par According to these results our conclusion is: Residuals are homoscedastic. Second Gauss-Markov condition is confirmed. We can use Ordinary Square in order to estimate model and find estimates[5]. par Durbin-Watson - Test. par Firstly we need to provide the following calculation in the excel table. Y_t is calculated as = y intersection + a_1 last value of X (2009 year) and it is equal to 2840,58. Then we need to find Y_t^- and Y_t^+ to estimate that modal is adequate. par According to calculations $Y_t^- = 2703,09$ and $Y_t^+ = 2978,08$. So $Y_t^- < Y_t < Y_t^+$ It means that the confidence interval contains Y_t so the model is adequate. par Now we can find DW. par $Dw = (e_t - e_{t-1})^2 / (e_t)$ par $Dw = 47996,85 / 23775,80 = 2,02$ par According to our input data number of observations is 10 and we have two variables. So we should find these values in Critical Values for the Durbin-Watson Test: 5T-4). To our model $dl = 0,87913$; $du = 1,31971$. Then we should build intervals and analyze the results. It is shown on the Figure 3. According to these table there is no autocorrelation and residuals. The third Gause-Markov Condition is confirmed and we may use ordinary list square for estimation [6]. par Model forecasting. par At the end of these work we can provide some forecasts to Final consumption per person with the usage of our previous calculation. par But firstly we need to calculate forecast error. In numerator we put modulus of the difference between Y_t and real last value of Y^d from our input data and in denominator we put also real last value of Y^d from our input data then we should multiply all this ratio by 100. Error is equal to 1,85. According to our estimated econometric model we can provide some forecasts. par If the personal disposable income in Brazil will increase up to 5500 in 2014 than final consumption per person will be : par $C = 1998,59 + 0,18 * 5500 = 2988,5$ (per person) But if disposable income will increase just to 5000, so par $C = 1998,59 + 0,18 * 5000 = 2898,5$ (per person). par **Conclusion.** par Our econometric model of Consumption function in an example of Brazil from 2000 to 2009 has passed all tests despite that Brazil has unstable economy last at the end of the 20-th century and hyperinflation. par According to (corr=0,96) there is a strong positive linear relationship between personal disposable income (US) and final consumption per person (US). Calculations of $R^2 = 0,93$ shown that regression model explains values of y with our concrete values of x. F test has shown that F crit is less than F. So the quality of specification of R-square is high and it was formed without influence of random values. T -test has provided prove that coefficients are significant. According to the results of Goldfield-Quant test residuals are homoscedastic. Second Gauss-Markov condition is confirmed. We can use Ordinary Square in order to estimate model. Confidence interval test has shown that model is adequate and Durbin - Watson - test has shown that the Third Gause-Markov Conditions is confirmed and we may use ordinary list square for estimation. par [1] http://en.wikipedia.org/wiki/Consumption_function

1. http://en.wikipedia.org/wiki/Consumption_function

2. 2. I.V.Tregub “Dynamic mathematical models of economical systems” Finance University 2007.
3. 3. <http://seekingalpha.com>
4. 4. <http://search.worldbank.org>
5. 5. <http://www.tradingeconomics.com>

Иллюстрации

Source:	http://www.tradingeconomics.com	http://search.worldbank.org/da	Consumtion/population
Year	Household final consumption expenditures(US \$)	Population, total	Final consumption per person (\$US)
2000	415000000000	174 504 898,00	2378,16
2001	424000000000	176 968 205,00	2395,91
2002	425000000000	179 393 768,00	2369,09
2003	429000000000	181 752 951,00	2360,35
2004	451000000000	184 010 283,00	2450,95
2005	460000000000	186 142 403,00	2471,23
2006	487000000000	188 134 315,00	2588,58
2007	520000000000	189 996 976,00	2736,89
2008	555000000000	191 765 567,00	2894,16
2009	560000000000	193 490 922,00	2894,19

Рис. 1: Table 1. Calculation of the data.

