PRELIMINARY REPORT

Econometric Model of Interest Rates on Deposits in Montenegro

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Summary: Last years econometric models had become very important toll in planning, analyses and prognoses. This paper presents the process and methodology that is used in econometric modeling, with a particular focus on the modeling performed by the E-views 3.0 software package. The interest rates on deposits in Montenegro will be presented to demonstrate the process of econometric modelling. Interest rates as macroeconomic phenomena determine and harmonize relations between demand and supply for credits; they aid in directing savings into investments, as well as provide adequate returns to participants in the financial market. Given the great importance of interest rates, this paper will define and analyze the factors which determine Montenegrin interest rates on deposits, and also formulates a model to predict these numbers.

Key words: Econometric models, Interest rate on deposits

JEL: C01, E43

Introduction

The Montenegrin economy is specific by it's monetary policy. The power of monetary policy is limited because Montenegro does not have it's own currency, but instead uses the euro. In the year 1999 Montenegro introduced DEM as the official currency, and by so doing denied the main instrument of monetary policy. This also choused the market from being the regulator of monetary value.

Interest rates on deposits in Montenegro had been constantly increasing in the last few years, as can be seen in Graph 1.

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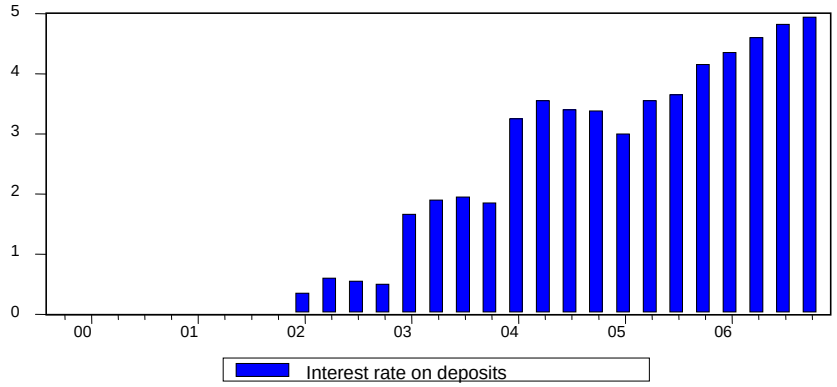
Graph 1. *Interest rate on deposits in Montenegro (2000-2006)*



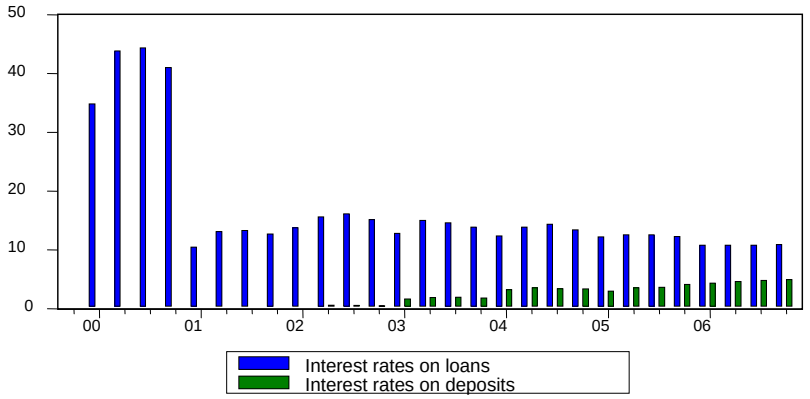
Source: Institute for Strategic Studies and Prognoses

Graph 1 presents data of interest rates on deposits at the quarterly level in the period 2000-2006. The increase of interest rates on deposits was instigated by the banks' need for large quantities of deposits. These would be invested in the form of high interest rate loans to citizens, companies and the government. Pressure resulting from competition among lending institutions in an environment of ever-mounting demand was also a factor. Banks in this period were experiencing outstanding growth in their credit portfolios.

