

## The impact of the USD/EUR exchange rate on Bulgaria's foreign trade

Lyubomir LYUBENOV<sup>1</sup>

<sup>1</sup> University of Economics, Varna, Bulgaria  
[lyubenov@ue-varna.bg](mailto:lyubenov@ue-varna.bg)

**Abstract.** The USD/EUR rate, with its volatility, is one of the most significant factors and measure of processes in the global economy. Specifically, its influence is most significant on each country's foreign trade. The article aims to make only this impact on the import and export of Bulgaria – before and after our country's entry into the EU, which also pre-defies the period considered. Based on the theory of elasticity and the use of single-factor linear regression models, for the first time the elasticity of imports and exports, in general and energy resources, is assessed against the USD/EUR exchange rate. Limitations to the study turned out to be multi-collinearity in modelling and different economic conditions before and after entering the EU. The negative effects of the exchange rate prevail on imports. It is found that in the future there is a possibility of greater energy dependence of Bulgaria, predetermined by the significant influence of the USD/EUR exchange rate. The conclusions drawn suggest that there may be a delay effect (lag) in the time of its impact. This allows experimentation with models of distributed lags, but only with data after Bulgaria's entry into the EU. From a research point of view, it is also of interest to study the impact of the USD/EUR exchange rate on specific groups of goods of exports and imports.

**Keywords:** USD/EUR exchange rate, external trade, single-factor regression models, elasticity, energy dependency, energy resources.

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### 1. Introduction

The Republic of Bulgaria is resource insecure, with an open economy, whose foreign trade is a factor in the development of its national economy. At the same time, foreign trade is influenced by a number of economic indicators that have a direct impact on its dynamics and value volumes. Examples are macroeconomic variables such as the EUR's exchange rate against the USD and oil prices on world markets. Exchange rates are the most important measures of processes in world economic systems. The variability in their levels is a consequence of economic and political events. The fact that our country is on a currency board predetermines the fact that our economy is affected by changes in the USD/EUR exchange rate. At the same time, our foreign trade is functionally linked to both currencies.

Our membership in the EU leads to certain limitations on the opportunities for import and export of certain groups of goods, which raises questions about the real opportunities for economic development and growth.

It follows from the above that our foreign trade is subject to many different influences that determine the economic system globally and regionally. In this sense, it is interesting to what extent the foreign trade of our country is determined by the influence of this macroeconomic indicator.

The purpose of this article is to assess the impact of the dynamics of the USD/EUR exchange rate on the foreign trade of Bulgaria – before and after eu membership. This is done with the help of the theory of elasticity (Rose, 1991) and one-factor linear regression (Dimitrov, 1995).

### 2. Literature review

The elasticity of foreign trade relative to the exchange rate is a specific property of any national economy (Hadjiev, 2001). Elasticity indirectly regulates the volume of imports and exports. The sensitivity of imports and exports to exchange rate changes is a prerequisite for successful integration of the national economy into international economic structures.

The theoretical foundations for the study of the elasticity of foreign trade were laid in the 1930s (Marshall, 1923; 1961). Many authors then developed the theoretical aspects of the elasticity of imports and exports relative to the exchange rate (Lerner, 1944; Salvatore, 1982; Gandolfo, 1987). Here we will not focus in detail on the mechanism of impact of the exchange rate on foreign trade. We will only note that the change in the relative prices of imports and exports caused by the dynamics of the exchange rate changes their demand, which also changes their volume (Hadjiev, 2001).

The econometric studies of the elasticity of foreign trade began after WWII. A significant development in this direction is the study of Junz and Rhomberg (1973), which consider short-term and long-term elasticity. The resulting estimates of elasticity are summarised by many authors. The publications of Goldstein and Khan (1985) and Gylfason (1987) can be mentioned here. The latest study covers 15 developed and 9 developing countries for the period from 1969 to 1981.

In recent decades, scientific interest in the elasticity of foreign trade has resumed. The following publications can be mentioned: Caporale and Chui (1999), Marquez (1999), Sinha and Sinha (2000).

