



Interrelation of Real Currency Rate and Economic Position of the World Countries

Averin Gennadiy Viktorovich*

The National Research University "Belgorod State University" (BelSU), Belgorod Doctor of Engineering Science, Professor, Head of a Department of General Math, Russia

Zviagintseva Anna Viktorovna

The National Research University "Belgorod State University" (BelSU), Belgorod Candidate of Engineering Sciences, docent, docent of Department of Applied Mathematics and Computer Modeling, Russia

Pozdnyayev Andrey Sergeevich

The Bauman Moscow State Technical University, Moscow Doctor of Economics, Head of the Department of Management of Scientific and Innovative Activities, Russia

Shvetsova Angela Alexandrovna

The National Research University "Belgorod State University" (BelSU), Belgorod, Russia

Abstract

Evaluation of real exchange rate of countries is an urgent task, as it is a key macroeconomic indicator characterizing the competitiveness of national goods in the world markets. An analysis of the relationship between the value of currencies and the position of the world countries in the field of economics and energy was carried out using an event valuation, which is one of the methods for the intellectual analysis of multidimensional data. A distinctive feature of this approach is the study of the relationship between the probabilities of simple and joint events of observing the values of statistical indicators of socio-economic objects. At the same time, the average statistical development trends of the studied sectors of the world economy are taken into account. In the process of research it was established that at present there are vast groups of countries for which the real value of national currencies is both overestimated and underestimated against the background of the contribution of these countries to the global economy. There is a tendency when, for many economically developed countries, the value of national currencies is overestimated. An example of a comprehensive assessment of Russia's position in the field of economics and energy shows the process of assessing the real value of the ruble. The event estimation method can be used in the analysis of the features and patterns of development processes both in the countries of the world and in other socio-economic objects, for example, regions, cities or enterprises.

Keywords: Event assessment; The world countries; Economic and energy indicators; Real value of national currencies; Interrelation of indicators.



CC BY: [Creative Commons Attribution License 4.0](https://creativecommons.org/licenses/by/4.0/)

1. Introduction

An objective analysis of the development of the global financial system is an urgent task of the global economy. One of the problems in this area is connected with the study of real exchange rates of world currencies. This line of research is devoted to a number of well-known works (Bozhechkova and Trunin, 2016; Chatterjee and Mursagulov, 2016; Habib and Kalamova, 2007; Lane and Milesi-Ferretti, 2000; Sosunov and Ushakov, 2009; Weber and Chunfang, 2011). When conducting comprehensive assessments of exchange rates, it is necessary to take into account political, financial, socio-economic, trade, investment, energy and other features of the development of countries (Bozhechkova and Trunin, 2016). Now there are 159 currencies in the world, while some of the currencies are in use in many countries. In the economy, money as a commodity has its own price, which is determined by the exchange rate, which depends on many pricing factors. It is known that the real value of the currency and its exchange rate can vary significantly. Cost is determined by the amount of goods and services that can be bought per unit of currency, and the rate is determined by the balance of supply and demand for currency in the market.

The quotation of any national currency is influenced by economic and political factors, in particular, decisions of the central banks of states and international organizations in the field of monetary policy, the formed economic, trade and energy indicators of the development of countries, etc. The real exchange rate is the nominal rate adjusted for the inflation that is observed in a given country. However, the real exchange rate most often does not match the real price of the national currency. In relation to the value, the exchange rate may be overvalued or underestimated. In other words, any national currency can be overestimated or underestimated, which is determined by many geopolitical, economic and financial factors.

Establishing the real value of national currencies is a rather complicated task of a system analysis in the field of financial and monetary activity of states. There are many ways to make such an assessment, one of the simplest

known approaches, although not very economically justified, is associated with the so-called Big Mac Index. The idea of valuation is based on purchasing power parity calculated using the same product in all countries of the world.

Economist Magazine publishes the Big Mac Index twice a year for countries around the world. This index, as the simplest estimate of currencies, was created in 1986 to check the ratio of the prices of a particular currency ([The Economist](#)).

For example, in the Big Mac index, the Russian ruble costs only 20.2 rubles per dollar. For comparison: the official dollar rate set by the Central Bank at the end of 2018 was 69 rubles. It turns out that the ruble is underestimated by about 3.3 times. Thus, as the researchers note, the Russian ruble is now one of the most undervalued currencies in the world. The Ukrainian hryvnia, Romanian leu, South African rand, etc. are also underestimated on this index. The most overvalued currencies of the world, except for the dollar, are the Swiss franc, Swedish krona, Canadian dollar, etc.