Interest rates on loans were high: at one point the state was expanding debt as a result of treasury bills featuring interest rates in excess of 12 percent. Privatization in the banking sector created a dynamic competition environment, and by so doing created the need for banks to compete in collecting resources from clients. In consideration of a high risk premium at that time caused by a non-existent credit rating and an unstable political situation, inflow of foreign capital. The economy began growing, revenues from privatization and the capital markets were expanding, and confidence in the banking system was returning. The concurrence of these events ushered in lower interest rates and a resulting environment of competition among banks to collect deposits.

The last few years have seen Montenegrin interest rates on loans decrease while interest rates on deposits increased (see Graph 2).

Graph 2. *Range of interest rates on loans and interest rates on deposits in Montenegro (2000-2006, at the quarterly level)*



Source: Institute for Strategic Studies and Prognoses

The large gap between interest rates on loans and interest rates on deposits is the consequence of several factors. Basic interest rates in Montenegrin banks are the same as those in euro zone countries. However, it is necessary to append to the basic interest rates a premium for risk as well as adjust for the expected rate of inflation.

The most frequently cited reasons for the high risk associated with the Montenegrin market are:

- inadequate functioning of institutions that are guarantying collectibles of claims
- inadequate legal solutions for insurance collections of claims
- sub-par quality of borrower companies
- sluggish judicial process
- premium for national credit rating

In addition to risk, the factors which influence interest rates are:

- inflation,
- bank operating costs
- demand for credits compared with supply

The effective interest rate on deposits is subject to future regression analysis. Upcoming work will focus on defining the model which explains the trend of this rate.

1. Model concerning the interest rate on deposits in Montenegro

The traditional approach to econometric modeling is to formulate the simplest equation that is consistent with certain economic theory. Following selection of

variables, the coefficients are estimated and their quality is evaluated by performing certain tests. The model's functional form must be suitable for this operation to occur.

The following explanation variables have been chosen based on the qualitative analysis of Montenegrin interest rates on loans. They take into consideration economic theory as well as specifics relating to the Montenegrin economy:

- total acceptances
- consumption of households
- market capitalization and
- interest rate on loans.

Aside from suggestions given by economic theory, the Granger Causality Test was used while choosing explanation variables for the estimation of interest rates on deposits. The Granger causality test answers the question of whether x causes y. y is said to be Granger-caused by x if x helps in the prediction of y.

Table 1. *Granger Causality test for interest rate on deposits*

Pairwise Granger Causality Tests			
Date: 02/19/07 Time: 21:51			
Sample: 1999:4 2006:4			
Null Hypothesis:	Obs	F-Statistic	Probability
DLOG(UKPRIM) does not Granger Cause DLOG(PKS)	23	**2.28214**	0.08467
DLOG(POTD) does not Granger Cause DLOG(PKS)	23	**5.87103**	0.00546
DLOG(MC) does not Granger Cause DLOG(PKS)	23	**3.43221**	0.06315
DLOG(AKS) does not Granger Cause DLOG(PKS)	23	**33.0247**	5.4E-07

The results of F statistics received by the Granger Causality test indicate that the explanatory variables are correctly chosen and that there is causality of:

- total acceptances on interest rates on deposits,
- consumption of households on interest rates on deposits,
- market capitalization on interest rates on deposits and
- interest rate on loans on interest rates on deposits.

In order to establish the correct model, it is necessary to gain the following results of testing and estimation:

1. Regression that is statistically significant (according to the F-test)
2. All estimated parameters are statistically significant (according to the t-test) and their signs are suitable
3. There is no autocorrelation in model
4. There is no heteroscedasticity in model
5. Residuals have normal distribution
6. There is no indication of wrong specification of the model

2. Testing stationary of time series

The series[1] used in the model for estimation of interest rates on deposits- PKS are: UKPRIM- total acceptances, POTD- consumption of households, MC- market capitalization, and AKS- interest rate on loans.

