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On the Formation of Currency Rates within Countries of the Eurasian Economic Union: Tenge and Russian & Belarusian Rubles

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Abstract

Taking into account the plans for the convergence of the Eurasian Economic Union countries, it is important to analyze the specifics of the currency exchange rate formation in Russia, Belarus, and Kazakhstan in the perspective of the transition to a joint currency area. The currency rate affects the world economy and, at the same time, depends on its conjuncture. Therefore, an understanding of the key influencing factors could make it possible to achieve monetary policy objectives more accurately and assess the risks associated with decisions in this area. This study proposes a research-based systematization of factors influencing exchange rates of currencies. An econometric model for constructing currency exchange rates of the Eurasian Economic Union countries has been proposed. It is based on the key concepts of stochastic process economics. The model is universal enough and could be used for the analysis of the currency exchange rate formation in any country.

Disciplinary: International Financial Economics.

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1 Introduction

The currency market is part of the global financial market. Currency fluctuations affect the world economy and political situation, and vice versa. Uncontrolled currency fluctuations can lead to major losses, due to exchange rate risks, reduced investment flows, high volatility of inflation, etc. (Colacito, 2011; Kapetanios *et al.*, 2012). The main factors in the currency value formation include the country's economic situation, the inflation rate, the balance of payments, supranational & state regulation of the economy, the markets' states, and interest rates (Asaturov, 2017).

Thus, the currency rate affects the world economy and, at the same time, depends on its conjuncture. Therefore, understanding the exchange rate dynamics is extremely important both for the government and for other economic entities. On 1 October 2019, the Concept of the creation of the common financial market of the Eurasian Economic Union was approved. The success of building this market requires optimal and stable internal conditions, including the exchange rate. That is why this paper analyses the particularities of the national currency value formation in states constituting the core of the EAEU (Russia, Belarus, and Kazakhstan).

A fair amount of research has been devoted to the problem of the reliability of exchange rate forecasts based on multifactor econometric models. It has been revealed that those models which are relevant for forecasting in one period may lose their relevance and objectivity for another period (Aghion *et al.*, 2009). In addition, models that had lost their relevance in analyzing and predicting currency dynamics tended to include a large set of economic factors and a small set of non-economic factors (Rodrik, 2007; Vorontsovsky & Vyunenko, 2017). Finally, when structuring factors, the so-called wildcard events (that is, changes in the economy or society, such as the Covid-19 pandemic, that were unlikely to occur, but had a strong impact on the economy and related currency dynamics) were not always taken into account (Chinn & Cheung, 2019). Therefore, the factors that determine alterations in the exchange rate can be allocated into socio-political (government involvement in the economy, quality of employment, and development of the public sector) and economic factors, such as the degree of national economic development relative to that of world economic leaders, the level of financial and investment openness of the economy, and efficiency of foreign economic activity.

2 Method

A research-based list of variables that affect the national currency rate was formed (Table 1). The data obtained were analyzed using fuzzy-multiple functions (Sztojanov *et al.*, 2016; Del Giudice *et al.*, 2017; Nguyen *et al.*, 2018), that is, through assigning each variable to a certain subset characterizing the level of that variable as “very low” to “very high” (Table 2).

Table 1: Variables influencing currency rate formation. (Source: developed by the author based on data from: Mauro & Juhn, 2002; Ozkan & Erden, 2015; Jiménez-Rodríguez & Morales-Zumaquero, 2016).

Variables	High transaction costs negatively affecting the exchange rate		Low and middle transaction costs positively affecting the exchange rate	
Role in trade (z_1): the product of shares in regional and global trade	Marginal role $z_1 \leq 0.05$	Minor role $z_1 \leq 0.33$	Significant role $z_1 \leq 0.66$	Leading role $z_1 \geq 0.67$
The most imported product (z_2): its share in total imports (g)	Minimally processed materials $z_2 = g * 1$	Highly processed materials $z_2 = g * 0.75$	Conventional end product $z_2 = g * 0.5$	Knowledge-intensive end product $z_2 = g* 0.25$
The most exported product (z_3): its share in total exports (g)	Minimally processed materials $z_3 = g * 0.25$	Highly processed materials $z_3 = g * 0.5$	Conventional end product $z_3 = g * 0.75$	Knowledge-intensive end product $z_3 = g * 1$
Export-import ratio (z_4): export value relative to import value	Export volume is significantly less than import volume	Export volume is less than import volume	Export volume is equal to or exceeds import volume (but is accounted for as $z_4 = 1$)	
Openness to world trade and investment (z5), according to the World Bank	Very closed economy $z_5 = 0.25$	Closed economy $z_5 = 0.5$	Open economy $z_5 = 0.75$	Very open economy $z_5 = 1$

Table 2: Determination of the membership function for variables that describe the institutional conditions and influence currency rate formation.

