

Factors Affecting the Dynamics of Exchange Rates and Their Econometric Analysis

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Abstract. The present work is devoted to the study of the interrelations of the exchange rate of manat with the main indicators of the monetary system in Azerbaijan. A mathematical-statistical model of the exchange rate has been constructed, allowing the study by econometric methods of its interrelations with the basic monetary aggregates and the interest rate. The model is analyzed for adequacy.

Key Words and Phrases: exchange rate, devaluation of manat, statistical-mathematical model, monetary aggregates, interest rate.

2010 Mathematics Subject Classifications: C1, C3, E4, E5, G1

Currency rates are considered as an important component of the international monetary system, which can affect the macroeconomic circumstance of each country, acts as a tool between the global and national value indicators in the system of world economic relations.

Nowadays, exchange rates change every day, which creates the necessity of studying their interpretation laws.

One of the key factors affecting the dynamics of exchange rates is the condition of the balance of payments. The balance of payments (In the statistical sources of Azerbaijan are presented quarterly and yearly) indicates the amount of payments inflows to and outflows from the country within a given time period and, in other words, the movement dynamics of the currency. The increase in demand for the national currency by creating a positive balance, in turn, enhances the offer and reinforces it. Naturally, the negative balance weakens the national currency, as the demand for foreign currency is increasing.

In general, the formation of a currency course [1, p. 639-685] can be characterized as a multinational process. In addition to the balance of payments, the rate of exchange rate inflation, trade balance deficit, unemployment rate, GDP, investment environment, interest rates, state debt, volume of state orders, economic productivity, industrial production index, oil price in world markets, government economic policy, changes in the management system, and so on. are exposed to indicators, and these factors are not interrupted separately but at the same time interfere the exchange rate formation process.

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Insurance, investment, and social security funds use more stable currencies to safe financial resources and the exchange rate of foreign currency used by them increases due to the large money consuming, while the national currency weakens.

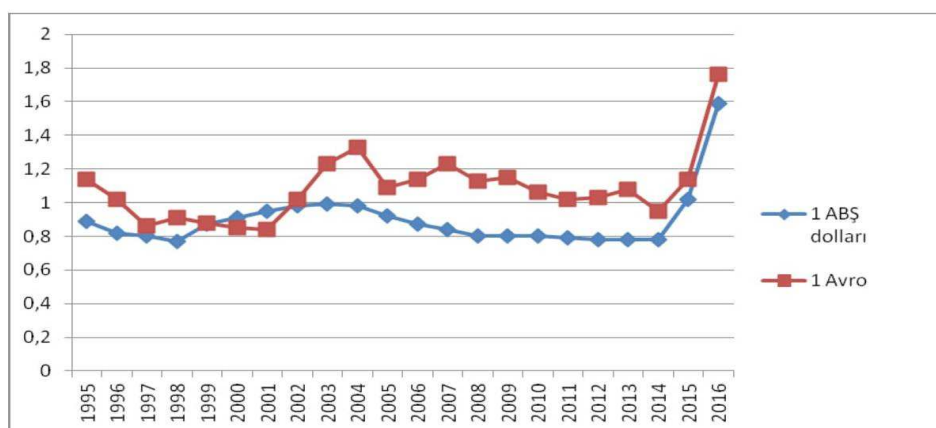
The investigation of the influence of the macroeconomic policy leading by the government to the occurring and increasing systematic risks process was taken an important place for the positive and negative sides [2, 3] of anticrisis financial events. Within managing explorers, especially, the financial tools such as the government currency resources, the main aggregates of money volume and interest rate have been probed in the role of eliminating financial-economic crisis and supporting the microeconomic stability processes with the help of world experience, were given essential advises.

Experience shows that the exchange rate significantly depends on the external factors. In particular, the dynamics of the national currency rate is explained by the volume of exports in many aspects in countries such as Azerbaijan.

The investigations which have been occurred was explored the influence mechanism of the balance of payment by the factors such as the export-import operations of manat course, the managing of total and foreign investment, the quality tendencies of model were investigated by creating an econometric model [4].

Figure 1 the dynamics of the exchange rate of manat is illustrated compared to the leading foreign currencies (US dollars, euro) from 1995 to 2016.

Figure 1. Dynamics of exchange rate of Azerbaijani manat according to the foreign currencies within 1995-2016



Source: Work of the authors

As can be seen from Figure 1, the exchange rate of manat from 1995 to 2014 can be relatively stable assumed compared with the leading currencies. The negative consequences of the global economic crisis since 2015 began to be felt in the Azerbaijani economy. The Azerbaijani manat was unable to maintain its firmness after the known processes and weakened by being times devaluated in 2015. This, in its turn, has been reflected in almost all macroeconomic indicators of Azerbaijan. With the sharp decline in oil prices in the world markets, the export of Azerbaijan also started to weaken.