Table 2. Results of ADF test (series in original form)- interest rate on deposits

Augmented Dickey-Fuller Test Equation			
Dependent Variable: **D(PKS)**			
ADF Test Statistic	**0.161097**	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290
Dependent Variable: **D(UKPRIM)**			
ADF Test Statistic	**-1.741454**	1% Critical Value*	-3.6959
		5% Critical Value	-2.9750
		10% Critical Value	-2.6265
Dependent Variable: **D(POTD)**			
ADF Test Statistic	**-0.812065**	1% Critical Value*	-3.6959
		5% Critical Value	-2.9750
		10% Critical Value	-2.6265
Dependent Variable: **D(MC)**			
ADF Test Statistic	**7.453372**	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290
Dependent Variable: **D(AKS)**			
ADF Test Statistic	**-3.358356**	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290

On the basis of Augmented Dickey-Fuller (ADF) Testing, we can conclude that series PKS, UKPRIM and POTD are non-stationary in absolute form. As one hypothesis for use of the method of least squares in estimation of parameters equations of the linear model is that the series used in the model are stationary, it is necessary to specify the number of lagged first difference terms to add to the test regression with the goal to solve problem of non-stationary.

[1] All series used for estimation of interest rate on deposits are series of data that are used for estimation of the Macro model of Montenegro. These are determined by the Institute for Strategic Studies and Prognoses, and are gathered for the use of the Central bank of Montenegro.

Table 3. Results of ADF test (first difference)- interest rate on deposits

Augmented Dickey-Fuller Test Equation			
Dependent Variable: D(PKS,2)			
ADF Test Statistic	**-4.190008**	1% Critical Value*	-3.7204
		5% Critical Value	-2.9850
		10% Critical Value	-2.6318
Dependent Variable: D(UKPRIM,2)			
ADF Test Statistic	**-6.246667**	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290
Dependent Variable: D(POTD,2)			
ADF Test Statistic	**-4.094846**	1% Critical Value*	-3.7076
		5% Critical Value	-2.9798
		10% Critical Value	-2.6290

Series PKS, UKPRIM and POTD are stationary on first difference, meaning that an equation may be used as growth rate (dlog). Series MC and AKS can be used whether in the absolute form or as dlog in the equation because of their stationary status in the absolute form (on zero difference) and then consequently on every higher difference.

3. Estimation of the model

Estimation of parameters has been performed by the method of ordinary least squares[2]. The estimation of the equation of interest rate on deposits could be shown as follows:

Table 4. Estimated equation of interest rate on deposits in Montenegro

Dependent Variable: DLOG(PKS)				
Method: Least Squares				
Sample(adjusted): 2001:1 2006:4				
Included observations: 24 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.261752	0.112477	2.327150	0.0312
DLOG(UKPRIM)	-1.437942	0.332572	-4.323698	**0.0004**
DLOG(POTD(-4))	3.027544	0.752601	4.022777	**0.0007**
DLOG(MC)	-0.465252	0.212584	-2.188554	**0.0413**
DLOG(AKS)	0.757716	0.364404	2.079331	**0.0514**
R-squared	**0.713526**	Mean dependent var		0.258439

[2] The model' estimation has been executed by E-views 3.0.

Adjusted R-squared	0.653215	S.D. dependent var	0.809004
S.E. of regression	0.476410	Akaike info criterion	1.537976
Sum squared resid	4.312362	Schwarz criterion	1.783403
Log likelihood	-13.45571	F-statistic	11.83090
Durbin-Watson stat	**1.905252**	Prob(F-statistic)	**0.000054**

The equation could also be written as follows:

DLOG(PKS) = 0.2617 - 1.4379*DLOG(UKPRIM) + 3.0275*DLOG(POTD(-4)) - 0.4652*DLOG(MC) + 0.7577*DLOG(AKS)

The coefficient of determination R^2 statistic measures the success of the regression in predicting the values of the dependent variable within the sample; it is the fraction of the variance of the dependent variable explained by the independent variables. In the presented equation this equals **71.35%.** This means that the dependent variable is explained 71,35% by the independent variables.