Interval series	Subsets of variable levels	Level membership function for variables
$0 < z_i < 0.1$	Very low level	$f = 1$
$0.1 < z_i < 0.15$	Very low level	$f_1 = 10 * (0.15 - z_i)$
$0.1 < z_i < 0.15$	Low level	$f_2 = 1 - f_1$
$0.15 < z_i < 0.25$	Low level	$f = 1$
$0.25 < z_i < 0.35$	Low level	$f_2 = 10 * (0.35 - z_i)$
$0.25 < z_i < 0.35$	Middle level	$f_3 = 1 - f_2$
$0.35 < z_i < 0.45$	Middle level	$f = 1$
$0.45 < z_i < 0.55$	Middle level	$f_3 = 10 * (0.55 - z_i)$
$0.45 < z_i < 0.55$	High level	$f_4 = 1 - f_3$
$0.5 < z_i < 0.6$	High level	$f = 1$
$0.6 < z_i < 0.7$	High level	$f_4 = 10 * (0.7 - z_i)$
$0.6 < z_i < 0.7$	Very high level	$f_5 = 1 - f_4$
$0.7 < z_i \leq 1$	Very high level	$f = 1$

Further, intermediate coefficients were calculated to yield an integral indicator characterizing the impact of the institutional conditions on the national currency formation. The calculation was performed using the following formula (Nguyen *et al.*, 2018):

$$m_k = \frac{\Sigma f_j}{n} \quad (1),$$

where f_j is the values of the membership functions for the observed variables; n – number of the observed variables.

The membership function generation was based on the variable classification following stipulated intervals of subset values, from “very low” to “very high” (Table 3).

Table 3: Fuzzy-multiple classification of variables that describe the institutional conditions and influence currency rate formation.

Variable	Variable levels according to stipulated value ranges																			
	Very low level				Low level				Middle level				High level				Very high level			
Role in trade (z_1)	0	0	0.05	0.1	0.05	0.1	0.15	0.2	0.15	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.7	0.8	0.9	1
The most imported product (z_2)	0.01	0.05	0.1	0.15	0.1	0.15	0.2	0.25	0.3	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.9	1
The most exported product (z_3)	0.01	0.05	0.1	0.15	0.1	0.15	0.2	0.25	0.3	0.4	0.45	0.5	0.55	0.6	0.65	0.7	0.75	0.8	0.9	1
Export-import ratio (z_4)	0.1	0.2	0.3	0.4	0.3	0.4	0.5	0.6	0.5	0.6	0.7	0.8	0.8	0.85	0.9	0.95	0.9	0.95	1	1
Openness to world trade and investment (z_5)	0	0	0.1	0.2	0.1	0.2	0.25	0.35	0.25	0.35	0.5	0.65	0.5	0.65	0.8	0.9	0.8	0.9	1	1

Based on the analytical data obtained, an integral indicator (I_{ER}) was calculated, which characterizes the institutional conditions in terms of the potentiation or depotentiation of the currency rate. Using data from foreign researches (Qiu *et al.*, 2016; Cozma & Reisinger, 2016) and the basic concepts of stochastic process economics, that is, institutional randomness that potentiates or depotentiates currency rate, a weighted function for calculating the integral indicator was determined, as

$$I_{ER} = 0.07m_1 + 0.3m_2 + 0.5m_3 + 0.7m_4 + 0.93m_5, \quad (2),$$

where m_k – intermediate ratio.

The resulting integral indicator value of the currency rate was compared with a given gradation of institutional conditions (Table 4).

Table 4: Institutional conditions that influence currency rate formation.