Figure 2. Dynamics of Azerbaijani Exports for 1995-2016 (in mln USD)



Source: Work of the authors

As we have noted, the volume of exports is one of the major factors affecting the national currency. The drop in exports starting since 2012 and being felt severely in 2014 hit the Azerbaijani manat overwhelmingly. The deviation from the main trends in the dynamics of the manat wasn't made wait itself and once again reaffirmed the sensitivity of the national currency in front of external factors.

We present the estimated value of manat depend on export volumes for 1996-2016 on the basis of correlation coefficients for the US dollar and the euro exchange rate in Table 1.

Table 1. Correlation coefficients between the exchange rate and export volumes

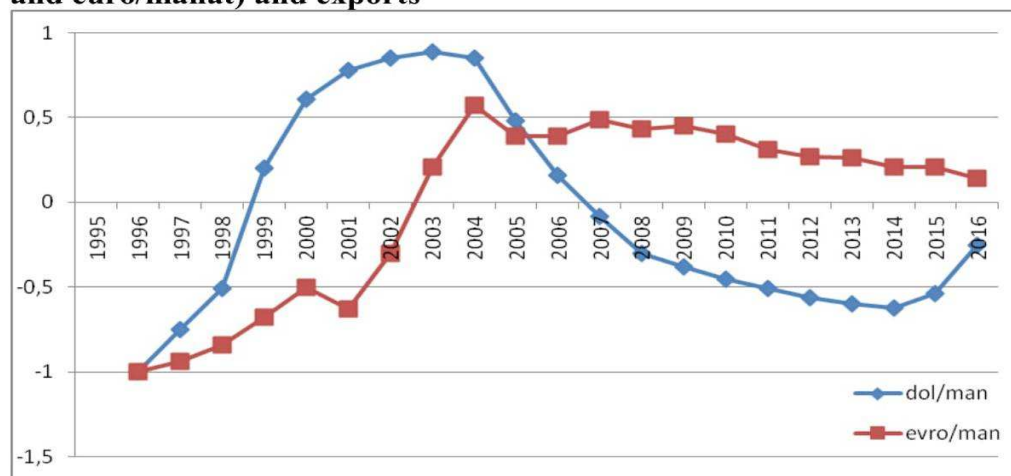
illər	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	
dol/man	-1	-0,75	-0,51	0,2	0,61	0,78	0,85	0,89	0,85	0,48	
evro/man	-1	-0,94	-0,84	-0,68	-0,5	-0,63	-0,3	0,21	0,57	0,39	
illər	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
dol/man	0,16	-0,08	-0,3	-0,38	-0,45	-0,51	-0,56	-0,6	-0,62	-0,54	-0,25
evro/man	0,39	0,49	0,43	0,45	0,4	0,31	0,27	0,26	0,21	0,21	0,14

Source: Authors' calculations

When analyzing the results, we see the periods in which currency is strongly dependent on the volume of exports. Thus, the exchange rate of manat in relation to the exports is strong enough by 2005 are expressed by the volume of ratios. The rise in this indicator to 0,89 (US dollar / manat dependency on imports and exports) in 2003 indicates strong dependence and density. Looking at statistical indicators since 2005, "invisible", but after computations gradual decrease of correlation of correlation coefficients is observed. Even

since 2007, correlation indicators have a negative mark, which means their passing in a converse state. Thus, the processes taking place in the world markets had had an impact on the manat since that period. Currently examining figure, the dependence between the rate of the Azerbaijani manat (US dollar/manat) and the export is relatively higher than the peak edge of global economic crisis in 2007 (-0,08) and is -0,25. The same weakening trend of the rate of manat in front of the euro and the volume of exports, however with a slower pace, has continued since 2007. The correlation dependence between the studied parameters is graphically shown in Figure 3.