During the existence of the Big Mac index, various similar approaches have appeared. For example, Australian Commonwealth Securities Bank uses the iPod index to analyze the purchasing power of currencies, which compares the dollar price of a 2GB iPod Nano MP3 player. Value Penguin, an analytical firm, estimates currencies by using latte cups from Starbucks (tall latte). The German bank Deutsche Bank uses the similar Cheap Date index, etc., to analyze the purchasing power of currencies.

In general, such comparisons are incorrect and weakly reflect the real state of the processes taking place. Even the ancient Greek philosopher Parmenides argued that reality is not limited to numbers. Adequate study of a complex system requires the construction of a set of models that reflect the diversity of all aspects of the analyzed system. In this case, from the point of view of many economists, it is necessary to conduct a comprehensive assessment of the impact of a combination of fundamental economic factors on the real value of world currencies. The main factors usually include labor productivity, the real price of oil, the net outflow of private capital, the share of government spending in GDP, etc.

The purpose of this article is to analyze aspects of the real value of world currencies, depending on the prevailing macroeconomic indicators of the economies and energy of countries, taking into account the average development trends of these sectors of the world economy.

The basic concept of the real course is the theory of purchasing power parity (PPP). The PPP concept, first proposed by Cassel, is that the nominal exchange rate, through economic and trading operations, equalizes the prices of baskets of traded goods produced in the two countries being compared. It was found that labor productivity and terms of trade have a significant impact on the formation of the exchange rate of currencies in the countries of the world ([The Economist](#)). The choice of the main indicator indicators for many authors differs from each other. Some analysts use for their estimates the ratio of net international reserves to imports, the ratio of broad monetary base to GDP, the ratio of budget deficit to monetary base, etc. Other authors use indicators of the growth of the ratio of international reserves to imports, the export price of oil, the indicator of the difference between GDP and exports, the indicator of the growth of international reserves, external debt, etc. The following factors are also considered as fundamental factors of the real exchange rate: labor productivity (GDP per capita), terms of trade (export, import, real price of Brent oil, etc.), as well as net foreign assets as the difference between the value of foreign assets owned by national residents and the value of national assets acquired by non-residents.

It is believed that one of the main factors affecting the exchange rate of the currency is labor productivity in the sector of traded goods in national and foreign currencies. Another of the fundamental factors of the exchange rate is the terms of trade, as well as indicators of the level of development of energy in the countries of the world.

An interesting task is to establish the real value of the currencies of countries based on their contribution to the formation of the global economy or energy. At the same time, an analysis of the value of currencies must be based on objective methods for a comprehensive assessment of macroeconomic indicators of the development of countries, taking into account trends in the development of the world economy.

2. Methodology for the Analysis of Statistical Data

Today, the analysis of information on the development of countries and regions of the world requires the use of data mining methods (IAD). In this area, the researcher operates with data arrays that contain hundreds of statistical indicators. A modern world map includes about 200 countries, in turn, the retrospective data depth can be tens of years for each object. Modern tools for analysis, statistical processing and visualization of multidimensional arrays of information are available so far only in IAD. In this area, answers to many pressing questions about the development paths of the world community and its future may lie.

The event valuation technique used is based on building models of the collective development of socio-economic systems in the form of phenomenological relations, based on the existence hypothesis for such systems of equations of state. This allows a group of objects in the form of countries to formulate generalized criteria for a comprehensive assessment. This technique is based on the theoretical works of the authors of the article [9–13]. A distinctive feature of the methods used is the analysis of not the interconnection of indicators of development of socio-economic objects, but the relationship of the probabilities of events of observation of the values of these quantities in the group of analyzed objects. In general, the technique includes several stages of processing and analysis of multidimensional data.

a) At the first stage, a database of indicators is compiled in the form of temporal arrays of structured data, in which the studied objects and information about them are represented by rows of database tables, and indicators that determine the state of objects are represented by columns of tables. Different tables correspond to different time-ordered periods of statistical observations. The objects of the same type are classes (entities), for example,

organizations (enterprises), cities, regions, countries, etc. As indicators (attributes) can be socio-economic, technical, biological, physical quantities, presented in numerical form.

b) At the second stage, a list of attribute indicators (state variables) is selected from the total number of indicators, which most fully characterize the state of the studied objects in a certain aspect. Given that the proposed method does not limit the number of studied objects and their indicators, the initial information in the form of an array of data can include dozens of indicators. However, for the purpose of efficiency of the analysis in the study of various aspects of the development of objects, data processing and search for patterns are carried out in groups of three to five indicators, which are used as state variables p_k .