Joint testing of a number of parameters that tries to answer the question whether the chosen explanatory variables make together statistically important influence on the trend of dependent variable, is tested by *F* statistics. The estimated equation has an **F statistic** value of **11,8309,** which is higher than the related table value. As a consequence of these results, we can conclude that the explanatory variables have a significant influence on the variation of dependent variables.

4. Validity of specification

As stressed above, specification of the model means formulation of the mathematical form of the regression equation, selection of independent variables and hypothesis regarding standard error. This is done according to the theory postulates, characteristics and specificity of economics, etc. Tests that are mostly used for evaluating the validity of specifications are:

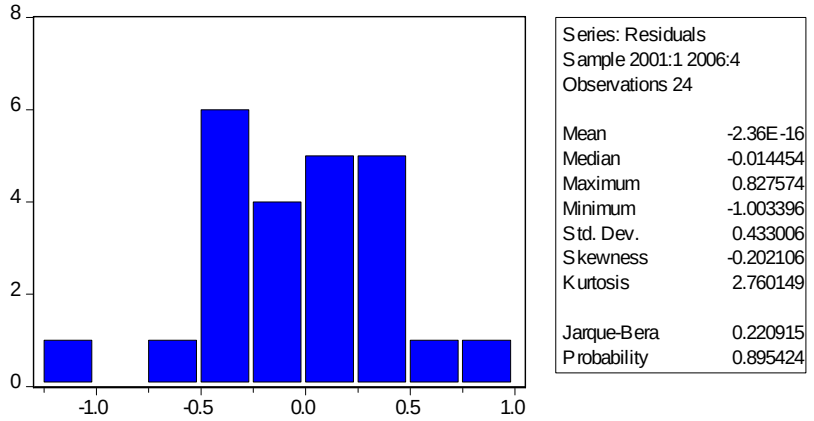
- Jarque-Bera test- for evaluating whether the series is normally distributed
- Ramsey reset test- regression specification error test
- Cusum test recursive residuals - cumulative sum test of the recursive residuals.

Jarque berra test

The Jarque berra test is used for testing whether the series is normally distributed. The test statistic measures the difference of the skewness and

kurtosis of the series compared to those from the normal distribution. The Jarque-Bera statistics for the estimated equation resulted in the following results:

Graph 3. *Results of Jerque berra test-interest rate on deposits*



As can be seen, we can not reject the null hypothesis of a normal distribution, and can therefore conclude that these residuals have normal distribution.

Ramsey RESET test

RESET is a general test for the following types of specification errors: omitted variables- x does not include all relevant variables; incorrect functional form- some or all of the variables in y and x should be transformed and correlation between X and error.

Table 5. Results of Ramsey RESET test for interest rates on deposits

Ramsey RESET Test:				
F-statistic	7.920390	Probability		0.003709
Log likelihood ratio	15.80299	Probability		0.000370
Test Equation:				
Dependent Variable: DLOG(PKS)				
Method: Least Squares				
Sample: 2001:1 2006:4				
Included observations: 24				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.187726	0.115887	1.619906	0.1237
DLOG(UKPRIM)	-0.765602	0.352256	-2.173424	0.0442
DLOG(POTD(-4))	-0.439904	1.172187	-0.375285	0.7121
DLOG(MC)	-0.119814	0.206600	-0.579933	0.5696
DLOG(AKS)	0.022795	0.350733	0.064993	0.9489
FITTED^2	-0.119600	0.396786	**-0.301421**	**0.7667**
FITTED^3	0.197979	0.132516	**1.494003**	**0.1535**

