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# АНАЛИЗ ВЛИЯНИЯ ЭНДОГЕННЫХ ФАКТОРОВ НА РЕАЛЬНУЮ ПРОЦЕНТНУЮ СТАВКУ США

***Аннотация:*** *Статья посвящена определению показателей, влияющих на формирование реальной процентной ставки США. В статье построена эконометрическая модель, показывающая взаимосвязь эндогенных и экзогенных факторов. Модель включает в себя такие факторы, как реальная ставка, номинальная, ВВП на душу, экспорт товаров и импорт товаров.*

***Ключевые слова:*** *правило Фишера, реальная ставка, номинальная ставка, экономика США, эконометрическая модель*

# ANALYSIS OF INFLUENCE OF ENDOGENIC FACTORS ON REAL INTEREST RATE OF THE USA

***Annotation:*** *The article is devoted to determining the indicators that influence the formation of the real interest rate of the United States. The article is devoted to the econometric model showing the interrelation between endogenous and exogenous factors. The model includes such factors as real rate, nominal, GDP per capita, exports of goods and imports of goods.*

***Key words:*** *Fisher's rule, real rate, nominal rate, US economy, econometric model.*

**Introduction.**

The following creative research work is prepared on the topic of econometric model of usage Fisher rule in USA. It includes statistical data for 36 years since 1980 till 2016 and econometric model estimation, forecasting and tests.

The object of research is nominal interest rate in USA and its relation to the real interest rate, GDP per capita, Imports, and Exports of the country.

The aim of this article is to estimate the existence of economic relationship between variables on the example of USA, construct econometric model and make several tests to check whether this model can be used for forecasting or not.

As of the previous works on this topic, there are some, published within Scopus. There is an article, written by Crowder, W. J., & Hoffman, D. L. in 1996 called "The long-run relationship between nominal interest rates and inflation: The fisher equation revisited". [1] In this article authors made statistical analysis that fails to recognize that the nominal interest rate and expected inflation may be modeled as distinct nonstationary series that share a common stochastic trend. In their model they also took into account taxes on interest income. In the article we would like also to include such exogenous factors, as GDP per capita, exports and imports of the country. [2]

An economic theory proposed by economist Irving Fisher that describes the relationship between inflation and both real and nominal interest rates. The Fisher effect states that the real interest rate equals the nominal interest rate minus the expected inflation rate. Therefore, real interest rates fall as inflation increases, unless nominal rates increase at the same rate as inflation.

In finance, the Fisher equation is primarily used in YTM calculations of bonds or IRR calculations of investments. In economics, this equation is used to predict nominal and real interest rate behavior.

**Econometric model.**

To begin with, we construct specification of a Fisher rule model. Economic model takes up the current form:

$$In = Ir + \prod,$$

that means that Nominal interest equals real interest rate + rate of inflation. We found that rate of inflation depend on GDP per capita, Imports and Exports, that's why we change $\prod$ in this formula to three variables.

It can be rewritten to the econometric model:

$$\begin{cases} Y_t = a_0 + a_1 * x_{1t} + a_2 * x_{2t} + a_3 * x_{3t} + a_4 * x_{4t} + \varepsilon_t \\ a_0, a_1, a_2, a_3, a_4 > 0 \\ E(\varepsilon_t) = 0 \\ \sigma(\varepsilon_t) = const \end{cases}$$

Where $Y_t$ – nominal interest rate

$x_{1t}$ – Real interest rate

$x_{2t}$ – GDP per capita

$x_{3t}$ – Imports

$x_{4t}$ - Exports

$\varepsilon_t$ - Disturbance term

In this model there is one endogenous variable $Y_t$ because it depends on other variable.

As for the correlation analysis, in order to define the linear relationship we have to find correlation coefficient.