Next, the modeling environment is formed in the form of a multidimensional phase space of H^n States. The space H^n is defined as the Cartesian space of coordinates, which are the indices p_1, p_2, \dots, p_n . The state of each object in the H^n space is estimated by the value of its parameters. We believe that information about the States of objects can carry both data in the form of values of indicators and various facts in the form of events. The description of States of objects based on the continuum principle of representation of quantitative information in the space H^n , in which a hypothetical environment in the form of the state space is continuous and the elements of space are linked, taking into account patterns inherent studied the subject area. This allows us to consider the statistical data of observations as a limited discrete sample from a certain General population of an infinite set of States of objects of one class.

The statistical sample consists of M_i points, the total number of which is equal to the number of studied objects multiplied by the number of data tables. In this approach, the state of any object in n -dimensional space at any time will be displayed by a multidimensional point M_i , and the process of changing the state of the object in time by a multidimensional curve, which is described by a point M_i in this space.

c) At the next stage, the method of event estimation is used, which allows any observed change in the state of the object to be considered as some kind of event. For this, joint events of simultaneous observation of the values of state variables are distinguished. These events are indicative and along with the values of indicators uniquely characterize the state of the studied objects. The fact of simultaneous observation of the values of several indicators of an object can be considered as a complex joint event and the probability of such an event can be estimated by known methods. In turn, any change in the state of an object, as an event, can be studied in a causal relationship with indicative events.

The article used the method of direct algorithmic calculation of posterior probabilities of both simple and joint events based on available statistical data. As a result, the state of each object will be characterized both by the totality of the values of variable states, and by the probability of an indicative event of observation of this population. Algorithms for sorting, grouping, and directly counting the frequencies of joint events, as well as scripts for determining posterior probabilities of these events, are presented in earlier works of the authors (Averin, 2014; Zviagintseva, 2016). Such an approach makes it possible to test the hypothesis of the existence of a multidimensional statistical distribution of indicative events and to study the relationship of the probabilities of these events with the probabilities of other characteristic events.

The data processing experience has shown that in many cases the distributions of indicative events can be found in the form of probit dependencies $\Pr = \Pr(p_1/p_{1_0}, p_2/p_{2_0}, \dots, p_n/p_{n_0})$. Here p_{k_0} are the values of the indicators p_k for the adopted reference state, with respect to which the states of all other objects relate.

d) At the fourth stage, based on statistical data, a phenomenological model of the state space is constructed, which will describe its probabilistic probability patterns. The construction of the model is one of the most labor-intensive stages of research, since a significant number of variant calculations is required for various lists of state variables, data arrays, and various characteristic events. The quality of the constructed phenomenological model is determined by the degree of correspondence between the calculated and experimental data, for which the values of the correlation coefficients are estimated, the significance of the regression equations by the Fisher criterion, and the adequacy of the models by residuals is analyzed.

The equations of state of objects are constructed in the form of multidimensional empirical distributions for joint events, which are presented as follows:

$$w = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\Pr} \exp\left(-\frac{t^2}{2}\right) dt; \quad \Pr = c_0 + s; \quad s = \sum_{k=1}^n c_k \ln \frac{p_k}{p_{k_0}}, \quad (1)$$

where w – statistical (posteriori) probability joint event of observation of indicator values p_1, p_2, \dots, p_n , algorithmically determined; \Pr (probit) – inverse normal distribution function with mean, equal to zero and a dispersion equal to unity; s – entropy of the state of objects; c_k – regression coefficients; p_k – state variables; p_{k_0} – values of indicators p_k for the reference object in relation to which the assessment is carried out.

2.1. Valuation Data

There are many different databases that carry information on the components and aspects of the development of the countries of the world. The most famous of them are the database of the UN Development Program, the database of World Bank development indicators, UN statistics, the CIA Fact Book, etc.

Today, these databases (DBs) are available in the public domain of the Internet, respectively, at the following addresses:

- UN Development Program database: <http://hdr.undp.org/en/data>;
- World Bank Database: <http://data.worldbank.org/>;
- UN statistical resources: <http://data.un.org>;
- CIA Fact Book: <https://www.cia.gov/library/publications/>

The UN Development Program database includes statistics on almost 100 countries for the period 1975–1980 and 187 countries for the period 2011–2018 and contains about 100 indicators that identify several indices that characterize various aspects of human development.

