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ASSESSMENT OF AN EXCHANGE RATE'S FLUCTUATIONS IMPACT ON THE FOREIGN EXCHANGE MARKET

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Abstract. The article analyzes the foreign exchange market functioning under the influence of exchange rate fluctuations. The main factors determining the exchange rate in the existing conditions have been determined. All course-forming factors are divided into fundamental ones, which include the main economic indicators; technical conjunctural; extraordinary (unexpected) and non-economical. The formation of the forward currency operations market trends, in particular forward contracts, currency swaps, options and other financial instruments, was also investigated. The income trends of the current currency market from quotes of the most used currency pairs are briefly described.

It was concluded that the most predictable indicator in the current currency operations market is the standardized exchange rate, determined on the basis of currency quotes of at least 6 commercial banks. When calculating the average arithmetic rate, the highest and lowest quotation rates are not taken into account.

The future foreign exchange market trends depend on the choice of the monetary policy vector, which is based on a qualitative and quantitative assessment. Since the processes in the currency market have a fractal structure and cannot be predicted using classical methods, the provisions of the fractal statistics theory are used for this purpose.

In particular, on the basis of existing quotations of the currency pair US dollar/Ukrainian hryvnia, the Hurst indicator, which reflects the level of anti-persistence of the national currency exchange rate dynamics, was calculated, and accordingly, its ability to change trends to the opposite in periods of high volatility and in the presence of factors that cause it. The volatility of the national currency rate and the level of anti-persistence of currency fluctuations depends on a number of measures in the field of currency regulation and currency and monetary policy. At the same time, any intervention of the state government in the exchange rate formation process causes a change in the trend. The results of the calculations can be used for operational and strategic planning of the business entities behavior on currency markets and measures aimed at countering the negative impact of exchange rate changes.

Keywords: currency, exchange rate, foreign exchange market, foreign exchange operations, foreign exchange regulation, foreign exchange operations, theory of fractal statistics, anti-persistence, Hurst indicator.

JEL Classification: D53

1. INTRODUCTION

The high level of exchange rate volatility against the backdrop of uncertainty in the financial markets necessitates the division of foreign currency transactions into current transactions with immediate delivery of currencies (Todd, Tom, Point) and forward transactions (options, futures, forwards and swaps). Current foreign exchange transactions are performed within two business days with high liquidity and currency spread. The availability of forward transactions makes it possible to carry out appropriate transactions over a long period and hedge against the risks of exchange rate fluctuations in the market. In these circumstances, the prognosis of exchange rate fluctuations in determining factors that affect its formation becomes especially important.

2. THEORETICAL BACKGROUND

Woo Kang and Dagli (2018) has mathematically explored the impact of real exchange rate on the export's volume in a number of countries, but due to the cyclicity of processes in the economy, the volume of export operations is affecting the purchasing power of the country and thus become one of the factors the exchange rate. Pareshkumar et al. (2014) has outlined factors of currency rate's impact and considered the use of fixed-term exchange operations as investment instruments. Those views were partially split by authors which caused the necessity of the following study.

Main conclusions of the framework were made considering the investigation of Shiller (2003), who defines a wide range of risks that occur in financial market. Each national foreign exchange market is in close correlation with world financial markets, but the level of exchange rate's volatility is higher in local markets. Interpreting some of the author's conclusions, it was defined that developed participants of the markets (governments of developed countries) can share the risks; while non-highly developed markets could be managed through currency restrictions, causing a reduction of national currency convertibility and higher fluctuations of its exchange rate as a result. The forms of systemic risks in banking system had been described by Cifuentes (2003). The author also created the model of deriving possible regulatory measures aimed at reducing risks level, Fengxia and Mei (2016) had also outlined proposals of dealing with such risks. Considering these papers, it has been worked out methods of quantitative and qualitative currency policy management.

The processes of market globalization especially manifest through trends in the foreign exchange market. Herewith, a great number of factors have an impact on and increase the correlation between the exchange rates and transactions in the foreign exchange market.