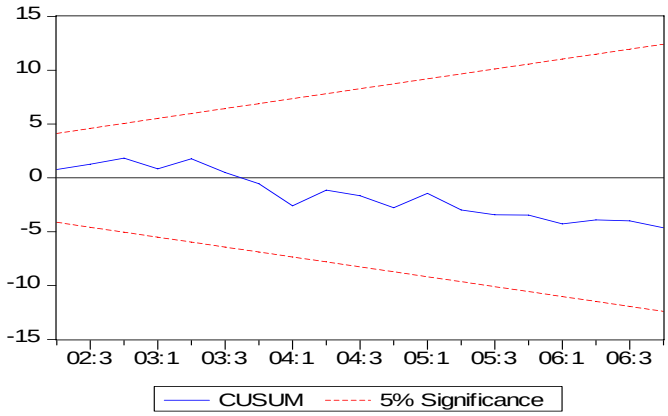
R-squared	0.851707	Mean dependent var	0.258439
Adjusted R-squared	0.799368	S.D. dependent var	0.809004
S.E. of regression	0.362369	Akaike info criterion	1.046184
Sum squared resid	2.232290	Schwarz criterion	1.389784
Log likelihood	-5.554214	F-statistic	16.27297
Durbin-Watson stat	1.710545	Prob(F-statistic)	0.000003

The Ramsey RESET test indicates that the equation of interest rate on deposits is correctly specified and that t-statistics are not statistically significant: it equates to 0.30 and 1.49. As a result, we accept the null hypothesis regarding correct specification of the model.

Cusum test recursive residuals

The Cusum test is based on the cumulative sum of the recursive residuals. This option plots the cumulative sum with the 5% critical lines.

Graph 4. *Results of Cusum test recursive residuals –interest rate on deposits*



As can be observed from the graph, the estimated equation is stable and the cumulative sum does not deviate beyond the two critical lines.

5. Testing of autocorrelation, heteroscedasticity and multicolinearity

Testing of autocorrelation

Autocorrelation is tested by means of the Durbin-Watson test, as well as correlogram and Q statistics. Autocorrelation in the regression analysis is related to the presence of the correlation between accidental errors; that is, the

assumption is that the value of the accidental error for one observation is not correlated to the value of the accidental error for any other observation.

Durbin-Watson test

The Durbin-Watson test is the most popular test used for testing of autocorrelation at the first level. The Durbin-Watson statistic is a test for first-order serial correlation and it measures the linear association between adjacent residuals from a regression model.

The value of d statistics for the estimated equation of interest rate on deposits is 1,9052. Since the d <2 we test the presence of positive autocorrelation. In estimated model number of observation is 24, number of explaining variables is 4, for the 5% significance the critical values are d d =1,013 and d g=1,775, and using the following rule 1,9052> 1,775 that is $d>dg$ we can conclude that there is no autocorrelation in the estimated equation of interest rate on deposits.

Correlogram i Q statistics

Keeping in mind that the Durbin-Watson test is not powerful, we will test the presence of autocorrelation by correlogram and Q-statistics. If the estimated equation is correctly specified, all Q-statistics should not be significant.

Table 6. Correlogram i Q statistics- interest rate on deposits

Sample: 2001:1 2006:4						
Included observations: 24						
Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. | . |	. | . |	1	0.036	0.036	0.0346	**0.852**
.**| . |	.**| . |	2	-0.276	-0.277	2.1927	**0.334**
. |* . |	. |* . |	3	0.102	0.136	2.5047	**0.474**
. | . |	. *| . |	4	-0.038	-0.143	2.5493	**0.636**
. | . |	. |* . |	5	-0.008	0.084	2.5515	**0.769**
. | . |	. *| . |	6	-0.001	-0.086	2.5515	**0.863**
. *| . |	. *| . |	7	-0.186	-0.154	3.8220	**0.800**
. | . |	. | . |	8	0.027	0.030	3.8514	**0.870**
. |* . |	. | . |	9	0.078	-0.029	4.1075	**0.904**
. | . |	. |* . |	10	0.008	0.075	4.1105	**0.942**
. | . |	. | . |	11	-0.005	-0.043	4.1119	**0.967**
. | . |	. |* . |	12	0.062	0.108	4.3126	**0.977**

Same as results of Durbin Watson test shown, the results of correlogram and Q-statistics (probability greater than 0.05) in estimated equation of interest rate on deposits there is no autocorrelation.