In turn, the World Bank database is much more extensive than the database of the UN Development Program. The World Bank has opened free access to more than 1,200 countries' development indicators, many of which have a retrospective of up to 50 years.

UN statistical resources cover about 60 million records across the world in the areas of agriculture, crime, communications, development, education, energy, the environment, finance, health, the labor market, manufacturing, population, trade, etc.

The CIA Fact Book contains statistics on countries around the world with sections on geography, demography, government, economics, telecommunications, transportation, the armed forces, and energy. In this work, we used the statistical data of the Book ([Central Intelligence Agency \(US\)](#)), although the proposed approach can be implemented when analyzing data from any sources structured in a special way.

The corresponding database of the CIA Fact Book, which characterizes the state of demography, economics, and energy, includes information for each of 204 countries. In this analysis, for each country, information was used on 79 indicators that formed 3 groups of statistical information: demography (24); economy (32 indicators); power engineering (23). As a result of the work performed, an array of statistical data was generated, which included 14 information tables (from 2005 to 2018) for 204 countries according to 79 indicators. From these tables, groups of indicators were selected for analyzing the development processes of countries in various aspects.

When analyzing the financial and economic situation of countries, a comprehensive assessment of the real value of world currencies and the relationship of their values with macro-indicators of countries in the field of economics and energy was made. The work used the values of national currencies of the currencies of countries (p) at the end of each calendar year, which were given in dollar terms.

In this article, for example, when studying the influence of economic factors on currency rates of the countries of the world, the following indicators (p_k) are selected:

- GDP at purchasing power parity per capita, p_1 , US dollars / person;
- import per capita, p_2 , US dollars / person;
- export per capita, p_3 , US dollars / person.

To study the influence of energy factors on the exchange rates of the countries of the world, the following indicators were selected:

- electricity consumption per capita, p_4 , kW hour / person;
- gas consumption per capita, p_5 , m^3 / person;
- consumption of refined petroleum products per capita, p_6 , barrels / person.

In the CIA Fact Book, all of the above indicators are available for 204 countries over the past 10 years.

2.2. The Average Estimate of the Real Exchange rate of World Currencies

To study the relationship between the exchange rates of different countries, the previously used event valuation method was used. For this purpose, we considered a joint event of observing the values of three indicators characterizing the economic or energy situation of the countries of the world, and algorithmically found the probabilities of such an event based on the available data arrays. Observation of the value of the currency exchange rate in a country for a certain period of time was considered as a simple event, for which a statistical probability was also found. Further, between the probabilities of a simple (w) and joint event (w_s), we found the equations of communication using regression analysis. The values of the corresponding indicators (P_{k_0}) for Russia, which were observed in 2015, were taken as reference values. As a result, for example, for 2015, the following regression dependencies were obtained:

- for a joint event of observing the values of three indicators characterizing the economic situation of the countries of the world, the dependence of the statistical probability (w_s) on the entropy of the state of objects (s) is obtained:

$$\Pr_s = -0,0613 + s; \quad w_s = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\Pr_s} \exp\left(-\frac{t^2}{2}\right) dt; \quad (1)$$

$$s = 0,2401 \ln\left(\frac{p_1}{p_{10}}\right) + 0,0847 \ln\left(\frac{p_2}{p_{20}}\right) + 0,2647 \ln\left(\frac{p_3}{p_{30}}\right);$$

- for a joint event of observing the values of three indicators characterizing the position of the world countries in the field of energy, the dependence of the statistical probability (w_s) on the entropy of the state of objects (s) is obtained:

$$Pr_s = -0,3242 + s ; \tag{2}$$

$$s = 0,1076 \ln \left(\frac{p_5}{p_{5_0}} \right) + 0,0751 \ln \left(\frac{p_6}{p_{6_0}} \right) + 0,3961 \ln \left(\frac{p_7}{p_{7_0}} \right) ;$$

- for a simple event of observing the exchange rate values, the dependence of the statistical probability (w) on the state entropy (s) is obtained:

$$Pr = -0,3994 + s ; \quad s = 0,2914 \ln \left(\frac{p}{p_0} \right) ; \quad w = \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{Pr} \exp \left(-\frac{t^2}{2} \right) dt \tag{3}$$

The study of the relationship between a simple event (an event of observing a currency rate in a country) and a joint event (an event of observing the values of three indicators in the field of economy or energy) was based on a regression analysis of data on the probabilities of these events. As a result, two regression dependencies were obtained for the economic and energy sectors, respectively:

$$w = 0.2008 + 0.8234 w_s ; \tag{4}$$

$$w = 0.2185 + 0.7168 w_s . \tag{5}$$

The correlation coefficients of equations (1)–(3) amounted to $0.96 \div 0.98$, and equations (4) and (5) – $0.70 \div 0.73$. The data processing results are shown in [Figures 1 2 3 4 5](#).