Interval series	Condition classification	Grade of membership
$0 < I_{ER} < 0.15$	The ultimate institutional failure in the economy: currency rate depotentiation*	$m = 1$
$0.15 < I_{ER} < 0.25$	The ultimate institutional failure in the economy: currency rate depotentiation	$m_1 = 10 * (0.25 - I_{ER})$
$0.15 < I_{ER} < 0.25$	Institutional failure in the economy: currency rate depotentiation	$m_2 = 1 - m_1$
$0.25 < I_{ER} < 0.35$	Institutional failure in the economy: currency rate depotentiation	$m = 1$
$0.35 < I_{ER} < 0.45$	Institutional failure in the economy: currency rate depotentiation	$m_2 = 10 * (0.45 - I_{ER})$
$0.35 < I_{ER} < 0.45$	Unsustainable institutional welfare: stochastic currency rate potentiation	$m_3 = 1 - m_2$
$0.45 < I_{ER} < 0.55$	Unsustainable institutional welfare: stochastic currency rate potentiation	$m = 1$
$0.55 < I_{ER} < 0.65$	Unsustainable institutional welfare: stochastic currency rate potentiation	$m_3 = 10 * (0.65 - I_{ER})$
$0.55 < I_{ER} < 0.65$	Relatively sustainable institutional welfare: currency rate potentiation	$m_4 = 1 - m_3$
$0.65 < I_{ER} < 0.75$	Relatively sustainable institutional welfare: currency rate potentiation	$m = 1$
$0.75 < I_{ER} < 0.85$	Relatively sustainable institutional welfare: currency rate potentiation	$m_4 = 10 * (0.85 - I_{ER})$
$0.75 < I_{ER} < 0.85$	Sustainable institutional welfare: currency rate potentiation	$m_5 = 1 - m_4$
$0.85 < I_{ER} < 1$	Sustainable institutional welfare: currency rate potentiation	$m = 1$

*Depotentiation refers herein to transition from algebraic to logarithmic expression, while potentiation refers to the transition from logarithmic to an algebraic expression.

3 Result and Discussion

Thus, a diversified mathematical model for assessing and predicting the national currencies of Russia, Kazakhstan, and Belarus was developed (Table 5).

Table 5: Factor indicators for modeling currency rates of the Eurasian Economic Union countries.

Factor indicator	Calculation formula	Legend
Economic factors (internal and external)		
Stability of the structure and dynamics of the economy* (x_{e1})	$x_{e1} = S * D \Rightarrow max$ $S = \frac{d_{ht} + d_{mt}}{d_{mi}}$ $D = GNI_{ne} / \overline{CNI}_{top5}$	*S, D – structural and dynamic indices of the national economic stability, respectively;* *d_{ht}, d_{mt} – share of high-tech and medium-tech industries in the manufacturing sector, respectively;* *d_{mi} – contribution of manufacturing to the gross domestic product;* *GNI_{ne}, GNI_{top5} – a country's gross national income (calculated using the Atlas Method and adjusted for the growth rate) relative to the weighted average of the gross national income of the five countries with the highest gross domestic product*
Ratio of investment net inflows and net outflows (x_{e2})	$x_{e2} = \sqrt{\frac{FDI_{in}}{FDI_{out}}}$	*FDI_{in}, FDI_{out} – net inflow and a net outflow of foreign direct investment as a percentage of the gross domestic product, respectively*
Stability of the structure and dynamics of foreign trade (x_{e3})	$x_{e3} = \sqrt{\frac{de_{ht}}{di_{ht}} * \frac{eg_{fp}}{ig_{fp}}}$	*de_{ht}, di_{ht} – share of high-tech exports and imports in the total volume of manufactured and imported products, respectively;* *ge_{fp}, ig_{fp} – growth rate of exports and imports in fixed costs*
Socio-political factors (internal and external)		
Companies' market capitalization (x_{p1})	$x_{p1} = 1 + d_{ldc}$	*d_{ldc} – share of publicly traded companies' market capitalization in the gross domestic product*
Government involvement in the economy (x_{p2})	$x_{p2} = \frac{1}{d_{gs}}$	*d_{gs} – contribution of the public sector to the gross domestic product*
Quality of employment in the economy (x_{p3})	$x_{p3} = \sqrt{\frac{d_{se}}{d_{ue}}}$	*d_{se}, d_{ue} – share of stably and unstably employed population relative to the total economically active population, respectively*

*The indicator was developed based on the "one-fifth and one-half" rule (Akaev *et al.*, 2011).

The proposed model makes it possible, firstly, to assess the degree of influence of several factors on the exchange rate, and, secondly, to make a relatively reliable forecast for the medium term, since it takes into account data on currency volatility. The study allowed for developing and complementing methodological approaches to the analysis of factors affecting exchange rates, as well as institutional conditions that determine the degree and depth of fluctuations in currencies. Finally, the designed model was piloted (Table 6).