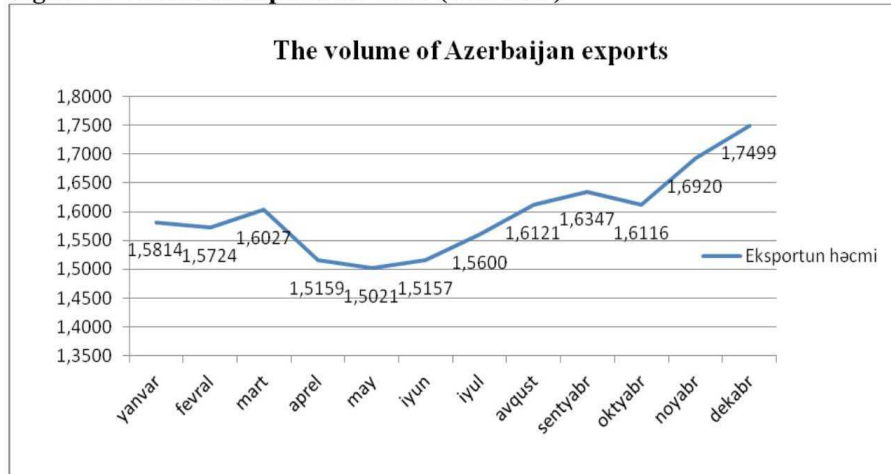
Figure 3. The correlation dependence between manat's course (US \$/manats and euro/manat) and exports



Source: Authors' calculations

Figure 3 illustrates a similar attitude to exports by both indicators, even with different frequency and intensity. The fluctuation amplitude and velocity of the floating exchange rate currencies are usually considered to be normally accepted for development tendencies. This is a multidimensional, complex, challenging and hard-predictable process. This is explained by the nature, mobility and dependence of many internal and external factors forming the exchange rate. In this regard, as it is always important to analyze the world economic crisis of recent decades, to examine countries with developed economies, evaluate the dependence on factors by applying mathematical-statistical methods in this field, expand the scope of scientific research and is even more important in the period when the exchange rate of manat weakened.

Analyzing the situation and evaluating the situation properly, the country's economic and social development strategy has focused on increasing export volume regardless of oil, creating new production areas, keeping the agrarian sector in focus, developing tourism, and building multidimensional industries. The results of the new strategy of the state in exports have started to be observed since 2016, even with small pace. An increase in the volume of exports for months is seen obviously in Figure 4.

Figure 4. Volume of exports for 2016 (mln USD)

Source: Work of the authors

The principal institution that affecting directly the exchange rate and has its management tools is the central bank that forms the monetary policy of the state. The central bank can directly intervene in these processes by increasing or decreasing the volume of money circulation. Along with regulation of the money supply, it also manages important mechanisms in the formation of the national currency environment in the country, even by changing interest rates.

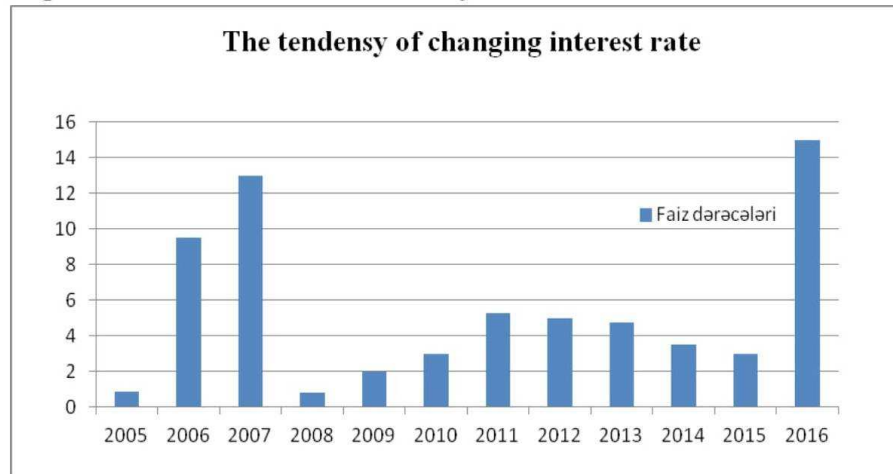
The Central Bank of Azerbaijan (CBA) carries out the role of important regulatory aggregate in the implementation of key economic strategies such as maintenance of stability of economic development in the Republic of Azerbaijan, secure and long-term investment climate, and sustainable macroeconomic stability. The main goals of the CBA are currently stabilization of the national currency by means of instruments such as monetary and national currency regulation policies, low inflation rates or a certain optimisation, encourage the banking sector which having recession after the depreciation of manat in 2015 and restore them as a major and active financial sector in the economic, financial environment, monetary and credit relations of republic, establishment of interbank money market in Azerbaijan, strengthening the trust among credit institutions, and developing non-cash payments.

Strengthening of the Azerbaijani manat, development of the banking sector and provision of a balanced financial environment are the leading directions of the CBA's macroprudential policy. The monetary policy of the Central Bank is aimed at maintaining the stability of prices by influencing the inflation processes, adjusting the exchange rate, money supply, and interest rates. As a direct tool, control over interest rates, loan corridor, loans directly or indirectly, as a roundabout instrument the open market operations, the money supply are applied to the issue [5]. The CBA chairman E.Rustamov mentioned [6] that during the floating course the exchange rate \$ 1 US dollar due to manat fell to 1,92 manat. However, stabilized and 11% below than the limit. The real effective exchange rate of the

manat has decreased by 50%, which is also reasonable. It is possible that strong manat can create new problems by increasing imports, while the increase in exports from the non-oil sector requires the manat to be more favorable for market participants.