The common denominator of all these studies is that in them the elasticity is considered as a one-time manifestation of the dependence within a period equal to the frequency of the time series used (Hadjiev, 2001).

In 1996, for the first time in economic literature Panagariya, Shah and Mishra (2001) assess the elasticity of import demand for a small country (Bangladesh), which is very large. At an intuitive level, economists generally believe that most developing and smaller developed countries do not have market power on the global market, which means that they face an infinitely elastic demand for their goods. However, the estimates of the elasticity of import demand they face rarely exceed 3%. Their research shows that for certain goods it is 26%.

In Bulgaria, BNB experts are researching and reaching interesting conclusions about the impact of the USD/EUR exchange rate (BNB, Economic Review, 2015). According to this study, the positive effects on the Bulgarian economy of the depreciation of the EUR against the USD are more significant than the negative ones. Classical economic theory suggests that the devaluation of the EUR will make exports to EUR area countries and, consequently, to Bulgaria more competitive. At the same time, imports will become more expensive. As a result of the small size and openness of the economy and the structure of Bulgarian foreign trade, Bulgaria's share with third countries is relatively higher compared to the average level of the EU and the EUR area. Given that Bulgaria is a net importer of primary goods and that the share of payments in USDs in imports is higher than in exports, we can expect the appreciation of the USD against the EUR to worsen trading conditions for Bulgaria for this group of goods. Regarding energy resources, it can be seen that Bulgaria trades them almost entirely in USDs, and their share in payments is significantly higher than that of the EU and the new Member States, especially in exports. Due to the similar currency structure of payments for import and export of petroleum products, the terms of trade for Bulgaria in this commodity group should not worsen due to the appreciation of the USD against the EUR. At the same time, the depreciation of the EUR is a factor in rising prices in the supply chain, with the balances of trade in primary commodities and petroleum products being the most affected.

We need to assess the elasticity of our foreign trade against the USD / EUR exchange rate and determine how true these assumptions are in the current conditions.

### **3. Methodology and information base of the study**

Data on total imports and exports, as well as on imports and exports of energy resources, by quarters, for the period 1999: 1-2021: 3 were used. A factor macroeconomic variable is the nominal exchange rate of the US USD against the EUR. The rise in the exchange rate shows the depreciation of the USD against the EUR, respectively, the appreciation of the EUR against the US USD.

The dependent variables for foreign trade in the study are total exports and imports and total exports and imports of energy resources.

Data on them are denominated in US USDs. This is necessary due to the following circumstances:

1. When examining the relationship between external trade and factor variable, EUR data would be indirectly influenced by the USD-to-EUR ratio, which would distort the final results;
2. Econometric theory requires comparability of source data.

The data sources are the statistical publications of the NSI, the BNB and the US Federal Reserve.

The data on the foreign trade of Bulgaria are based on the statistical publications of the NSI and the BNB by quarters for the indicated period.

Accordingly, data on the USD / EUR exchange rate are from the US Federal Reserve. They are quarterly averages of the average daily exchange rate.

Quarterly data are preferred because it leads to some desired effects. According to Hadjiev (2001), this increases the reliability of the conclusions on the sustainable trend. In this way the variation caused by the dynamics of the exchange rate is limited.

The beginning of the period of this study is set in 1999 for the following reasons:

1. The EUR was presented on the world financial markets as a virtual currency for cashless payments and accounting purposes on 1 January 1999, replacing the former European Currency Unit ecu at a ratio of 1:1 (1.1743 USD)<sup>1</sup>. Since then, the USD/EUR exchange rate has officially existed.
2. In Bulgaria the currency board was introduced in 1997, and the stabilization of economic processes, including our external trade, occurred after a period of about 2 years.

In order to detail the study and more clearly assess the influence of the factor, modelling is carried out for both the entire study period and the two subperiods included in it – until our EU membership and beyond – 1999:1–2006:4 and 2007:1–2021:3 respectively.