The presence of problems raises the requirement of constant monitoring of trends, setting of patterns and features of currencies turnover, foreign exchange transactions, the functioning of the currency market and, in general, the currency system.

Dritsaki (2019) has used mathematical calculation for searching optimal parameter causing the exchange rate volatility and modeled its impact with statistical models. Kravets and Gaponenko (2015) suggested the use of a fractal method for that purpose. Considering that fractal statistical elements were used for the evaluation of currency rate predictability in the framework.

3. RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The purpose of the study is to investigate existing trends of current and fixed currency transactions in Ukraine, to evaluate aspects of individual currencies' and foreign exchange transactions ratio. It has been conceptually distinguished the exchange rate and the fractal nature of the exchange rate behavior. To achieve these results general scientific methods of generalization

and synthesis; methods of system and comparative analysis, economic-statistical and mathematical methods were used in the study.

4. RESULTS AND DISCUSSION

For successful transactions, the foreign exchange markets participants predict price movements and take into account various economic and non-economic factors of exchange rate formation. In particular, there are three groups named as fundamental; technical and unexpected factors.

The group of fundamental factors most characterizes long-term structural factors of influence. It is a set of basic indicators of economic characteristics such as gross national product; industrial production index; inflation index; exchange rate according to purchasing power parity; the level of real interest rates; unemployment rate.

Technical factors are circumstantial, as they describe the basic patterns of behavior of exchange rates in retrospect and determine what influenced the decision to buy or sell currency in the past. So they have a psychological component too. Technical factors are used to perform technical analysis. It predicts that the market has a memory that the movement of the course in the future is significantly influenced by the patterns of its behavior in the past. This provides a high degree of predictability.

The impact of fundamental and technical factors can be predicted. However, there are also extraordinary, unexpected factors that can significantly change the dynamics and value of the exchange rate. Usually, they are based on a non-economic component. Among them are force majeure events - natural disasters, pandemics; political developments, change in policy vector and central bank currency interventions. A new factor that strongly affected all types of markets after 2019 was the coronavirus pandemic (Fig. 1.)