The correlation analysis shows the strength of the relationship between 2 variables. The calculated correlation matrix takes the following way:

*Table 1.Correlation matrix*

| Correlation analysis | | | | | | |
|---|---|---|---|---|---|---|
| | *Year* | *Y Nominal interest rate (%)* | *X1 Real interest rate (%)* | *X2 GDP per capita (current US$)* | *X3 Imports of goods and services (% of GDP)* | *X4 Exports of goods and services (% of GDP)* |
| Year | 1 | | | | | |
| Y Nominal interest rate (%) | -0,65 | 1 | | | | |
| X1 Real interest rate (%) | -0,13 | 0,68 | 1 | | | |
| X2 GDP per capita (current US$) | 1,00 | -0,66 | -0,16 | 1 | | |
| X3 Imports of goods and services (% of GDP) | 0,95 | -0,62 | -0,21 | 0,97 | 1 | |
| X4 Exports of goods and services (% of GDP) | 0,82 | -0,49 | -0,23 | 0,82 | 0,84 | 1 |
| | | | | | | |
| | | | | | | |
| | | strong positive linear correlation | | | | |
| | | strong negative linear correlation | | | | |
| | | weak negstive linear correltion | | | | |

If the coefficient is positive that means that relationship between 2 variables is also positive and vice-a-versa. If coefficient is equal to 0 that means that there is no relationship. But in the range of data, which was chosen, there are no independent variables. [3]

To estimate the model regression analysis should be performed. The regression analysis made in Excel by Data Analysis.

Estimated form of the model:

$$\begin{cases} Y_t = 0{,}84 + 0{,}91 * X1_t - 0{,}0003 * X2_t + 0{,}54 * X3_t + 0{,}56 * X4_t + \varepsilon_t \\ (2{,}61) \quad (0{,}11) \quad (0{,}001) \quad (0{,}35) \quad (0{,}26) \quad (1{,}49) \\ R^2 = 0{,}83 \quad F = 38{,}2 \quad Fcrit = 2{,}67 \quad Tcrit = 2{,}04 \end{cases}$$

**R test**

Here we can see that $R^2$ is close to 1, which means that independent variables describe Y by linear regression model. [4]

**F test**

Here we would like to make test for checking non-randomness of $R^2$

We would like to make F-test to see whether quality of specification of a model is high or low. With the help of formula «F.ОБР.ПХ» in Excel we calculate F critical

under probability of mistake 5% and df1=2 (number of variables), df2=37-(4+1)(number of observations-number of variables-1). F critical=2,67.

If Fcrit < F then R2 is not random and quality of specification is high.
2,67< 38,2 – then R2 is not random and quality of specification is high.

**T test**

The test for checking of significance of coefficients.

We would like to perform t-test to check the significance of our coefficients. With the Excel formula «СТЬЮЕНТ.ОБР.2Х» we calculate t critical under probability of mistake 5%. T critical = 2,04. If $|t|>t_{crit}$ then coefficient is significant. Now, we compare t-statistics and t critical:

$$Tcrit = 2{,}04$$

|T|>T crit

As a result we conclude that, as A0=0,32, |0,32|<2,04, A0 is non-significant, A1= 8,38, |8,38|>2,04, A0 is significant, A2= -4,40, |-4,40|>2,04, A0 is significant, A3= 1,55, |1,55|>2,04, A0 is significant, A4= 2,17, |2,17|>2,04, A0 is significant

**Conclusion.**

As a result of our investigation, we can see, that all of our chosen endogenous and exogenous factors are significant, which means, that are correlated with the real interest rate and changes in these factors will cause change of the real interest rate. To be more detailed, through the econometric model we have found that there is strong positive linear relationship between nominal interest rate and real interest rate, between GDP per capita and Imports, between GDP per capita and Exports, relationship between Imports and Exports and strong negative linear relationship between nominal interest rate and GDP per capita between nominal interest rate and Imports, between nominal interest rate and Exports, between consumption and output. Also, there is weak negative linear relationship between real interest rate

and GDP per capita, between real interest rate and Imports and between real interest rate and Exports.

**References.**


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