### **Single-factor linear regression models**

Using single-factor regression models aims to identify significant relationships that occur within the current quarter between the variables studied. The classic model allows easy and direct interpretation of the results obtained (Dimitrov, 1995). It provides a solid basis for the development of research towards the identification of real and long-term existing dependencies between the factor and dependent variables. Initially, one-factor regression models were used to estimate elasticity (Hadjiev, 2010). The natural development of the classical one-factor linear model based on time series are the multifactor lag models (PDL)<sup>2</sup>. But this study will only address aspects of one-factor models. The reason for this is that the use of quarterly data allows us to assess the impact of the factor over a relatively long period of time, without having to complicate the model.

### **Econometric models for assessing elasticity**

Econometric modelling is carried out both for the entire observed period and for the periods before and after Bulgaria's membership of the EU. The aim is both to study the impact of the exchange rate over a longer period (23 years) and to assess the elasticity of Bulgaria's foreign trade under different conditions of functioning of the external economic market environment.

In the specific study, total imports and exports, total imports and exports of energy resources are selected as dependent variables. Imports of energy resources, on average for the entire study period, accounted for 19.2% of total imports, and exports of energy resources accounted for 12.1% of total exports. Prior to Bulgaria's entry into the EU, these shares were 21.1% and 11.7%, and then 18.1% and 12.2%, respectively. We believe that these relative shares are crucial for the inclusion of the relevant variables in this study, given the trends in global resource markets.

These foreign trade time series, as well as the selected macroeconomic variable, are tested for a unit root. The test is applied to seasonally adjusted data. This is necessary because when establishing dependencies, seasonality in the variables can mask or artificially increase the studied dependence. The method for seasonal adjustment is Census X11.2. After removing the influence of seasonality, the data are subjected to logarithmization. This is done to stabilize the variance of the studied time series. The obtained estimates with the series of natural logarithms are more reliable and do not distort the results of the modeling (Fig. 1, Fig. 2). The resulting time series are subjected to the augmented Dickie-Fuller test (Charemza, W. W. and D.F. Deadman, 1997), the results of which are presented in Table 1. Criteria for selecting the basic equation in the ADF<sup>3</sup> test are the absence of autocorrelated in residues and optimal values for the AIC<sup>4</sup> and SC<sup>5</sup> criteria (Caporale, G. and M. Chui, 1999). The critical value for all-time series is fixed at 1 % error risk.

After testing, it was found that all studied time series were integrated from the first order (Table 1). In modeling to dependencies, this allows their first differences to be used. In this sense, the obtained regression coefficients can be interpreted as pure coefficients of elasticity.

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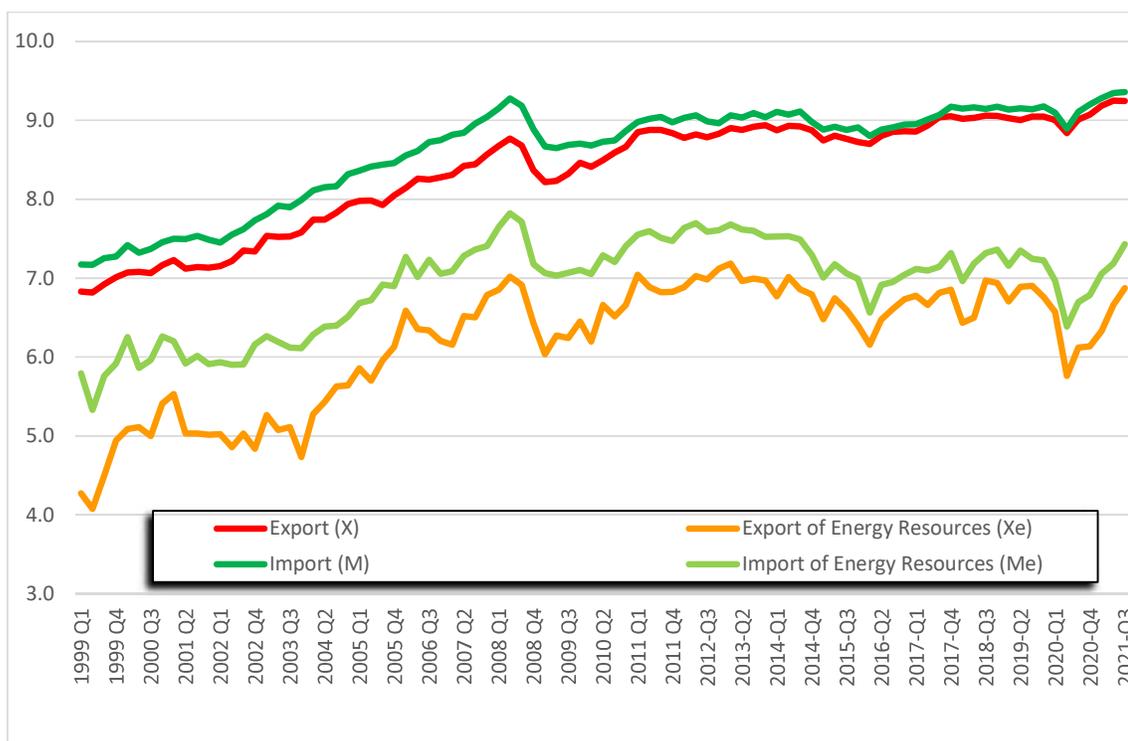
<sup>1</sup> <http://profit.bg/news>