Table 6: Results of modeling the dynamics of national currencies of Russia, Kazakhstan, and Belarus.

Currency	Equation	Outcome
The Russian ruble	In terms of the influence of economic factors: $y_e = 0.213 + 0.949_{x1} + 0.273_{x2} - 0.226_{x3}$	The P-value from Fisher's test is 1.0 Factor X_1 has the strongest influence in the economic context, while factor X_3 does in the socio-political context
	In terms of the influence of socio-political factors: $y_p = -2.361 + 1.369_{x1} + 0.920_{x2} + 1.217_{x3}$	
The Kazakhstani tenge	In terms of the influence of economic factors: $y_e = -604.16 + 457.48_{x1} + 110.29_{x2} - 207.22_{x3}$	The P-value from Fisher's test is 1.0 Factor X_2 has the strongest influence in the economic context, while factor X_1 does in the socio-political context
	In terms of the influence of socio-political factors: $y_p = 34.135 + 0.513_{x1} + 11.564_{x2} - 18.615_{x3}$	
The Belarusian ruble	In terms of the influence of economic factors: $y_e = 0.008 - 0.031_{x1} - 0.002_{x2} + 0.06_{x3}$	The P-value from Fisher's test is 1.0 Factor X_3 has the strongest influence in the economic context, while factor X_2 does in the socio-political context
	In terms of the influence of socio-political factors: $y_p = -0.11 + 0_{x1} + 0.143_{x2} - 0.001_{x3}$	

Thus, from the economic point of view, fluctuations in the Russian ruble exchange rate turned out to be influenced by a factor characterizing the stability of the structure and dynamics of the national economy. Currently, there is an imbalance in the Russian economy's structure and dynamics; however, there is, in fact, a potential for growth there (an upturn in the stability of the Russian economy could increase the national currency rate by 6%). From the socio-political point of view, the quality of employment in Russia has the greatest impact on the ruble exchange rate (a tendency for the growth of informal employment is presently observed there). Provided that the quality of employment improves and labor productivity increases, the growth of the national currency may amount to 21%.

Among the three countries under consideration, Kazakhstan's economy appears to be the most steadily developing, as indicated by the applied model. The most significant impact factor from an economic point of view is the ratio of net inflow and outflow of investments. Kazakhstani economy is investment-attractive, which might ensure almost a threefold increment in the national currency rate. The growth of Kazakhstani companies' capitalization relative to the gross domestic

product should also be regarded as a factor of the national currency upturn from the socio-political point of view (this factor could provide up to 50% tenge exchange rate growth).

The economy of Belarus can be categorized as the least developed among those observed herein, which was confirmed by the elaborated model. Virtually all factors specified in the model have a negative impact on the national currency exchange rate (from both economic and socio-political points of view). The least negative influence is exerted by the factor characterizing a trend towards a relative reduction of the imbalance in the structure and dynamics of foreign trade. From the point of view of the impact of socio-political factors, the most significant influence is exerted by the factor characterizing the tendency for a decrease in the share of the public sector, which could ensure the growth of competition in Belarus's economy and would therefore increase the Belarusian ruble's exchange rate by 0.14 percentage points.

Currency exchange rate model construction is one of the most challenging tasks in macroeconomics. First, this is because there is a variety of methodological approaches based on different theoretical paradigms. Second, the exchange rate is determined by the influence of various factors, and according to several PEST analyses (Sociological, Technological, Economical and Political Change), the most significant factor influencing exchange rates of currencies is the socio-political one (Fornaro, 2015; Ghosh *et al.*, 2016). But there is also no consensus on whether the essence of its influence is opportunistic or non-alternative (Filardo & Nakajima, 2018; Horvath & Zhong, 2019).

4 Conclusion

The analysis of trends and patterns of exchange rate formation in the three countries forming the core of the EAEU conducted in this study has confirmed that the economies of Russia, Belarus, and Kazakhstan are relatively similar, and their specifics of factor influence are approximately the same as well. Their national currencies have quite low value and are vulnerable to external economic pressure. The proposed econometric model is sufficiently universal and can be used for the analysis of the currency exchange rate formation in any country.

5 Availability of Data and Material

Data can be made available by contacting the corresponding author.

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