UDC 338.24

Construction of econometric model on the basis of money market function of macroeconomic model of the U.S. economy

Klycheva Violetta Vasil'evna

Master student,
Faculty of International Finance,
Financial University under the Government of the Russian Federation,
P.O. Box 125315, Leningradskii ave., No. 49-55, Moscow, Russian Federation;
e-mail: to.violetta@mail.ru

Abstract

This article is dedicated to the econometric analysis of the money market of five developed countries: USA, Australia, Norway, the Netherlands and Switzerland. For analysis was used macroeconomic model of the U.S. economy, money market function. The purpose of this research is to understand how various external factors influence the changes in Interest rates. An econometric model was created in order to predict the behavior of the Interest rate, which is under the influence of exogenous variables such as GDP and Money supply. Creation of econometrical models provides an empirical evidence to support the evaluation of economic relationships, which occur in a modern society.

For citation

Klycheva, V.V. (2014), "Construction of econometric model on the basis of money market function of macroeconomic model of the U.S. economy" ["Postroenie ekonometricheskoi modeli na osnove funktsii denezhnogo rynka makroekonomicheskoi modeli ekonomiki SShA"], *Ekonomika: vchera, segodnya, zavtra (Economics: Yesterday, Today and Tomorrow)*, No. 8-9, pp. 49-57.

Keywords

Econometrics, macroeconomic model of the U.S. economy, money market function, correlation, regression, estimation, testing, Student's t-test, Goldfield-Quandt test, Darbin-Watson test, model adequacy.

Introduction

Econometrics is a discipline that combines mathematics with the study of economics to analyze information and work with mathematical models to explore scenarios and theoretical situations. The study of econometrics tends to be especially strong on statistics, with statistics being a powerful tool when it comes to analysis, and it requires comfort in the fields of both economics and mathematics. Thus, it helps analyzing various economic phenomena, forecast their development and predict future fluctuations[1].

Money market plays a central role in the monetary policy transmission mechanism by providing a key link in the operations of monetary policy to financial markets and ultimately, to the real economy. The level of development of a money market serves as a barometer for measuring the level of development of the economy.

In my opinion, one of the most important issues of the economy is the organization of monetary circulation. The level of development of a money market serves as a barometer for measuring the level of development of the economy. That's why, money market function of macroeconomic model of the U.S. economy was chosen for econometric analysis.

Econometric model on the basis of money market function of macroeconomic model

Throughout this work, an econometric model was created to forecast the situation on the money market of 5 well developed countries: The USA, Australia, Netherlands, Norway, Switzerland.

1 Timofeev, V.S., Fadeenkov, A.V., Shchekoldin, V.Yu. (2013), *Econometrics* [*Ekonometrika*], NGTU, Moscow, 346 p.

There are four variables in this model. The first variable is Interest rate (r_t) – endogenous because it depends on different factors. Other variables are independent on factors, they build a base for relationship analysis and are called exogenous. In our case they are:

– Gross Domestic Product (Y_t) – represents the whole value of the economy, its current situation, economic condition and dynamics;

– Money supply (M_t) – is the total amount of monetary assets available in an economy at a specific time;

– Interest rate (r_{t-1}) – is the rate at which interest is paid by a borrower for the use of money that they borrow from a lender.

Initial form of econometric model:

$$\begin{cases} r_t = b_0 + b_1 Y_t + b_2 M_t + b_3 r_{t-1} + \varepsilon_t \\ E(\varepsilon_t) = 0 \\ \sigma(\varepsilon_t) \text{ const} \end{cases}$$

The variables that it includes are the following:

r_t, r_{t-1} – interest rates in the moments of time t and $t-1$;

Y_t – GDP;

M_t – money supply;

E – is expectation of residual/disturbance term. Residual is, basically, a difference between real and theoretical points;

ε_t – is a disturbance term, showing random factors which can occur at any point in time and still influence the endogenous variable;

σ – is a standard deviation.

An econometric model specifies the statistical relationship that is believed to hold between the various economic quantities pertaining to a particular economic phenomenon under study.

First of all in order to provide relationship between endogenous and exogenous variables a correlation analysis was done.

