

Empirical Analysis of Balance of Payments Dynamics

E.G. Orudzhev, N.S. Ayyubova

Abstract. The article deals with the construction of econometric model, which characterizes the dynamics of the balance of payments, formed on the basis of economic and mathematical tools, and serves to predict the preventive signals of the balance of payments crisis. Over time, the unsteady character created by the denomination of the Azerbaijani manat was corrected, and a multidimensional model of linear regression was created for the dynamics of balance of payments development.

Key Words and Phrases: balance of payments, current account, export, import, investment, manat rate, regression, adequacy, t statistics, F -criterion

2010 Mathematics Subject Classifications: C1, C12, C5

1. Introduction

At the beginning of the transformation process in a number of transition countries, such as Azerbaijan, liberalization of the currency market and foreign economic relations increased the level of openness of the economy and its integration into the world economy. At present, the cooperation of the Azerbaijani economy with the world commodity and financial markets has reached a broad and multidimensional level. Therefore, the study of issues related to the regulation of foreign economic relations is particularly relevant.

The balance of payments is central to the macroeconomic regulation of the foreign economic relations sector. The structure of the balance of payments is in principle determined by economic indicators, such as foreign trade, receipts from direct and portfolio foreign investments, in general, the prospects for economic growth. Therefore, along with the problems of ensuring economic growth, high inflation and unemployment, the issues of maintaining stability and stability of the balance of payments are among the priorities of our state's economic policy.

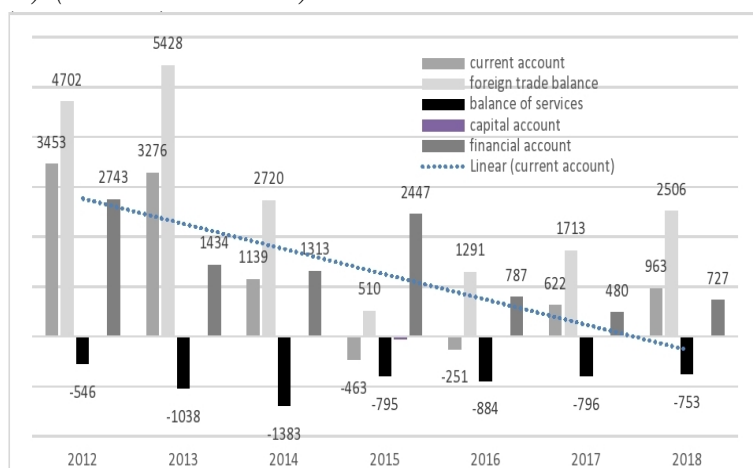
Recent processes such as global economic instability, volatility of oil prices in world markets and surges influenced by various external and endogenous factors, devaluation of national currencies lead to a balance of payments crisis. Monitoring of changes in the structure and dynamics of the balance of payments in order to develop a set of preventive and anti-crisis measures is one of the most difficult issues of monetary policy in state regulation of the economy.

The study of the causes and consequences of balance of payments crises, their early detection and, in general, the search for ways out of the crisis, the development of effective balance of payments methods are the most pressing economic policy issues in any market economy. These issues are particularly important in countries such as Azerbaijan, whose economies are heavily dependent on energy, foreign trade and other external factors [6, 8, 9]. (see: figure 1).

Both at the macro level and the micro level, modern economic theory inevitably turns to mathematical and statistical models and methods, and this approach has now become an important element of economic theory. Applying mathematics to economics first of all reveals more important dependencies of economic variables and objects and creates opportunities for formal description, because studying complex objects requires a high level of abstraction [1]. Precise input information and deduction methods allow obtaining results and making forecasts adequate to the object under study. Mathematical and statistical methods inductively allow obtaining the newest knowledge about the object under study about parameters and forms of dependent variables on the basis of possible observations.

Relevance of the problem, theoretical and practical significance of methodological and analytical approaches [2, 3, 4, 5], as well as balance of payments modeling, econometric analysis of its interrelation with the main forming factors, analysis of changes in the structure of the balance of payments, taking into account the interest and demand, we have defined the creation of an econometric model that provides the balance of payments as an object of research, forecasting of crisis prevention signals as a goal and includes economic and mathematical tools for crisis prevention.

