International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 10, October - 2022, Pages: 223-230

Analysis of Trade Trends in Global Non-Precious Metal Markets

Oleksandr Zeleniy[1], Vyacheslav Lyashenko[1], Olena Shapran[2]

[1]Department of Media Systems and Technology, Kharkiv National University of Radio Electronics, Ukraine
e-mail: lyashenko.vyacheslav@gmail.com

[2]Department of Marketing, National Technical University «Kharkiv Polytechnic Institute», Ukraine

Abstract: *International trade occupies one of the key places in the system of economic relations, the development of various sectors of the economy and society. This is achieved through the organization and functioning of various types and types of markets that allow us to implement and maintain the necessary economic relations. This, ultimately, determines the feasibility of conducting ongoing research aimed at analyzing trade trends in world markets. Such an analysis can be carried out both from the point of view of the development of market relations in general, and taking into account the specifics of the functioning of individual market segments. Among the many segments of the world market, we single out the base metals market. The base metal market is a part of the commodity market where primary goods are traded. This makes this market special and attracts close attention. We consider the statistical characteristics of futures for various types of non-precious metals; we present the dynamics of such quotes. To analyze the mutual influence of individual quotes on futures, wavelet coherence estimates are used in the work. The paper presents a number of graphs and diagrams that help to understand the logic of the study, the reliability of the results.*

Keywords—analysis; trends; world market; commodity market; hard goods; base metals; wavelet analysis; wavelet coherence

1. INTRODUCTION

International trade is organized on the basis of the exchange of goods and services between different countries through exports and imports [1], [2]. At the heart of such an exchange is the system of international commodity-money relations, which is formed from the foreign trade of all countries of the world [3], [4]. To implement such principles, a whole system of markets is used, which form a single world market [5]. In such markets, various goods and services are traded, which is also reflected in various securities. It is these papers that are the embodiment of the corresponding commodity-money relations. You can track the movement that occurs in individual market segments using the appropriate tools (indices, futures market quotes). These tools have their own dynamics over time. Therefore, the analysis of such tools makes it possible to understand the functioning and development of individual market segments, the impact on the economic development of various sectors of the economy.

Among the existing variety of individual segments of the world market, one can single out the commodity market. A characteristic feature of the commodity market is the trade in primary goods, not industrial goods [6], [7]. Thus, the commodity market can be considered as the primary source of functioning and development of the economy. This allows us to say that the commodity market is the primary basis for the functioning of the world market, the basis for the functioning of the economy, and the development of society. This determines the importance of considering both the dynamics of the development of the commodity market as a whole and its individual sectors.

The commodity market can also be divided into a number of distinct segments. This is a segment where non-solid goods, solid goods, and energy resources are circulating. In turn, precious and non-precious metals can be distinguished among solid goods. Trading in each market segment is reflected in the change in the respective indices or futures quotes. Analysis of changes in such parameters is the basis for understanding the functioning of the relevant segment, its interaction with other markets, the development of the economy as a whole or its individual sectors, business entities. It should also be noted that such an analysis helps to make the most effective investment decisions. This, in turn, allows us to speak about the importance of analyzing trade trends in world markets in terms of organizing the corresponding financial flows.

To analyze and study the dynamics of certain market identifiers, you can use different tools. Among such tools are classical methods and approaches of statistical analysis, fuzzy set theory, mathematical analysis, optimization and control theory [8]-[12]. We can also use different methods and approaches that are applied in other areas of research [13]-[20]. Then the presence of different tools for analysis allows you to get new additional data, conduct new research and make the most effective decisions.

An important point in the study of the dynamics of changes in individual market identifiers (indices, quotes) is also the analysis of mutual influences in a separate group of such identifiers or for a certain market segment. Mutual analysis allows you to identify hidden trends and factors in the dynamics of changes in individual market identifiers, to better understand the features of its functioning and development. It is this direction that will determine the main goal of our work.

2. RELATED WORKS

Analysis of trends in the development of the commodity market and its individual segments is the basis of research in many works.

P. K. Narayan and S. S. Sharma in their study analyze time-varying prices in commodity markets [21]. At the same time, such an analysis concerns prices that are formed at the time of the opening of trading for certain goods. This study is based on the sliding window error correction method. At the same time, the authors showed that the pricing of nine commodities is determined by the spot market, while only six commodities are priced by the futures market. Thus, the authors of the study challenge the established idea of commodity markets, according to which it is the futures market that dominates the price determination process [21]. This is an important point in determining the appropriate investment strategy, determining the moment to enter a certain segment of the commodity market.