Correlation matrix of the USA:

	r_t, %	Y, bln USD	M, bln USD	r_{t-1}, %
r_t, %	1			
Y, bln USD	–0,78	1		
M, bln USD	–0,78	0,89	1	
r_{t-1}, %	0,84	–0,76	–0,78	1

Correlation matrix shows if there is a linear relationship between each exogenous variable and the explained variable. The bigger the correlation coefficient, the more linearly dependent is Y on a specific X. Correlation coefficient lies between 0 and 1. If it equals 0, the variables are independent, while if it is equal to 1, the variables are perfectly dependent.In our case variables Y_t (–0,78) and M_t (–0,78) have negative sign. That means a strong negative linear relationship between endogenous variable r and exogenous variables Y_t and M_t. Variable r_{t-1} (0,83) has a positive sign. That means a strong positive linear relationship between r_t and r_{t-1}.

According to correlation matrixes of other 4 countries, only Netherlands has a strong linear relationship between variables, in other words, variables are close to 1. Most variables of other three countries are low and close to zero. This means that there is no linear relationship between them.

Then it was possible to estimate all coefficients by creating a regression econometric model. It can be done using Microsoft Excel, Analysis package. Estimated model helps to understand that in all the countries growth of GDP and Money supply leads to the decrease in Interest rate and vice versa.

Then the model was tested by R^2-Test, F-Test, T-Test, Goldfeld-Quandt-Test and Durbin-Watson –Test and generally, it passed all tests successfully.

R^2 test shows the percentage of estimation of the dependent variable.

Table 1

	Australia	Switzerland	Netherlands	Norway	USA
R^2	0,5630	0,3944	0,6348	0,3273	0,7465

For example, in Australia R^2 = 0,5630. This means that there is a 56,3 % probability that the forecast built on this model will be truth. The same can be done with results of other countries.

F-test: Another way of checking R^2 is based on testifying F. F critical should be compared to F calculated in a model by Excel, using the formula: Fcrit = Finv (0,05; df1; df2).

Table 2

	Australia	Switzerland	Netherlands	Norway	USA
F stat	12,02	6,07	26,07	2,18	27,49
F crit	2,94	2,94	2,94	2,94	2,94

In Australia, Switzerland, Netherlands and the USA Fcrit < Fstat. This means that R^2 is not random and quality of specification of econometric model is high. In Norway Fcrit > Fstat, that means R^2 is random and quality of specification of econometric model is low.

T-test:

In order to check the significance of coefficients Student's t-test was used. The inequality $|t| \leq t_{crit}$, where t is the value of t-statistics had to be tested.

Table 3

	Australia	Switzerland	Netherlands	Norway	USA
T stat 1	3,78	1,04	6,91	4,21	2,87
T stat 2	1,51	1,66	0,57	0,31	–0,78
T stat 3	–2,25	–1,87	–2,68	–1,04	–1,12
T stat 4	2,48	1,88	2,71	1,05	3,32
T crit	2,05	2,05	2,05	2,05	2,05

In Australia and Netherlands only one of the variables is not significant and can be excluded from the model as it is less than T-critical.

In Switzerland all coefficients are less than T-critical and are not significant.

In Norway and the USA only one variable is significant as it is higher than T-critical.

Goldfield-Quandt test:

Goldfield-Quandt test checks the second assumption of Gauss-Markov theorem about homoscedasticity of random disturbances in regression analyses. Formula:

$$GQ = ESS_1 / ESS_2$$

Table 4

	Australia	Switzerland	Netherlands	Norway	USA
GQ	13,73	32,92	8,87	18,15	0,69
1 / GQ	0,07	0,03	0,21	0,06	1,47
F cr for GQ	2,55	2,55	2,55	2,55	2,55

In our case both GQ and 1 / GQ are less than the value of Fcrit for GQ. That means that the model is homoscedastic. This means that the least square method may be used in order to estimate econometric model. Thus, GQ-test is passed successfully – the model can be estimated through least square method.

In other four countries

$$\begin{cases} GQ > Fcrit\ GQ \\ 1 / GQ < Fcrit\ GQ, \end{cases}$$

that means that these four models are heteroscedastic. This means that the least square method may not be used in order to estimate econometric model. We can't use these models for forecasting.

Adequacy of the model was checked using the data of given countries, namely, US, Norway, Australia, Netherland, Switzerland and was adequate in each country so the model can be used for forecasting.

Darbin-Watson test:

DW test checks a particular case of third assumption of the Gauss-Markov theorem about the absence of autocorrelation (a relationship between values separated from each other by a given time lag) between residuals in the model. We can calculate Darbin-Watson statistics using values of the residuals εt.

There are 32 observations in each model, hence intervals are the same:

Table 5

0	dl	du	2	4-du	4-dl	4
0	1,373	1,502		2,498	2,627	4

Results:

Table 6

	Australia	Switzerland	Netherlands	Norway	USA
DW	2,48	3,89	0,58	1,46	1,65

DW1 = 2,48 => du < DW1 < 4–du – residuals are not autocorrelative.