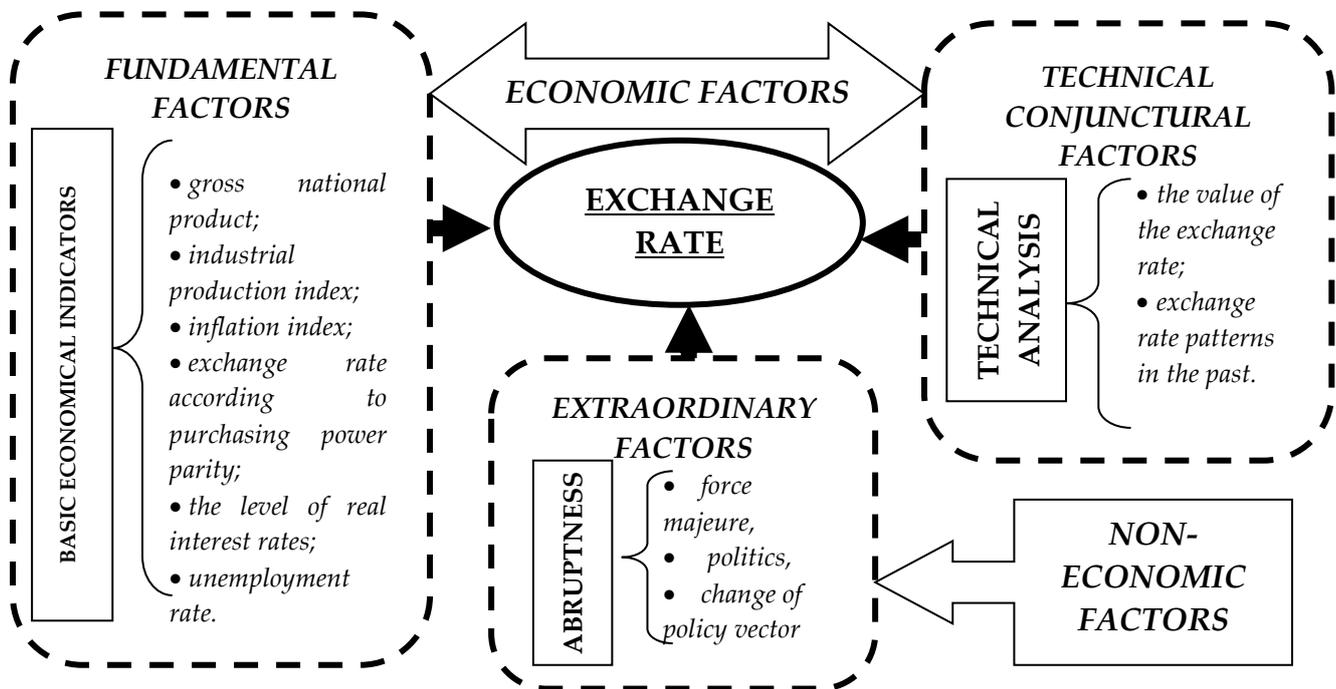


Fig. 1. Rate-forming factors

In conducting currency transactions, it is often used the real effective exchange rate (REER), based on a trade-weighted average of bilateral exchange rates and adjusted by some measure of correlative prices or costs. Changes in the REER thus take into account both nominal exchange rate developments and a country's inflation differential vis-à-vis trading partners.

Nominal EERs are calculated as geometric weighted averages of bilateral exchange rates. The weights are derived from manufacturing trade flows and capture both direct bilateral trade and third-market competition by double-weighting. Real EERs are calculated on the basis of the same weighted averages of bilateral exchange rates and are adjusted by relative consumer prices in the comparator countries (Woo Kang & Dagli, 2018).

Accurate measures of EERs are essential for policymakers and financial market participants because effective exchange rates (EERs) are useful summary indicators that show the overall strength or weakness of a country's currency. Thus, the EEA can be used as an indicator of a country's competitiveness, a threat indicator, a monetary policy tool, and the ultimate goal of such policy.

Analyzing the international currency market, it should be noted that the dominant currency used in transactions was the dollar. It was used in 90% of all bidding. The value of transactions in the foreign exchange markets amounted to \$ 8 trillion per day in 2021.

Sales desks in five countries - the United Kingdom, the United States, Hong Kong SAR, Singapore, and Japan - facilitated 79% of all foreign exchange trading. Trading activity in the United Kingdom and Hong Kong SAR has grown by more than the global average. Mainland China also recorded a significant rise in trading activity, making it the eighth largest FX trading center (Pareshkumar et al., 2014).

The analysis of the foreign exchange market by instruments enables the conclusion that the upward trend is not stable by any instrument except Currency swaps. After all, the total turnover for the analyzed period grew by \$277 billion (by 5.7% in relation to the total volume of turnover) (Fig. 2.).