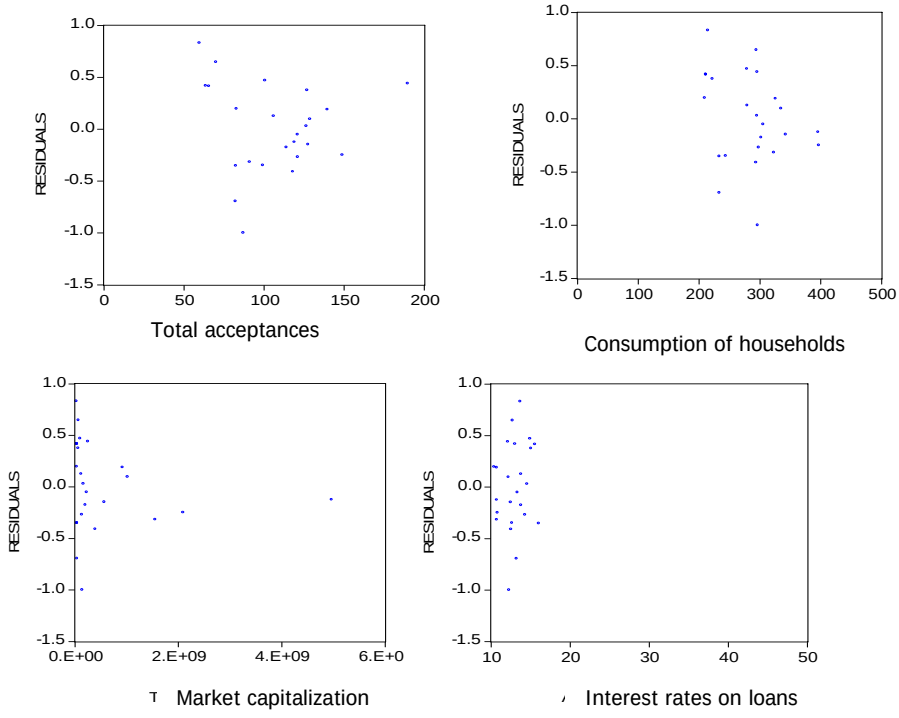
Heteroskedasticity

One of the hypotheses of the linear regression model relates to constant variance of stochastic error and means that, for every value of *Xi,* the value of error demonstrates the same level of dispersion around it's average.

Diagram of residuals

One of the simplest ways to test the presence of heteroscedasticity is in visual presentation of residuals of estimated model.

Graph 5. *Presentation of residuals- equation of interest rate on deposits*



Graph 5 illustrates the possibility of heteroscedasticity problems, necessitating the comparison of this problem with other tests.

White's Heteroskedasticity Test

This is a test for heteroskedasticity in the residuals from a least squares regression. Ordinary least squares estimates are consistent in the presence of heteroskedasticity, however the computed standard errors are no longer valid.

Table 7. Results of White's heteroskedasticity test –interest rate on deposits

White Heteroskedasticity Test:				
F-statistic	3.920625	Probability		0.010952
Obs*R-squared	16.23552	Probability		0.039130
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Sample: 2001:1 2006:4				
Included observations: 24				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.140286	0.062629	2.239973	0.0407
DLOG(UKPRIM)	-0.312283	0.157696	-1.980285	0.0663
(DLOG(UKPRIM))^2	0.774796	0.501245	1.545742	0.1430
DLOG(POTD(-4))	1.783918	0.715732	2.492439	0.0249
(DLOG(POTD(-4)))^2	-2.431015	2.109880	-1.152205	0.2673
DLOG(MC)	-0.158336	0.105216	-1.504873	0.1531
(DLOG(MC))^2	-0.074683	0.080500	-0.927738	0.3682
DLOG(AKS)	-0.150356	0.396320	-0.379380	0.7097
(DLOG(AKS))^2	-0.326248	0.313583	-1.040390	0.3146
R-squared	0.676480	Mean dependent var		0.179682
Adjusted R-squared	0.503936	S.D. dependent var		0.243512
S.E. of regression	0.171510	Akaike info criterion		-0.408355
Sum squared resid	0.441235	Schwarz criterion		0.033415
Log likelihood	13.90027	F-statistic		3.920625
Durbin-Watson stat	2.009089	Prob(F-statistic)		0.010952

According to the results of White's test we can conclude that there is a presence of the problem of heteroscedasticity in the estimated equation on interest rate on deposits.