It should be noted that interest rates in Azerbaijan are 15% since September 14, 2016. CB's head [7] noted that due to the decrease of inflation rates the interest rates has declined, updates the issue of transition to the softer regime. Figure 5 presents the dynamics of interest rates in Azerbaijan.

Figure 5. Interest rate in 2005-2016 years



Source: Work of the authors

As it is clear from the graph, interest rates at 3% in 2015 are raised to 15% by the end of 2016 within the framework of regulatory arrangements of the CBA.

In this case, we look at quantifying the dependence between the national currency rate and interest rates in Azerbaijan and the regression analysis of the statistical indices in order to determine how the exchange rate changes depending on the interest rate.

According to the results of the regression analysis of the exchange rate and interest rates, the Student criterion was $t=2,54$; the significance level was $p=0,03$; the standard deviation was $S=0,01$. The p -significance level is sufficiently low and does not exceed $0,05$, the results are considered satisfactorily. The double regression model is formed as follows, given that the free boundary $a_0=0,69$ and the regression coefficient $a_1 =0,03$:

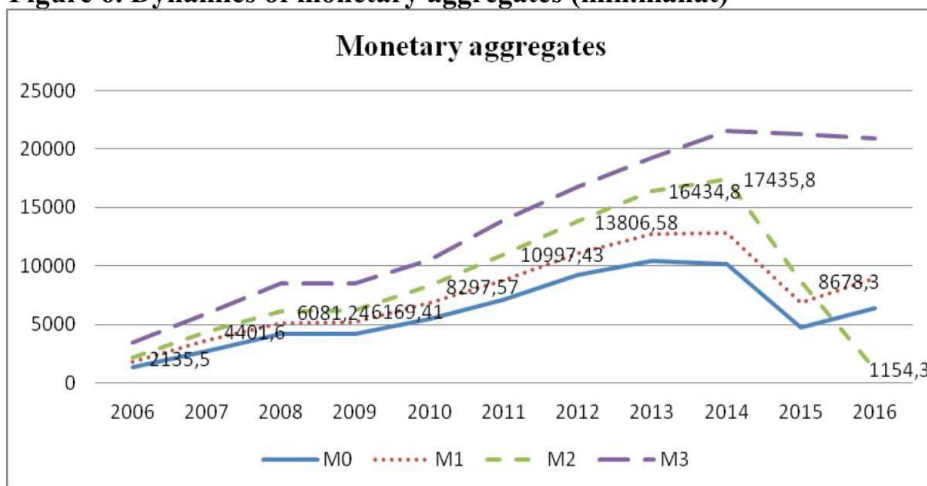
$$MR = 0,69 + 0,03IR$$

where MR -manat rate; IR -rates interest rates. According to the model, the correlation coefficient $r = 0,69$; determinate coefficient $R^2 = 0,41$.

41% of determinate coefficients indicate that 41% of exchange rate fluctuations occurred on the basis of interest rates, and 59% were due to factors not included in the model. This created a necessity to continue research.

Now let's look at the money aggregates. The sharp decline of key monetary aggregates in Azerbaijan after the devaluation of manat is graphically illustrated in Figure 6. Particularly, the M2 aggregate, which amounts to 17435,8 million manats in 2014, having fallen to 8678,3 million manats in 2015 and 1154,3 million in 2016 is observed.

Figure 6. Dynamics of monetary aggregates (mln.manat)



Source: Work of the authors

here

M0 - the most liquid part of the money supply, banknotes and coins in circulation;

M1-*M0*+demand deposits and deposits denominated;

M2- *M1*+denominated term deposits and savings;

M3-*M2*+ is expressed in a freely convertible currency savings deposits [5]

We conducted a multidimensional regression analysis based on the fact that there was a significant dependence on the currency exchange rate between the major monetary aggregates in Azerbaijan. The main results are presented in Table 2.