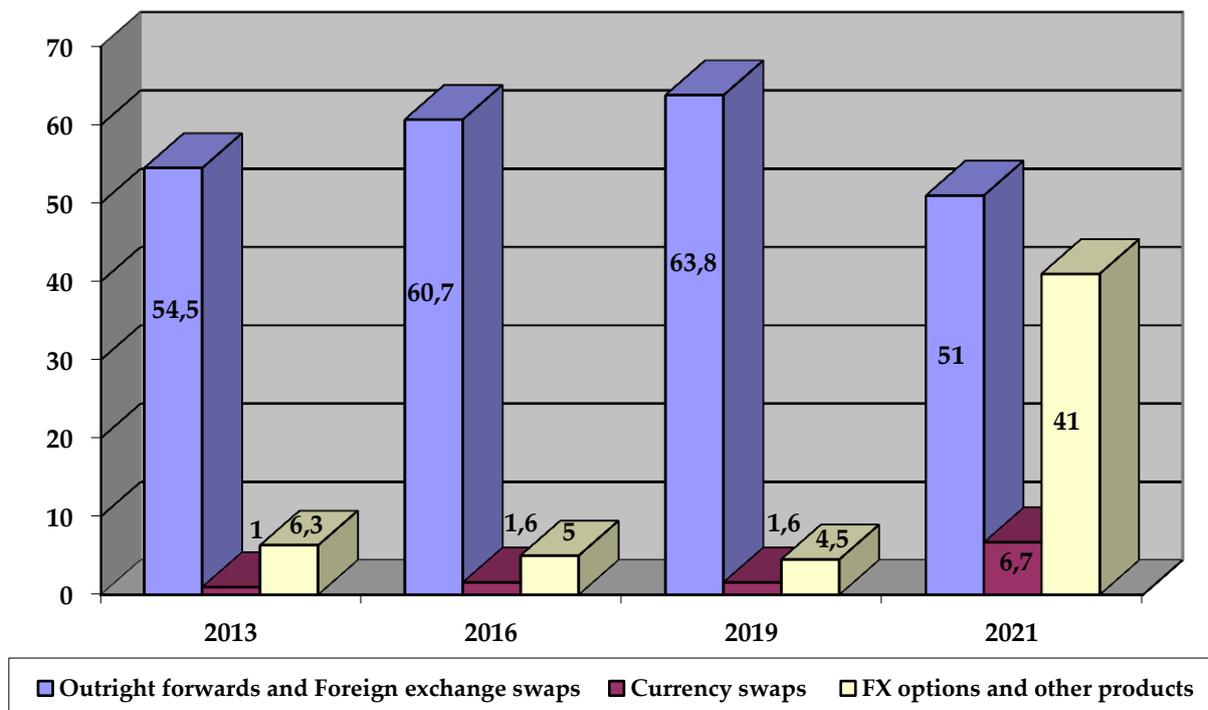


Fig. 2. Foreign exchange market turnover by instrument

Source (<https://cutt.ly/uNjx0uD>; <https://cutt.ly/oNjclCq>; <https://cutt.ly/KNjcX0V>).

Outright forwards and Foreign exchange swaps continued to gain market share, accounting for 54,5% of total foreign exchange market turnover in April 2013, 60,7% of total foreign exchange market turnover in April 2016, 63,8% of total foreign exchange market turnover in April 2019. But in 2021 their share decreased to 51% in the total turnover of the foreign exchange market (*Tab. 1*).

Table 1. OTC foreign exchange turnover by instrument, Net-net basis, daily averages in April, in billions of US dollars and percentages

Instrument	2013		2016		2019		2021	
	Amount	%	Amount	%	Amount	%	Amount	%
Outright forwards and Foreign exchange swaps	2,919	54,5	3,078	60,7	4.201	63,8	2,556	51
Currency swaps	54	1.0	82	1.6	108	1.6	331	6.7
FX options and other products	337	6.3	254	5.0	294	4.5	2,072	41
Total	5,357	100.0	5,066	100.0	6,590	100.0	4,96	100.0

Source: (<https://cutt.ly/uNjx0uD>; <https://cutt.ly/oNjclCq>; <https://cutt.ly/KNjcX0V>).

The most traded instrument is the FX swap. It is used in managing counterparty financial liquidity and currency risk insurance. Overall, foreign exchange swaps grew by more than a third to reach \$ 3.2 trillion a day. The main currency for FX swap trading is the dollar, which was used in 91% of transactions.

The trading segment with institutional investors has decreased. And the share of foreign currency trading with institutions that are not reporting dealers, again exceeding inter-dealer trading volumes accounts for 55% of world FX trading. Basically, these were transactions with non-reporting banks, hedge funds and proprietary trading firms (PTFs).