Solving the problem of heteroskedasticity

Solving the problem of heteroscedasticity is possible by dividing every heteroscedasticity error by the standard deviation and by so doing to get homoscedastic error. This method of solving the problem of heteroscedasticity is possible to execute by the HAC method (Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors) in the software program E-views.

Table 8. Equation of interest rates on deposits in Montenegro (after solving problem of heteroscedasticity)

Dependent Variable: DLOG(PKS)
Method: Least Squares
Sample(adjusted): 2001:1 2006:4
Included observations: 24 after adjusting endpoints

White Heteroskedasticity-Consistent Standard Errors & Covariance				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.261752	0.109965	2.380316	**0.0279**
DLOG(UKPRIM)	-1.437942	0.421935	-3.407969	**0.0030**
DLOG(POTD(-4))	3.027544	1.235713	2.450038	**0.0241**
DLOG(MC)	-0.465252	0.172119	-2.703083	**0.0141**
DLOG(AKS)	0.757716	0.323244	2.344096	**0.0301**
R-squared	**0.713526**	Mean dependent var		0.258439
Adjusted R-squared	0.653215	S.D. dependent var		0.809004
S.E. of regression	0.476410	Akaike info criterion		1.537976
Sum squared resid	4.312362	Schwarz criterion		1.783403
Log likelihood	-13.45571	F-statistic		11.83090
Durbin-Watson stat	**1.905252**	**Prob(F-statistic)**		**0.000054**

In the new equation there is no change in the point of the estimates of the parameters, solely in the estimated standard errors. This means that after solving the problem of heteroscedasticity, the value of t-statistics coefficients is changed. From Table 8 we can see that the estimated parameters remain statistically significant after solving the problem of heteroscedasticity.

Multicolinearity

The concept of multicolinearity states that there is correlation between explanatory variables in the model. The coefficient of correlation is the main indicator of correlation. If the value of the correlation coefficient r close to ± 1, then we can conclude that the multicolinearity is high.

Correlation coefficients of the equation of the interest rate on deposits are shown in Table 9.

Table 9. Correlation coefficients in the equation of the interest rate on deposits

	DLOG (PKS)	DLOG (UKPRIM)	DLOG (POTD)	DLOG (MC)	DLOG (AKS)
DLOG(PKS)	1.000000	-0.554252	-0.161843	-0.194913	0.150963
DLOG(UKPRIM)	**-0.554252**	1.000000	0.012754	-0.152063	-0.085680
DLOG(POTD)	**-0.161843**	0.012754	1.000000	0.158952	-0.734534
DLOG(MC)	**-0.194913**	-0.152063	0.158952	1.000000	0.065226
DLOG(AKS)	**0.150963**	-0.085680	-0.734534	0.065226	1.000000

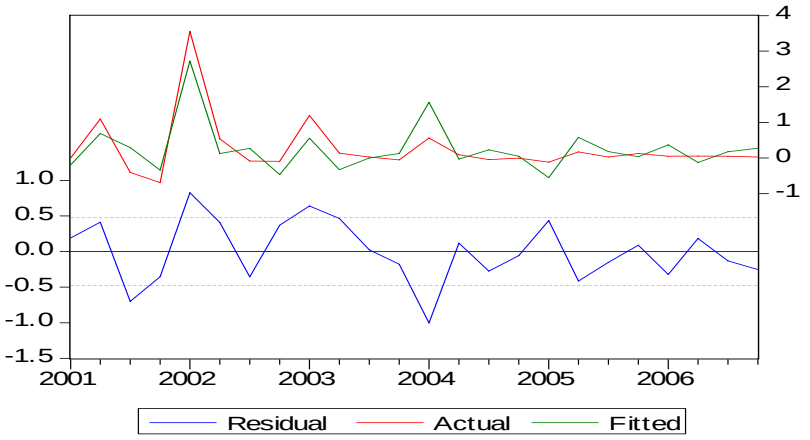
As can be seen from Table 9, values of the correlation coefficients are lower than 0,60, meaning we can conclude that there is no problem of multicolinearity in this estimated equation.