Figure-1. Dependence of statistical probability w_s of a compatible event of observation of values of three indicators of economy on entropy s (2015)

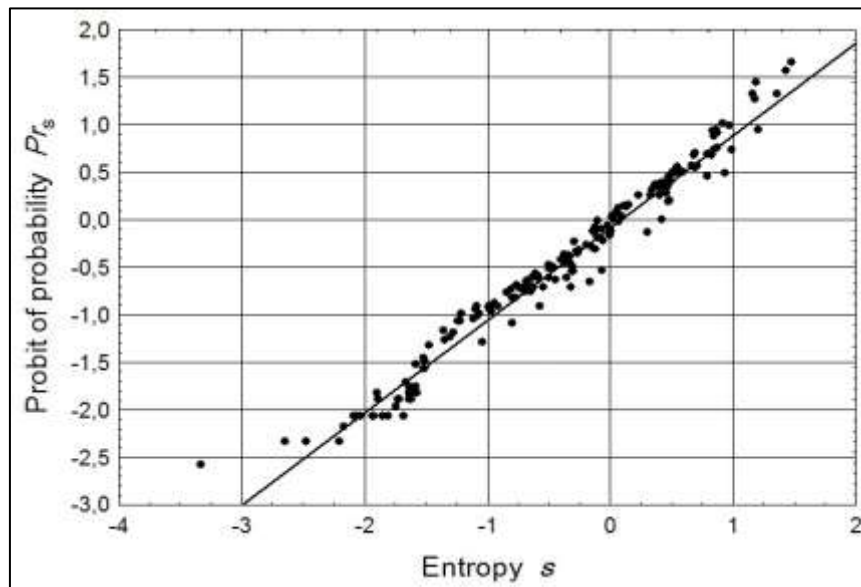


Figure-2. Dependence of statistical probability w_s of compatible event of observation of values of three indicators of energetics on entropy s (2015)

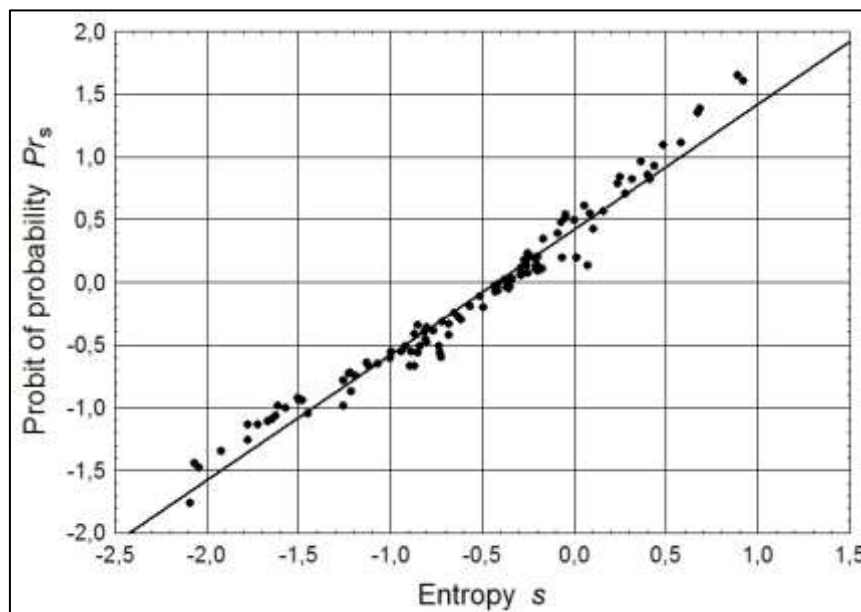


Figure-3. Dependence of statistical probability w of simple event of observation of exchange rate values on entropy s (2015)