Analyzing the volume of transactions in the context of the top 10 currencies brings to the inference that most of the term transactions (currency swaps) were concluded using the US dollar (88%), the euro (32%), the Japanese yen (17%) and the British pound sterling (13%). These are currencies with the most stable exchange rate and high enough value. Thus we can distinguish these features as the most relevant to the exchange rate on transactions in the foreign exchange market.

In contrast, in 2019 several other Asia-Pacific currencies gained market share. Turnover in the Hong Kong dollar more than doubled relative to 2016, and the currency climbed to ninth place in the global ranking (up from 13th in 2016). The Korean won, Indian rupee and Indonesian rupiah also moved higher in the global rankings. Turning to the currencies of other EME regions, the Mexican peso and the Turkish lira were among the currencies which dropped several places in global rankings (<https://cutt.ly/KNjcX0V>). Average daily turnover across all financial instruments rose totally to \$3.276 billion which was 11% rise compared to the same indicator in April 2021 and 47% in comparison with a daily turnover in 2016. Turnover in currency pair USD/CNY increased to \$952 billion, 53% from 2016 (<https://cutt.ly/uNjx0uD>). During the 2022 Asia-Pacific Region, Japan, South Korea and China's currencies weakened against the USD, whilst the rate of the Australian Dollar was at the same level (<https://www.cnbc.com/abigail-ng/>).

In addition, economic processes globalization, the deepening of local currency markets, increase the number of speculative currency transactions, conditions and requirements liberalization for participants of the currency market should be factors of trends' formation in markets for fixed-term foreign exchange transactions.

The most predictable and comprehensible foreign exchange market data is the standardized exchange rate. The average exchange rate of foreign currency is calculated by the exchange in the established order.

First, the calculation is made in terms of rules and conditions (forward quotes) when information is received from at least six commercial banks. If data is less than six commercial

banks, the exchange determines the average foreign currency rate by peer review based on quotations received from commercial banks and taking into account current trends in the currency market of Ukraine.

Second, if data came from at least six but not more than ten commercial banks, the obtained data determine one highest and one lowest buying rates and one highest and one lowest foreign currency selling rates, that are not further taken into account (cut off) when calculating the average foreign exchange rate as the arithmetic mean.

Third, if the information came from eleven or more commercial banks, the two highest and two lowest buying rates and the two highest and two lowest foreign currency sales rates, that are no longer taken into account (cut off) when calculating the average foreign exchange rate, are defined arithmetically.

Finally, the average exchange rate is calculated as a sum of ask and bid currencies rates in the international currency market, provided by a certain bank, adjusted for the number of such rates, used in the calculation.

The most basic value of exchange rate is the nominal exchange rate, set in the foreign exchange market. Whereas the foreign exchange market is an integral part of the financial market, it is assumed the economic nature's identity of all the processes and phenomena in these markets.

Thus, a conclusion that the volatility of exchange rates is caused not only by systematic risks that arise due to the peculiarities of financial markets' structure can be drawn. The range of such risks is outlined by mentioned above affecting the processes of exchange rate formation factors. Moreover, the higher the degree of market centralization and currency restrictions applied by the regulator, the higher the level of systematic risks. In currency markets with a high degree of centralization, high volatility of currency pairs will be caused even by events that are "non-systematic". On the contrary, in decentralized markets, market regulation processes are becoming more effective, so the level of systematic risks will be lower (Cifuentes, 2003).

It could be supposed that the level of systematic risk can be evaluated by using quantitative methods. As the foreign market processes are having a fractal structure and couldn't be predicted with the use of classical methods, it is offered to use fractal statistic theory statements for evaluation of national currency resistance to volatility.

Because USD is the main currency which are used in Foreign Exchange Markets, gains the large share of their turnover, it was decided to assess the stochasticity of the USD / UAH currency pair. For determination its quotations it was used fractal analysis. As the result is the calculated Hurst indicator (H), which defines the persistence level of time series, that is, the indicator's value will clarify whether the USD / UAH time series is stable, or the formation of the course is random, with significant deviations.