6. Statistical and contents conclusions

The estimated equation of interest rates on deposits has satisfied all main statistical and econometrical criteria. Moreover, the resultant relations are in accordance with the postulates of economic theory. This paper is aligned with the sentiment that the results of a model must be in accordance with the principles of economic theory. A model, no matter how complex and perfectly technically and quantitatively functional, can never be considered valid if it's results are in contradiction with economic theory.

A fitted graph contrasted with the actual graph of interest rates on deposits can be shown as follows:

Graph 6. *Fitted and actual graph of interest rates on deposits in Montenegro*



From Graph 6 we can conclude that the estimated equation of interest rates on deposits approximates very nearly the trend of this rate.

This estimated equation suggests that an increase of total acceptances for one percentage point will lead to a decrease of interest rates on deposits for 1.4379 percentage points. The negative sign in front of this coefficient is expected and in accordance with economic theory because every increase of any good (in this case money) will lead to the reduction of it's price- interest rates on deposits (price that is paid by banks for the use of another's means).

An increase in consumption of households by one percentage point will lead to an increase of interest rates on deposits for 3.0275 percentage points after four quarters, because every increase of consumption means postponing of decisions to save and means increase of the lacking of the good- money. This positive sign in front of the coefficient is expected and in conformity with economic theory and practice.

Regression analysis of interest rates on deposits showed that the increase of market capitalization for one percentage point will lead to a decrease of interest rates on deposits for 0.4652 percentage points. This negative sign is expected because the Montenegrin capital market is characterized by important and constant growth of turnover as well as the number of transactions and value of market capitalization. Foreign investors have made a great impact on the Montenegrin economy, meaning that domestic and foreign investors exchange different means of properties in a way that non residents become owners of domestic securities, and Montenegrin entities (citizens, investment funds and companies) receive cash. Montenegrin residents usually save this cash as deposits in the domestic banking system until it is needed for the next large expenditure (real estate, automobiles, investments, etc). Respecting the basic economic rule of supply and demand, this elevated flow of deposits translates to a decrease in interest rates paid to depositors. This logic applies to the opposite situation between interest rates on deposits and market capitalization.

The estimated equation suggests that the increase of interest rates on loans for one percentage point will lead to the increase of interest rates on deposits for 0.7577 percentage points. The positive sign present in this ratio is expected and in accordance with economic theory because every increase in interest rates on loans gives banks the opportunity to provide a greater return on the savings of citizens.

Conclusion

This model demonstrated that the value of interest rates on deposits depends on the value of UKPRIM- total acceptances, POTD- consumption of households, MC- market capitalization and AKS- interest rate on loans. The estimated equation of interest rates on deposits is:

*DLOG(PKS) = 0.2617 - 1.4379*DLOG(UKPRIM)+ 3.0275*DLOG(POTD(-4)) - 0.4652*DLOG(MC) + 0.7577*DLOG(AKS)*

The positive sign preceding the explanatory variables consumption of households and interest rates on loans shows that increase of this variables leads to the growth of interest rates on deposits, while a negative sign in front of variables total acceptances and market capitalization shows that their growth will lead to the decrease of the interest rates on deposits.

The presented model clearly evinced that the use of statistical and econometrics methods in the analysis of economic phenomena has limited utility. While introducing mathematical relations to describe economic phenomena we must not forget the fact that all economic phenomena are the

result of social relations and activities, and that human behavior can not be completely described by deterministic equations.

Today, the banking system in Montenegro is 100 percent privatized, the number of credible banks is growing, the state's credit rating is relatively good, capital flows freely, and the state is reducing its direct borrowing from the domestic bank market. For this reason, it is to be expected that significant decreases of interest rates on deposits and increase of the interest rates on loans will occur.

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