Figure 1. Dynamics of key indicators of Azerbaijan's balance of payments in 2012-2018 (years) (million US dollars)



The Balance of Payments is a statistical report that systematically reflects the final results of the state's foreign economic operations with other countries. Information on the balance of payments and the position of the state with regard to international investments inevitably play an important role in the formation of domestic and foreign economic

policy. This information also includes balance of payments analysis, identification of reasons for contraindications, assessment of regulatory measures, assessment of the role and interdependence of foreign trade and foreign direct investment, external debt, economic growth, income distribution, and the current and financial balance of payments, is very important and invaluable for analyzing the relationship between foreign operations and exchange rates reflected in the accounts.

Any modern economic research is based on a combination of theory and practice, joint application of statistical indicators with an economic model. Thus, while theoretical models are used to describe and explain observed processes, statistical indicators are used for empirical construction and justification of models. For both public policy and any economic entity, the ability to predict the situation means reducing losses and damages, increasing profits and, in general, getting as close to the desired result as possible.

Our research is devoted to building an econometric model based on the adequacy of the balance of payments, which provides the projected values of the balance of payments based on the main factors that determine its dynamics.

The regression methodology includes the analysis of stationary and, most importantly, non-stationary series in order to predict the dynamics. LSM, GLS, VAR, taking into account seasonality, the inclusion of models based on multicollinearity, etc. methods are very popular in this area [4, 5]. The novelty and urgency of our research is connected with application of the analysis of these methods to non-stationary time series.

In our initial research on modeling the dynamics of the balance of payments [7] regression analysis was carried out for the purpose of econometric analysis of dependence of the current account of the balance of payments on general and foreign investments, export and import, exchange rate of Azerbaijani manat. In the research, since the current account of BP's balance of payments depends on a variable, foreign investment FI, EX-exports, IMP-import, the exchange rate of manat against the US dollar, the total investment in GI for 1995-2017, respectively, the explanatory variables.

Table 1. Results of regression analysis (1995-2017)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
<i>FI</i>	-1.041597	0.214275	-4.861035	0.0001
<i>EXP</i>	0.855962	0.071390	11.98994	0.0000
<i>IMP</i>	0.040745	0.054360	0.749535	0.4638
<i>CM</i>	0.127631	0.220403	0.579079	0.5701
<i>GI</i>	-0.074593	0.144352	-0.516739	0.6120
<i>C</i>	-978.5116	1126.953	-0.868281	0.3973
Dependent Variable <i>BP</i>				
Method Least Squares				
Included observations 23 after adjustments				
Sample (adjusted) 1 23				
R-squared	0.986318	Mean dependent var		4332.196
Adjusted R-squared	0.982293	S.D. dependent var		6943.397
S.E. of regression	923.9354	Akaike info criterion		16.71462
Sum squared resid	14512163	Schwarz criterion		17.01084
Log likelihood	-186.2181	Hannan-Quinn criter		16.78912
F-statistic	245.0926	Durbin-Watson stat		2.928609
Prob(F-statistic)	0.000000			

Source: author's work

Based on the results of regression analysis with the parameters involved in the research, the number of observations: 23; R^2 - Determination factor: 0,98; F statistic - Fisher Criterion: 245,1; severity level: prob.- 0,00; DW-Durbin Watson's statistic's: 2,92. The results are quite satisfactory. Explanatory variables included in the model according to the determination coefficient explain the result variable by 98%. Criterion F received a fairly reliable estimate with a high probability. However, the result obtained for the DW criterion cannot be considered satisfactory. $n = 23$ and $k = 5$ (number of explanatory factors included in the model) critical boundaries for DW criterion with indicators are $D_L = 0,90$ and $D_U = 1,92$ Since the calculated DW criterion value for the model is higher than 2, the 4-DW value = 1.08 is compared with the critical value. $D_L < 1,08 < D_U$. Alternatively, $4 - D_U < DW < 4 - D_L$ we get a similar result: $2,08 < 2,92 < 3,1$ DW falls into an area of uncertainty and it is impossible to decide if autocorrelation exists.