The indicator is calculated by the Formula 1:

$$\frac{R}{S} = (aN)^H \quad (1)$$

By the property of logarithms, it is obtained $H = \log_{aN} \frac{R}{S} = \frac{\log_c \frac{R}{S}}{\log_c aN}$, where c is an arbitrary number. Provided that $aN > 0$, $aN \neq 1$, $\frac{R}{S} > 0$, $\frac{R}{S} \neq 1$, $R \neq S$. If $c = 10$ was taken, the formula will look as follows:

$$H = \frac{\lg\left(\frac{R}{S}\right)}{\lg(aN)} \quad (2),$$

where H - Hurst indicator;

St - standard deviation of a number of observations x for the analyzed period Z, which is part

of period N ;

N – number of observation periods;

a – constant.

$$S = \sqrt{\frac{1}{N} \sum_{i=1}^N (x_i - x_{av})^2} \quad (3)$$

$$x_{av} = \frac{1}{N} \sum_{i=1}^N x_i \quad (4),$$

where x_{av} – arithmetic mean of a x observations number over N periods

The range of the cumulative deviation R is the most important element in the Hurst index's calculation formula. In general, it is calculated as follows:

$$R = \max_{1 < u < N} (Z_u) - \min_{1 < u < N} (Z_u) \quad (5),$$

where Z_u – the accumulated deviation of the series x from the average x_{av} (Kravets & Gaponenko, 2015).

For the purposes of calculations, it has been taken the USD/UAH rate, since in the currency market of Ukraine, as well as in the world currency markets, the vast majority of foreign economic payments are made in USD. The data on the dynamics of the exchange rate of this currency pair was taken for the period 2014 - 2019 (72 months) (International Monetary Fund, 2014). This period was chosen due to the fact that since February 2014 floating exchange arrangement has been implemented in Ukraine. That means the exchange rate of the national currency is formed on the basis of demand-supply in the foreign exchange market, but can be supported through central bank interventions in the foreign exchange market.

Since the number of analyzed series is more than 20, for calculations it was used $a = \pi^* \frac{z}{2}$, z was taken as 105 months from 2014 till the third decade of 2022 (Tab. 2).

Table 2. Calculation of normalized span and standard deviation for different periods Z

Year	Number of periods Z	R/S	H	Year	Number of periods Z	R/S	H	
2014	3	1,95	0,08	2018	57	18,37	0,35	
	6	0,95	-0,01		60	18,89	0,35	
	9	85,17	0,54	2019	63	18,91	0,36	
	12	18,21	0,35		66	19,31	0,36	
2015	15	45,17	0,46		69	20,32	0,36	
	18	28,17	0,41		72	20,56	0,36	
	2016	21	1,41	0,04	2020	75	19,28	0,36
		24	41,79	0,45		78	20,68	0,37
27		205,13	0,64	81		21,27	0,37	
30		14,34	0,32	84		20,76	0,37	
2017	33	49,28	0,47	2021	87	21,22	0,37	
	36	8,84	0,26		90	23,13	0,38	
	39	14,33	0,32		93	21,18	0,37	
	42	15,81	0,33		96	21,18	0,37	
2018	45	15,99	0,33	2022	99	22,52	0,38	
	48	15,11	0,33		102		0,00	
	51	17,37	0,34		105	20,30	0,36	
2018	54	18,00	0,35					

Source: calculated based on data (National Bank of Ukraine, 2022)

Using the method of least squares, it could be derived the regression equation, which allows to check the correctness of the calculations and show a correlation between the given values. Based

on the available data and mathematical calculations, it could be obtained a system of equations

$$\begin{cases} 65309.42p + 42.66b = 417.60 \\ 42.66p + 105b = 11.86 \end{cases}$$