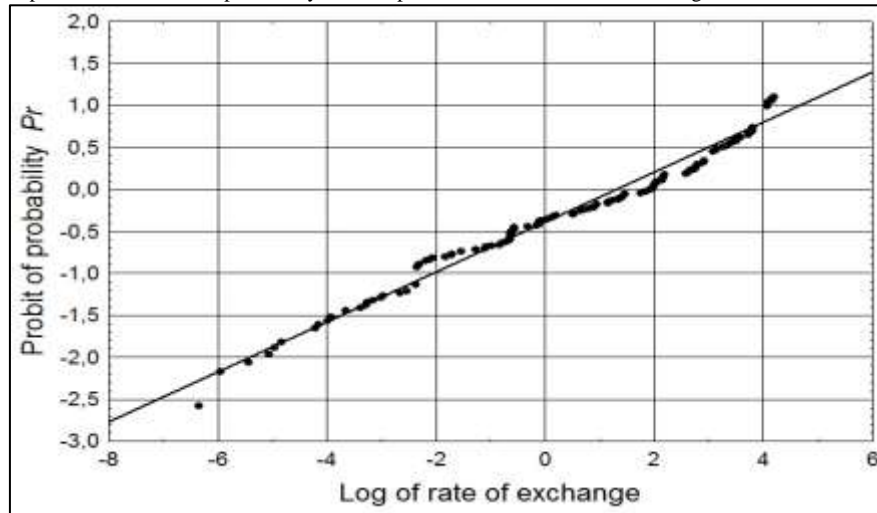
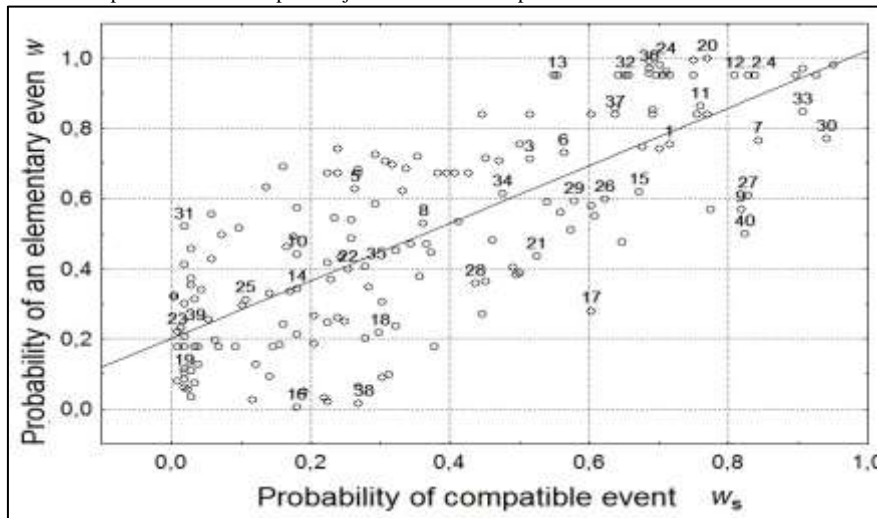
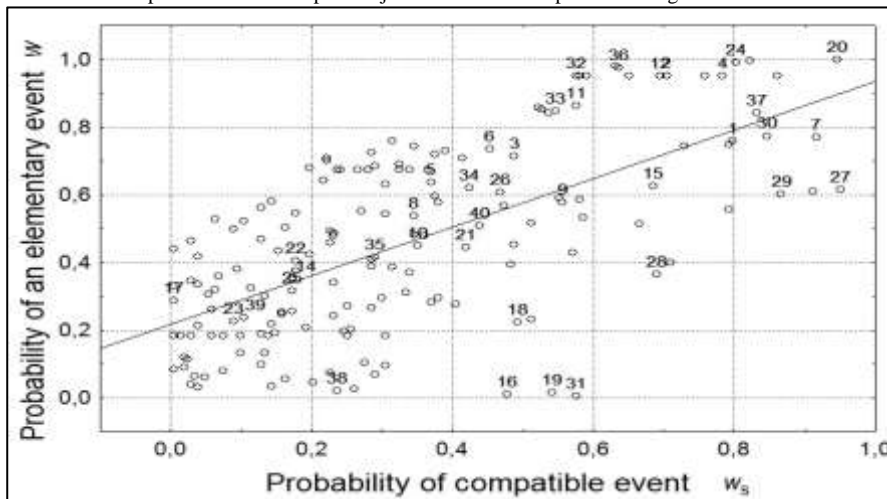