Table 2. Results of regression analysis for major monetary aggregates and exchange rate

	<i>Coeff.s</i>	<i>Stand.error</i>	<i>t-stat.</i>	<i>P-value</i>
Y	0,766017	0,022012	34,80011	3,75E-08
M0	-0,00015	5,79E-05	-2,65195	0,03793
M1	0,000185	5,33E-05	3,464232	0,013398
M2	-5,8E-05	3,21E-06	-18,0756	1,85E-06
M3	1,01E-05	5,01E-06	2,027254	0,089002

Source: Authors' calculations

Taking the results, we have the following multidimensional regression model:

$$MK = 0,76 - 0,00015M0 + 0,0002M1 - 5,8M2 + 1,01M3$$

According to the model, the correlation coefficient $r=0,99$; the determinant coefficient $R^2=0,99$.

Considering the fact that the interest rate factor is essential in the dynamics of the exchange rate (in the previous model $R^2=0,41$), we added the interest rate dependent variable to the latter model.

The results of the multidimensional regression model describing the impact of the major monetary aggregates in Azerbaijan ($M0$, $M1$, $M2$, $M3$) and interest rates (IR) on the Azerbaijani manat rate are presented in Table 3.

Thus, based on the results we have obtained, we have set up the next multi-dimensional regression model:

$$MR = 0,74 - 9,8M0 + 0,0001M1 - 5,4M2 + 1,53M3 + 0,0048IR$$

According to the model we received, $r=0,99$; $R^2=0,99$; $S=0,01$ indicates that the model is sufficiently adequate. Thus, the fact that the correlation coefficient obtained by almost the maximum price dependent variables is very strong, dense, and the determination factor $R^2=0,99$. The $M1$, $M2$, $M3$, $M4$, IR factors change the maximum rate of manat, explaining that 99% of these factors are the result. $S=0,01$ indicates that the standard error in the model is low. The $F=1,28$ price of the Fischer criteria for the model is compared to the table price to evaluate the overall quality of the model. If the evaluation of the model is more than an estimate, the model is considered more qualitative.

Table 3. The results of the regression analysis performed among the M0, M1, M2, M3, IR factors and MR-result marks

RESULTS								
<i>Regres. stat.</i>								
R	0,998881							
R ²	0,997762							
Norm. R ²	0,995525							
Stand. error	0,016112							
Observation	11							
Variance analysis								
	<i>Df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>F</i>			
Regression	5	0,57877	0,115755	445,891	1,284E-06			
Remainder	5	0,0013	0,00026					
Total	10	0,58007						
	<i>Coeff.</i>	<i>Stand.error</i>	<i>t-stat.</i>	<i>P-value</i>	<i>lower 95%</i>	<i>Upper 95%</i>	<i>Lowre95,0%</i>	<i>Upper95,0%</i>
Y-	0,743649	0,01705	43,61322	1,2E-07	0,6998184	0,78748	0,699818	0,78748
M0	-9,8E-05	4,4E-05	-2,2217	0,07696	-0,000212	1,54E-05	-0,00021	1,54E-05
M1	0,000128	4,2E-05	3,052305	0,02835	2,015E-05	0,000235	2,01E-05	0,000235
M2	-5,4E-05	2,5E-06	-21,5252	4E-06	6,099E-05	-4,8E-05	-6,1E-05	-4,8E-05
M3	1,53E-05	3,9E-06	3,93207	0,01105	5,287E-06	2,53E-05	5,29E-06	2,53E-05
FD	0,004803	0,00172	2,796489	0,03815	0,000388	0,009218	0,000388	0,009218

The regression ratios of the $M1$, $M2$, $M3$, $M4$, IR factors, corresponding to the course of the manat, are either flat or reverse, ie the elasticity values are as follows:

$$a_0 = 0.74, a_1 = -9.8, a_2 = 0.00013, a_3 = -5.4, a_4 = 1.53, a_5 = 0.005$$

Note that positive signage regression coefficients show the direct relationship between the variables and the negative regression coefficients show the inverse.

The default errors for $M1$, $M2$, $M3$, $M4$, IR are the following prices.

$$S_1 = 4.4, S_2 = 4.2, S_3 = 2.5, S_4 = 3.9, S_5 = 0.001$$

estimated for Student criterion

$$t_1 = -2.22, t_2 = 3.05, t_3 = -21.5, t_4 = 3.93, t_5 = 2.79$$

prices are compared with table prices. Factors that are bigger than the table price criteria are considered to be more important for the model. The relatively high price of the estimated values indicates the acceptance of the hypothesis that the factors are important. The fairly low prices of the obtained value for p significance levels are also a positive factor for the model. This means that the results have been gained with higher probability.

Thus, the multi-dimensional linear regression model we have established can be used to predict the course of the manat, depending on the interest rate and key aggregates of

the money supply. We believe that our research can be regarded as important analytical calculations in the investigation and management of the financial and economic system and its key assets, planning and forecasting development dynamics, and regulation of the manat's course.

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Received 28 April 2017

Accepted 22 June 2017