	<i>(C) Final consumption per person (US \$)</i>	<i>(Yd) Personal disposable income (US\$ per capita)</i>
<i>(C) Final consumption per person (US \$)</i>	1	
<i>(Yd) Personal disposable income (US\$ per capita)</i>	0,96	1

Рис. 2: Table 2. Matrix of pair correlation

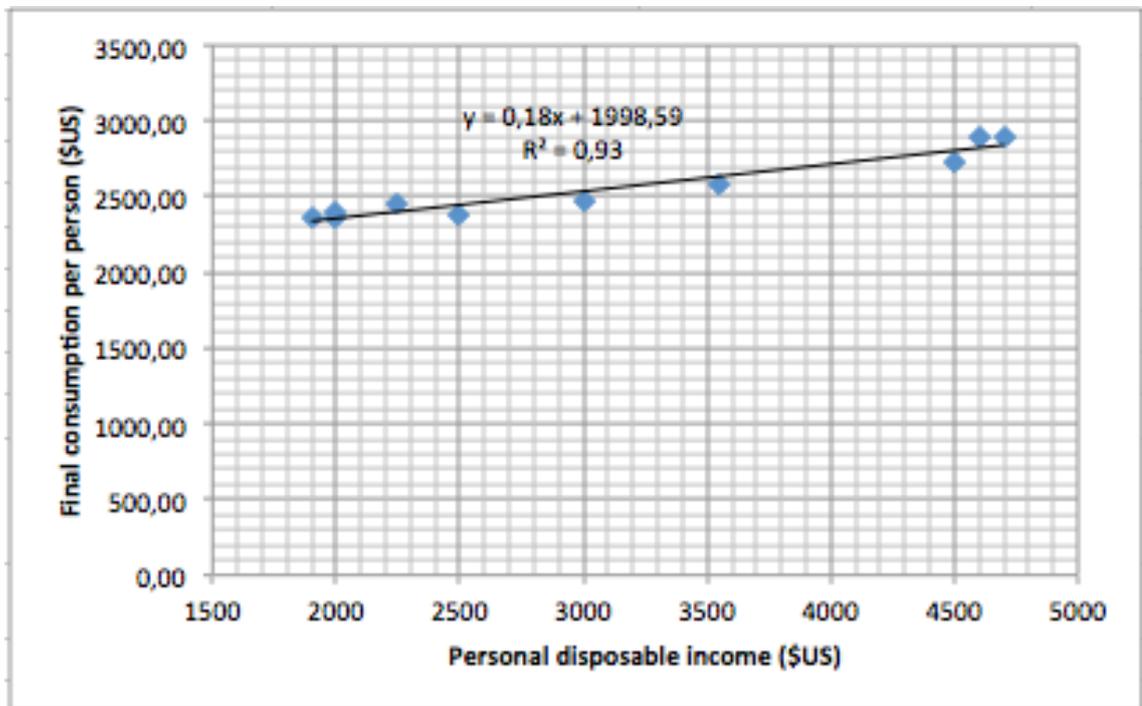


Рис. 3: Figure 1. Scatter diagram.

	a_1	a_0
	0,18	1998,59
	0,02	56,75
R^2	0,93	59,63
F	107,65	8,00
	382717,52	28441,28

Рис. 4: Figure 2. Estimated coefficients, R-square, F, standard deviation of the model.

RSS1	=	4709,70
RSS2	=	10243,13
F crit GQ	=	9,28
GQ	=	0,460
1/GQ	=	2,175
GQ	<	F crit GQ
1/GQ	<	F crit GQ

Рис. 5: Table 3. Results of the GQ – test.

DW		2,02					
dl		0,87913		du < 2,02 < 4 - du			
du		1,31971					
	0	dl	dU	2	4 - du	4 - dl	4
	0	0,88	1,32	2,00	2,68	3,12	4

Рис. 6: Figure 3. Value of DW in the estimated intervals.