<sup>2</sup> Distributed Lag Models

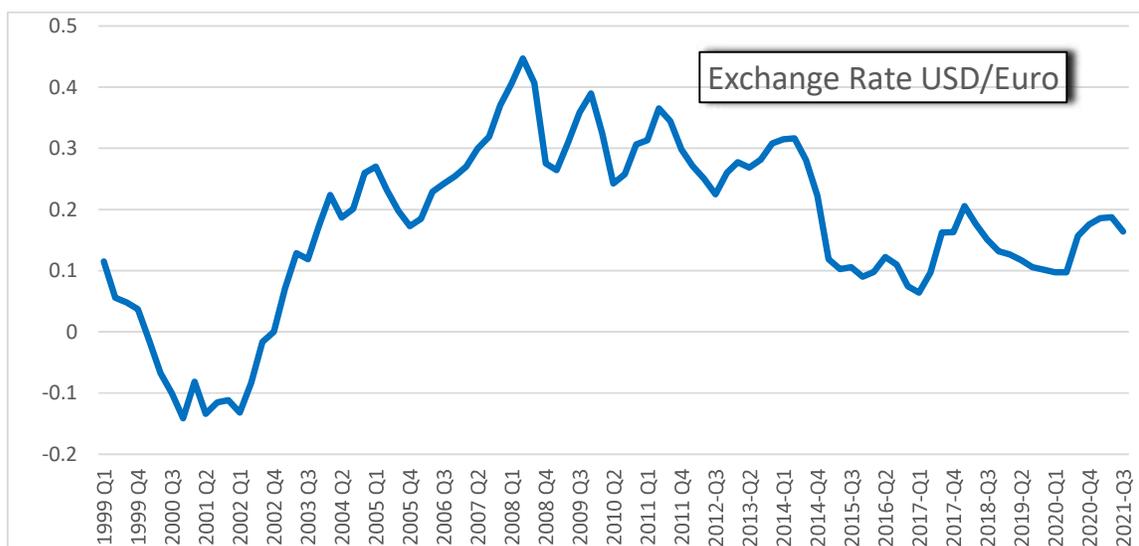
<sup>3</sup> Augmented Dickey-Fuller test

<sup>4</sup> Akaike Information Criterion

<sup>5</sup> Schwarz Criterion



**Figure 1.** Dynamics of natural logarithms of the dependent variables  
 Source: Own elaboration



**Figure 2.** Dynamics of natural logarithms of the exchange rate USD/EUR  
 Source: Own elaboration

**Table 1.**

Results of the conducted tests for integration of the studied time series for the period 1999: 1 - 2021: 3