Units of measurement of independent variables FI, EXP, IMP, GI included in the model for regression analysis are expressed in US dollars. As it is known, in 2006 the denomination of Azerbaijani manat was conducted in the ratio of 1:5000. One of the explanatory factors is the exchange rate of KM manat in the national currency, which created a serious problem for the stability of the considered time series. Thus, large amplitude jumps occurred in time, which, in turn, formed a non-stationary sequence. Unsteady time series lose their importance for econometric studies and are not suitable for forecasting because the model is inadequate. For this purpose, the time series research period was shortened, the number of observations was reduced to 12 and covered 2006-2017 years. Continuing the regression analysis in a new chronological order, we obtained results in Table 2 below.

Table 2. Results of regression analysis (2006-2017)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FI	-0.043786	0.851259	-0.051436	0.9606
EXP	0.940172	0.130751	7.190547	0.0004
IMP	0.075568	0.097305	0.776614	0.4669
CM	-3669.255	3126.497	-1.173600	0.2850
GI	-0.505909	0.394494	-1.282425	0.2470
C	-365.0545	3458.028	-0.105567	0.9194
Dependent Variable	BP			
Method	Least Squares			
Included observations	12			
Sample (adjusted)	1 12			
R-squared	0.977251		Mean dependent var	9106.875
Adjusted R-squared	0.958293		S.D. dependent var	6616.478
S.E. of regression	1351.229		Akaike info criterion	17.56227
Sum squared resid	10954912		Schwarz criterion	17.80472
Log likelihood	-99.37361		Hannan-Quinn criter	17.47250
F-statistic	51.54956		Durbin-Watson stat	2.922200
Prob(F-statistic)	0.000075			

Source: author's work

Number of observations from the 2nd regression analysis:12; R^2 -0,97; F statistic - 51,5 severity level: prob.=0,000075; DW -2,92. Thus, the model we have created for the dynamics of the current account of the balance of payments at this stage of the research looks as follows:

$$BP = -0,043786\dot{F} + 0,940172EXP + 0,075568\dot{IMP} - 3669,255CM - 0,505909\dot{G}$$

According to the latest results, there are no significant changes in model quality, i.e. the model quality does not increase or decrease significantly, and DW statistics still fall into the zone of uncertainty. This does not tell us if there is autocorrelation in time, so we cannot be sure that the model is adequate. In such cases, steps such as extending the time sequence and editing explanatory factors in the model can be used to improve the quality of the model. In the next stages of our study, in addition to these steps, appropriate econometric tests will be applied to verify the adequacy of the model in more detail.

Current account deficits generated by the trade balance can be financed by capital inflows in the following forms: foreign loans from other countries, the International Monetary Fund, the World Bank; assets sold to foreign investors; direct investments that bring foreign currency into the country in order to create new production facilities; foreign exchange reserves.

The application of these measures contributes to the reduction of the country's foreign assets. However, if the government increases its external debt, which significantly exceeds the current account deficit, then the country faces a balance-of-payments external debt crisis. Proper regulation of these financial processes is very important for the balance of payments and the dynamic development of the country's economy as a whole.

2. Results

1. The time series of macroeconomic indicators were systematized for econometric modeling of the current account of the balance of payments;
2. The model of multidimensional linear regression was created for the current account of the balance of payments, assuming that foreign investments, exports, imports, exchange rate of manat against the US dollar, total investments - macroeconomic indicators are independent variables;
3. Corrected model for the period 2006-2017. was proposed by eliminating factors that caused serious problems with the stationarity of time series, and an analysis was performed to verify the adequacy of the model.

The urgency of the problem, the need to build an econometric model that reflects the dynamics of the current account in the form of trends and indicators of full adequacy for the forecast evaluation of the balance of payments, as well as the results of our study make it necessary to continue the study.

We believe that the results of the research will make it possible to identify real balance of payments trends and balance of payments dynamics that may be useful for the CIS and Eastern European countries based on the analysis of interdependence of the balance of payments with macroeconomic indicators may be important in shaping regulatory measures.

The results of the research can also be used as teaching material in lectures on economic theory, economic mathematics, econometrics, statistics.

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Elshar G. Orudzhev
Baku State University, AZ 1148, Baku, Azerbaijan
E-mail: elsharorucov63@mail.ru

Natavan S. Ayyubova
Baku State University, AZ 1148, Baku, Azerbaijan
E-mail: neyyubova@mail.ru

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