DW2 = 3,89 => 4–dl < DW2 < 4 – residuals are negatively autocorrelative.

DW3 = 0,58 => 0 < DW3 < dl – residuals are positively autocorrelative; third assumption of the Gauss-Markov theorem is disturbed.

DW4 = 1,46 => dl < DW4 < du – is in the zone of uncertainty.

DW5 = 1,65 => du < DW1 < 4–du – residuals are not autocorrelative.

Conclusion

Finally, we have estimated the lower and the upper boundaries of confidence interval in order to check if our models are adequate. According to our calculations, all 5 models are adequate, as the real values of endogenous variables for the last years observed fit into confidence intervals.

We have created an econometric model in order to estimate the situation on the money market of 5 developed countries.

We can see the following:

The relationship between endogenous and exogenous variables:

– the higher interest rate the lower supply for money. It means that high interest rate doesn't allow commercial banks to issue much money, because the higher interest rate the less money commercial bank can borrow from Central bank. That leads to reduction of money supply;

– the higher the interest rate the lower the level of GDP and vice versa. The changes in the interest rate depend on the economic situation. If there is a recession expansionary monetary policy is used. It is designed to fix a recession and increase aggregate demand, lower the unemployment rate and increase real GDP. In that case the interest rate will be decreased. Contractionary monetary policy has the opposite effect and is designed to avoid inflation by decreasing aggregate demand, which lowers the price level and decreases real GDP, while the interest rate will be increased.

Thus, we can say, that the creation of an econometric model gives an opportunity to forecast future changes of endogenous variable (in our model it is Interest rate), that is really important in today's world of economic uncertainty.

References

1. "Index Mundi", available at: http://www.indexmundi.com/
2. "The World Bank", available at: http://www.worldbank.org/
3. Timofeev, V.S., Fadeenkov, A.V., Shchekoldin, V.Yu. (2013), *Econometrics* [*Ekonometrika*], NGTU, Moscow, 346 p.

4. Tregub, I.V. (2009), *Forecasting economic performance in a market economy* [*Prognozirovanie ekonomicheskikh pokazatelei v usloviyakh rynochnoi ekonomiki*], PSTM, Moscow, 196 p.
5. Tregub, I.V. (2009), *Mathematical models of the dynamics of economic systems: (monograph)* [*Matematicheskie modeli dinamiki ekonomicheskikh sistem: (monografiya)*], Finansovaya akademiya, Moscow, 120 p.

Построение эконометрической модели на основе функции денежного рынка макроэкономической модели экономики США

Клычева Виолетта Васильевна

Студент, магистр,
Международный финансовый факультет,
Финансовый университет при Правительстве РФ,
125315, Российская Федерация, Москва, Ленинградский пр., 49-55;
e-mail: to.violetta@mail.ru

Аннотация

Данная статья посвящена эконометрическому анализу денежного рынка пяти развитых стран: США, Австралии, Норвегии, Голландии и Швейцарии. Для проведения анализа была использована функция денежного рынка макроэкономической модели экономики США. Цель исследования заключается в понимании того, как различные внешние факторы оказывают влияние на изменение процентной ставки. Была создана эконометрическая модель для прогнозирования поведения процентной ставки, находящуюся под влиянием таких экзогенных переменных, как ВВП и предложение денег.

Для цитирования в научных исследованиях

Клычева В.В. Построение эконометрической модели на основе функции денежного рынка макроэкономической модели экономики США // Экономика: вчера, сегодня, завтра. – 2014. – № 8-9. – С. 49-57.

Ключевые слова

Эконометрика, макроэкономическая модель экономики США, функция денежного рынка, корреляция, регрессия, оценка, тестирование, т-критерий Стьюдента, тест Гольдфельда-Квандта, критерий Дарбина-Уотсона, адекватность модели.

Библиография

1. Index Mundi. [Электронный ресурс]. – Режим доступа: http://www.indexmundi.com/
2. Всемирный банк. [Электронный ресурс]. – Режим доступа: http://www.worldbank.org/
3. Тимофеев В.С., Фадеенков А.В., Щеколдин В.Ю. Эконометрика. – М.: НГТУ, 2013. – 346 с.
4. Трегуб И.В. Математические модели динамики экономических систем: (монография) – М.: Финансовая академия, 2009. – 120 с.
5. Трегуб И.В. Прогнозирование экономических показателей в условиях рыночной экономики. – М.: ПСТМ, 2009. – 196 с.