Variable	Type of test model*	First differences		Order of integration
		Test value	1% risk	
		ADF	p-value	I~(d)
<u>For the entire period 1999:1 - 2021:3</u>				
Logarithms of seasonally adjusted import and export time series				
Import (M)	const	-7,464	0,000	1
Import: Energy resources (Me)	none	-10,907	0,000	1
Export (X)	const	-7,545	0,000	1
Export: Energy resources (Xe)	none	-10,410	0,000	1
Logarithms of the seasonally adjusted time serie of the factor variable				
Nominal exchange rate USD per EUR	none	-6,314	0,000	1
<u>For the first subperiod 1999:1 - 2006:4</u>				
Logarithms of seasonally ajusted import and export time series				
Import (M)	const	-6,651	0,000	1
Import: Energy resources (Me)	const	-8,628	0,000	1
Export (X)	const	-6,204	0,000	1
Export: Energy resources (Xe)	none	-2,285	0,022**	1
<u>For the second subperiod 2007:1 - 2021:3</u>				
Logarithms of the seasonally adjusted time serie of the factor variable				
Nominal exchange rate USD per EUR	none	-4,356	0,000	1
Logarithms of seasonally ajusted import and export time series				
Import (M)	none	-5,787	0,000	1
Import: Energy resources (Me)	none	-7,630	0,000	1
Export (X)	none	-5,509	0,000	1
Export: Energy resources (Xe)	trend/const	-8,178	0,000	1
Logarithms of the seasonally adjusted time serie of the factor variable				
Nominal exchange rate USD per EUR	none	-5,945	0,000	1

\*none - no constant or line trend included; trend/const - with constant and line trend included; const - with constant only on.

\*\*the zero hypothesis is rejected at a 5% error risk.

Source: Own calculations

### Results of experimentation with linear single-factor models

In modeling, an option was introduced to exclude the constant from the model. All models are of the following type, given that the applied transformation of the data is the finding of the first differences of logarithms<sup>6</sup> :

<sup>6</sup> The proposed model is a modification of the author

$$\begin{pmatrix} Y_t \\ Y_{t-1} \end{pmatrix} = \left[ e^{\omega_t \delta} \right] * \begin{pmatrix} X_t \\ X_{t-1} \end{pmatrix}^\beta$$

Where

$Y_t, Y_{t-1}$  - values of the dependent variable at moments  $t$  and  $t-1$ ;  
 $X_t, X_{t-1}$  - values of the factor variable at moments  $t$  and  $t-1$ ;  
 $e, \omega, \delta$  - parameters of the model representing its constant;  
 $\beta$  - regression coefficient of the model.

In this case, the obtained significant regression coefficients can be interpreted directly as pure coefficients of elasticity.

For convenience in reading the characteristics of the models in Table 2 presents their interpretation.

**Table 2.**

Interpretation of the characteristics of single-factor models	
Characteristic	Interpretation
Adj R-sqr	Adjusted coefficient of determination of the model
DW stat	Value of the test for autocorrelation of the model residues
AIC / SC	Information criteria of Akaike and Schwartz
Const	Constant of the model (where there is no constant, we mark "none")
BETA	Regression coefficient $b_1$ / Coefficient of elasticity
SE	Standard error of the coefficient $b_1$

Following the use of the criteria of Akaike and Schwarz, the models presented in Table 3 were selected.

From the results obtained, imports are distinguished by more significant models according to the criteria set (8 out of 10). At the same time, it can be noted that for the period before our entry into the EU, there is no significant model for imports. The presence of a constant in the pattern or its absence does not lead to a significant change in the results obtained.

For the whole studied period there are significant models only for imports, which are characterized by elasticity over 1, but with low determination. The elasticity of the models for the import of energy resources is higher, over 1.2%, but their determination is very low - less than 5%.

For the period before our accession to the EU, there is only one significant model, which is for common exports. It has a coefficient of determination of 25.7% and elasticity to the exchange rate below 1% - 0.875%.

For the period after Bulgaria's entry into the EU, the statistically significant models are for total exports and imports of energy resources. They are characterized by higher determination of the model and greater elasticity to the exchange rate.