As the result it has been got the following: $p = 0.00632$, $b = 0.11036$

The equation of a straight line, which allows to come up with conclusion about the existence of a correlation between the two currencies:

$$y = 0.00632x + 0.11036 \quad (6)$$

Calculations show that the value of the Hurst indicator for the USD/UAH exchange rate during the first 24 analyzed months (except 9-th month) is within $0 < H < 0,5$, which means the time series antipersistence, to wit: if the system grows over a time period, then following periods should be expected to decline. Further, the values of the currency series gain signs of persistence ($0,5 < H < 1$) till 2-nd decade of 2016, that is the row acquires a sign of stability. We assume a reason for this was the monetary policy on the basis of inflation targeting implementation in 2016 in Ukraine. Although in fact, this regime was applied in 2016, its main elements were introduced in 2015. Later periods show a low level, but steady downward trend of antipersistence. This trend continued until 2022 (2-nd decade), when great volatility of the UAH exchange rate that could have been caused by full-scale war was restrained with the regime of its rigid fixation. That gave rise to the antipersistence level and the value of the Hurst indicator fell to zero. Each period of high antipersistence was followed by decrease in the exchange rate of the national currency.

The results of the calculations can be displayed in the graph (Fig. 3):

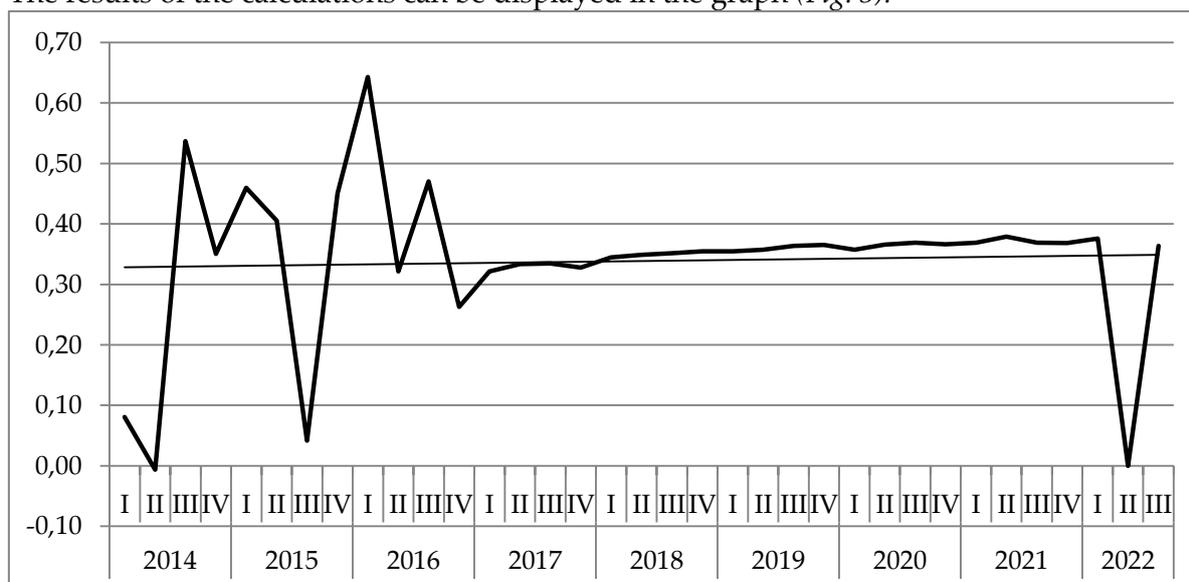


Fig. 3. Hurst rate for the USD/UAH currency pair during 2014 – 2022

Source: Constructed based on the data calculations (National Bank of Ukraine, 2022)

Therefore, the status of each country's currency market can be characterized by such indicators as the official rate of the national currency; the weighted average rate of national currency on transactions with other currencies, the volume of operations in the interbank foreign exchange market; the extent economic instruments use in the state currency regulation policy. The latter include discount and foreign exchange policies, exchange rate regimes and policies on the foreign exchange reserves formation, measures for the national currency devaluation and revaluation.