Figure-4. Interrelation of probabilities of simple and joint events for the sphere of economic domain of the world countries in 2015



- | | | | |
|----------------|-------------------|--------------------|---------------------|
| 1 – Australia; | 11 – Finland; | 21 – Mexico; | 31 – Afghanistan; |
| 2 – Austria; | 12 – Germany; | 22 – Nicaragua; | 32 – Spain; |
| 3 – Belarus; | 13 – Greece; | 23 – Nigeria; | 33 – Switzerland; |
| 4 – Belgium; | 14 – India; | 24 – Oman; | 34 – Turkey; |
| 5 – Brazil; | 15 – Israel; | 25 – Pakistan; | 35 – Ukraine; |
| 6 – Bulgaria; | 16 – Venezuela; | 26 – Poland; | 36 – Great Britain; |
| 7 – Canada; | 17 – Japan; | 27 – Qatar; | 37 – USA; |
| 8 – China; | 18 – Kazakhstan; | 28 – Russia; | 38 – Vietnam; |
| 9 – Denmark; | 19 – South Korea; | 29 – Saudi Arabia; | 39 – Yemen; |
| 10 – Egypt; | 20 – Kuwait; | 30 – Singapore; | 40 – Sweden. |

Figure-5. Interrelation of probabilities of simple and joint events for the sphere of energetic of the world countries in 2015



1 – Australia;	11 – Finland;	21 – Mexico;	31 – Afghanistan;
2 – Austria;	12 – Germany;	22 – Nicaragua;	32 – Spain;
3 – Belarus;	13 – Greece;	23 – Nigeria;	33 – Switzerland;
4 – Belgium;	14 – India;	24 – Oman;	34 – Turkey;
5 – Brazil;	15 – Israel;	25 – Pakistan;	35 – Ukraine;
6 – Bulgaria;	16 – Venezuela;	26 – Poland;	36 – Great Britain;
7 – Canada;	17 – Japan;	27 – Qatar;	37 – USA;
8 – China;	18 – Kazakhstan;	28 – Russia;	38 – Vietnam;
9 – Denmark;	19 – South Korea;	29 – Saudi Arabia;	39 – Yemen;
10 – Egypt;	20 – Kuwait;	30 – Singapore;	40 – Sweden.

Figures 4 and 5 show that the real value of world currencies, depending on macroeconomic indicators and taking into account the prevailing average statistical development trends in the sectors of the world economy and energy, can be overestimated or underestimated. The scatter of data relative to the average regression line is quite significant, which indicates many factors that influence the formation of the real value of currencies. The dynamics of these changes in time is also significant.

3. Analysis of the Results

A study of the data in Figure 4 shows that there is an average level that determines the global trend of the relationship between the real value of world currencies and macroeconomic indicators of economic development (the regression line in figure 4).

An analysis of the situation of countries reflects the existence of a developed group of countries over the regression line for which national currencies are revalued (Greece, Spain, Turkey, Oman, Kuwait, Finland, Austria, Belgium, Germany, the USA and etc.) The group of developing countries on the left side of the figure above the line regressions (Afghanistan, Dominican Republic, Eritrea, Papua New Guinea, Sudan, Tajikistan, Tonga, etc.) have also overvalued national currencies.

In turn, in the group of developed countries (Czech Republic, Denmark, Hungary, Japan, Norway, Qatar, Singapore, Sweden, Taiwan, etc.), national currencies are underestimated. The group of developing countries in the left part of the figure under the regression line (Burma, Colombia, Guinea, Indonesia, Iran, Iraq, Laos, Lebanon, Uzbekistan, Venezuela, Vietnam, etc.) also has undervalued national currencies.

The value of the currencies of Australia, New Zealand, China, Turkey, Ireland, Luxham Burg, Bangladesh, India, Pakistan and others. Corresponds to the average level of development of the world economy.

If we proceed from the development of energy in the countries of the world, then from the data in figure 5 it can be seen that there is also an average statistical level that determines the global trend of the relationship between the real value of world currencies and energy development indicators (regression line in figure 5).

Based on energy consumption, there is an energetically developed group of countries above the regression line for which national currencies are overvalued (Austria, Bahrain, Belgium, Estonia, Finland, France, Germany, Ireland, Italy, Latvia, Netherlands, Oman, Switzerland, Great Britain and etc.) The group of energetically underdeveloped countries in the left part of the figure above the regression line (Afghanistan, Dominican Republic, Eritrea, Ethiopia, Ghana, Moldova, Papua New Guinea, Sudan, Tonga, Zambia, etc.) also has revalued national currencies.