Exports reported the highest determination of all models presented: 42.2%. At the same time, the high elasticity is reported: 1.466%. It turns out that after our entry into the EU, the increase in the USD / EUR exchange rate increases exports, which is an interesting effect. As noted at the beginning of this study, the increase in the exchange rate shows a depreciation of the USD against the EUR.

An explanation for this effect may be the fact that the data used are quarterly. This reflects the long-term impact and dependence of our foreign trade on the constraints imposed by our EU membership. This has already been noted in another study (Lyubenov, 2013).

Import models again show higher determinism in those for total imports - nearly 30%, compared to those for imports of energy resources - about 10%. But the elasticity of the latter is the highest, in general, over 1.57%.

It can be noted that the significant regression models for the whole study period are determined by the presence of stronger dependencies on the exchange rate during the second subperiod. It turns out that after our entry into the EU, the depreciation of the USD against the EUR significantly increases our imports and exports in general. In particular, when importing energy resources, the reaction is stronger, but on a more limited scale.

However, the continuing upward trend of the USD against the EUR over the last ten years raises concerns about the deteriorating conditions of the EU's foreign trade with the rest of the world, in particular for Bulgaria.

**Table 3.**

Basic parameters of the single-factor models of the elasticity of foreign trade to the exchange rate							
Model №	Dependent variable	Characteristics of the model					
		Adj R-sqr	DW stat	AIC / SC	Const	BETA	SE
<u>For the entire period 1999:1 - 2021:3</u>							
Import							
1	M	0,262	1,92	-221,3/-216,3	0,0237	1,077	0,188
2		0,185	1,72	-213,4/-210,9	none	1,085	0,198
3	Me	0,047	2,24	-38,3/-33,3	0,0175	1,206	0,521
4		0,049	2,22	-39,5/-37,0	none	1,212	0,520
<u>For the first subperiod 1999:1 - 2006:4</u>							
Export							
5	X	0,257	2,17	-86,4/-83,5	0,043	0,875	0,259
<u>For the second subperiod 2007:1 - 2021:3</u>							
Export							
6	X	0,422	1,67	-153,7/-149,5	0,0185	1,446	0,219
Import							
7	M	0,293	1,91	-137,3/-133,1	0,0122	1,263	0,2523
8		0,286	1,86	-137,7/-135,6	none	1,249	0,254
9	Me	0,087	2,10	-30,9/-26,8	0,0088	1,587	0,622
10		0,101	2,09	-32,8/-30,8	none	1,578	0,617

#### 4. Conclusion

As a result of this research several conclusions may be made.

For the observed period, the elasticity of external trade can be directly assessed against the USD/EUR rate by means of single-factor regression models; Our foreign trade is of high elasticity in terms of the USD/EUR rate. Total imports, and in particular imports of energy resources, have higher elasticity against the USD / EUR exchange rate, but with lower determination compared to total exports.

Total exports are significantly affected by the exchange rate, and its elasticity and dependence increase more significantly after our entry into the EU. There has been an expected increase in imports after the USD has decreased against the EUR, but exports are also rising. This effect is explained using quarterly data, as well as by the restrictions imposed on Bulgaria's foreign trade by EU membership.

The thesis from the experts of the BNB (BNB Economic Review, 2015) on the existence of positive and negative effects on Bulgaria's foreign trade from the impact of the USD/EUR exchange rate is confirmed.

We tend to assume that negative effects prevail insofar as imports are more affected than exports. Especially given the fact that imports of energy resources have the greatest elasticity, albeit with low determinism. This shows that in the future there is a possibility for greater energy dependence of Bulgaria, determined by the significant impact of the USD/EUR exchange rate.

The conclusions drawn suggest that it is possible to have a delay effect (lag) in the time of the impact of the USD / EUR exchange rate. This would allow experimenting with models of distributed lags, using mainly data after Bulgaria's accession to the EU. From an investigator's point of view, it would also be interesting to examine in more detail the impact of the USD/EUR exchange rate on specific groups of goods of exports and imports.

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