Currency regulation has to promote production and net exports, public debt reduction, foreign exchange reserves increase, GDP, and ensure the formation of positive trends in other macroeconomic indicators that determine the level of country economic development.

In turn, the monetary policy vector could be determined by the key factors that influence the process of the national currency exchange rate formation, which simultaneously reflects the level of macroeconomic risks.

5. CONCLUSION

However, just like in financial markets, in the foreign exchange market, there are idiosyncratic risks. These risks also entail the volatility of the national currency and are largely driven by the functioning of the currency market peculiarities in a certain country and its participants' economic expectations. The display of these risks is not systematic and may be in the irrational decision-making field, but idiosyncratic risks lead to considerable course fluctuations (fat-tails in the financial market data). Factors having an idiosyncratic nature are not amenable to modeling by mathematical or statistical methods and their evaluation is possible only through the use of qualitative estimation methods. These methods are based on causation, are not standardized, and formed on the basis of experts' opinions about the identified situations and phenomena.

In modern conditions, qualitative assessment involves the state management transformation aimed at the diversification of official reserves, transformation of approaches to the exchange rate regime choice, the formation of the national currency rate taking into account the country's economic and monetary integration into the world monetary system.

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Солоджук Тетяна, Мигович Тетяна. Оцінка впливу коливань валютного курсу на валютний ринок. *Журнал Прикарпатського університету імені Василя Стефаника*, 9 (3) (2022), 55-64.

У статті аналізується функціонування валютного ринку під впливом коливань валютного курсу. Визначено основні фактори, що визначають курс валюти в існуючих умовах. Усі курсоутворюючі фактори розділено на фундаментальні, що включають основні економічні індикатори; технічні кон'юнктурні; екстраординарні (неочікувані) та неекономічні. Також досліджено формування тенденцій розвитку ринків строкових валютних операцій, зокрема форвардних контрактів, валютних свопів, опціонів та інших фінансових інструментів. Коротко описано тенденції доходу поточного валютного ринку від котирувань найбільш використовуваних валютних пар.

Зроблено висновки, що найбільш прогнозованим і передбачуваним показником на ринку поточних валютних операцій є стандартизовані обмінні ставки, що визначаються на основі валютних котирувань щонайменше 6 комерційних банків. При розрахунках середньої арифметичної ставки найбільші та найменші ставки котирувань не враховуються.

У статті висловлено припущення, що рівень систематичних ризиків, що генеруються на валютних ринках, може бути визначений за допомогою кількісних методів. Майбутні тенденції валютного ринку залежать від вибору вектора монетарної політики, який базується на якісній та кількісній оцінці. Оскільки процеси на валютному ринку мають фрактальну структуру і не можуть бути передбачені за допомогою класичних методів, для цієї мети використовуються положення теорії фрактальної статистики.

Зокрема, на основі існуючих котирувань валютної пари долар США/гривня України проведено розрахунки показника Херста, який відображає рівень антиперсистентності динаміки валютного курсу національної валюти України, а відповідно його здатність змінювати тенденції на протилежні у періоди високої волатильності та при наявності факторів, що її зумовляють. Волатильність курсу національної валюти і рівень антиперсистентності валютних коливань залежить від заходів у ряду у сфері валютного регулювання та валютної та монетарної політики. При цьому будь-яке втручання з боку держави у процеси курсоутворення обумовлює зміну тенденції. Результати розрахунків можуть бути застосовані для оперативного та стратегічного планування поведінки суб'єктів господарювання на валютних ринках та заходів, спрямованих на протидію негативному впливу змін валютних курсів.

Ключові слова: валюта, валютний курс, валютний ринок, валютні операції, валютне регулювання, валютні операції, теорія фрактальної статистики, антиперсистентність, показник Херста.