In the group of energy-developed countries (Qatar, Russia, Saudi Arabia, Taiwan, the United Arab Emirates, etc.), national currencies are underestimated.

The group of countries with relatively low energy consumption in the left part of the figure under the regression line (Colombia, Guinea, Indonesia, Iraq, Laos, Lebanon, Madagascar, Mongolia, Paraguay, Tanzania, Uganda, Uzbekistan, Vietnam and etc.) also has underestimated national currencies.

At the bottom of Figure 5 are Iran, Venezuela, and Libya, in which national currencies are underestimated very much.

The data obtained allow us to estimate the real exchange rate of any country based on the average statistical trends in the global economy and energy. For example, in Figure 4, the economic situation in Russia is determined by the probabilities $w_s=0.436$ and $w=0.356$. Based on the average statistical trends in the economy, which are determined by the presented regression dependence (4), the optimal value of the probability should be $w=0.560$. With this probability, from equation (3) we obtain the value for the ruble exchange rate in the range of 8–10 rubles per dollar.

In turn, in figure 5, Russia's position in the energy sector is determined by the probabilities $w_s=0.69$ and $w=0.356$. Based on the average statistical trends in the energy sector, which are determined by the regression dependence (5), the probability value should be $w=0.810$. With this probability, from equation (3) we obtain the value for the ruble exchange rate in the range of 1.5–2.5 rubles per dollar. Thus, it can be seen that the Russian currency is significantly underestimated. The US currency, when assessed by the selected indicators of the economy, is somewhat overestimated, and by the energy indicators, it almost corresponds to the average global trend (figs. 4 and 5). The currency of China in both cases is somewhat overvalued, and the currency of India is in line with the global trend.

4. Conclusions

Thus, the above results show the possibility of assessing the real value of national currencies depending on macroeconomic indicators of the development of countries. This takes into account the contribution of countries and the prevailing average trends in the development of various sectors of the world economy. The proposed integrated assessment method allows you to search for patterns between the probabilities of events associated with the observation of the values of various indicators of the development of countries.

It has been established that there are vast groups of countries for which the real value of national currencies is currently both overvalued and underestimated, while there is a tendency when, for many economically developed countries, national currencies are overvalued.

Based on the proposed method, the development processes of both countries of the world and other socio-economic objects can be analyzed. This makes it possible to identify trends in the development of cities, regions and countries, as well as to establish the influence of economic factors on the position of individual objects in relation to the entire group of studied objects.

References

- Averin, G. V. (2014). *System dynamics*. Donetsk, Donbass. 405. <http://www.chronos.msu.ru/ru/rnews/item/sistemodinamika>
- Bozhechkova, A. V. and Trunin, P. V. (2016). *Analysis of dynamics factors real currency exchange rate of rouble*. Moscow, Publishing house "The case",. 96.
- Central Intelligence Agency (US): Available: <https://www.cia.gov/library/publications/>
- Chatterjee, S. and Mursagulov, A. (2016). Fiscal policy and the real exchange rate. *Macroeconomic Dynamics*, 20(7): 1742–70. Available: <https://doi.org/10.1017/S1365100515000048>
- Habib, M. and Kalamova, M. (2007). Are there oil currencies? The real exchange rate of oil exporting countries. European central bank. Working paper series, no 839 / december 2007. 39.
- Lane, P. R. and Milesi-Ferretti, G. M. (2000). The transfer problem revisited: Net foreign assets and real exchange rates. *The review of economics and statistics*. Imf working paper wp/00/123, international monetary fund. 38.
- Sosunov, K. and Ushakov, N. (2009). *Determination of real exchange rate of ruble and assessment of longrun policy of real exchange rate targeting*. Working paper, wp12/2009/02. . State University - Higher School of Economics: Moscow. 64.
- The Economist: Available: <https://www.economist.com/printedition/2019-11-30>
- Weber, A. and Chunfang, Y. (2011). Armenia: An assessment of the real exchange rate and competitiveness. Imf working paper, wp/11/20. International monetary fund. 40.
- Zviagintseva, A. V. (2016). *Probabilistic methods of a complex assessment of natural and anthropogenic systems*. Cpektr Publishing House: Russia, Moscow. 257. <http://dspace.bsu.edu.ru/handle/123456789/17837>