A. N. Slobodianyk, N. P. Reznik and G. D. Abuselidze analyze hedging methods and tools in the exchange commodity market, where the Ukrainian market is considered as such a market [22]. The paper, first of all, highlights the main instruments of protection against price fluctuations in the agricultural exchange market of corn and analyzes the use of hedging to minimize risks [22]. Thus, this paper analyzes such a segment of the commodity market as the market for non-solid goods. The paper shows that the combined effect of seasonality, fluctuations in production volumes, natural and climatic conditions have a significant impact on the formation of prices for agricultural products [22]. These factors also increase the risks of price volatility for non-solid goods. Therefore, the paper analyzes ways to use hedging to minimize the corresponding risks.

B. Włodarczyk and I. Miciuła conduct an empirical analysis of the effectiveness of predicting the volatility of commodity market returns using the example of gold and silver [23]. Thus, the authors consider the dynamics of the price of classic goods in the solid goods market. For such an analysis, the authors examine the effect of long memory and the asymmetry of the data series that are formed as a result of the dynamics of the corresponding commodity prices. This analysis included testing a wide range of linear and non-linear GARCH-type models [23]. At the same time, the purpose of this work was to study the relationship between rates of return and volatility, and to choose the optimal model. The authors showed that the FIAPARCH model turned out to be the best for estimating VaR forecasts for long and short trading positions [23]. At the same time, the FIAPARCH model produced the fewest VaR violations (lowest model risk) for all series, which means that it seems to be the most profitable predictive model for gold and silver from the point of view of financial institutions [23].

W. M. Ahmed explores the relationship between the stock and commodity markets [24]. Such a study examines data on the time frequency and interdependence of global equity and commodity markets in terms of the first four moments of their respective return distributions [24]. The author showed that the structure of the joint movement of moments of the same order of return on capital, gold and energy, as a rule, depends on both time and frequency [24]. The paper also shows that the links between cross skewness and cross kurtosis are more pronounced in the short and medium term and, which is especially noticeable, after global recessions [24]. This allows you to determine the optimal moments of entry into the relevant commodity markets.

E. J. A. Abakah, L. A. Gil-Alana and T. Tripathy consider and analyze the stochastic structure of metal prices [25]. In particular, the authors investigate the long-term memory properties of the price series of two major precious metals (gold and silver) and six non-precious metals (aluminum, copper, lead, zinc, tin, and nickel) using a fractional integration model under control for structural discontinuities and non-linearities [25]. The authors also take into account structural discontinuities and non-linearities. This is due to the fact that all the studied series are subject to multiple breaks. Thus, it is advisable to use other methods of analysis.

M. Naeem, A. K. Tiwari, S. Mubashra and M. Shahbaz consider various issues related to modeling the volatility of precious metals markets [26]. For these purposes, GARCH models with mode switching are considered. Thus, the article aims to test the existence of regime changes using MSGARCH models when modeling the volatility of four precious metals: gold, silver, palladium and platinum [26]. The results show that the use of MSGARCH models can provide accurate value-at-risk predictions and is therefore effective for portfolio optimization, derivatives pricing, and risk management [26]. This is important when making investment decisions.

C. Ciner, B. Lucey, and L. Yarovaya explore spillovers, integration, and causation in non-ferrous metals markets [27]. To this end, the authors consider the relationship in the world markets for non-ferrous metals over a 22-year period. Various econometric methods were used for this study. The paper noted the high intensity of secondary effects, both profitability and volatility in the markets that are being studied [27]. The data obtained show that the behavior of non-ferrous metals is similar to that of other traditional asset classes such as stocks and bonds, which justifies the proposition that metals have become an investment class [27]. This allows you to draw informed conclusions when choosing investment decisions.

B. A. Wahab and A. O. Adewuyi in their study analyze the main prices for metals [28]. Such an analysis involves the study of structural gaps, non-linearity, stationarity and price bubbles. At the same time, the authors explore the properties of prices for such metals as gold, silver, platinum, palladium and copper. The authors use daily and weekly datasets, as well as two conventional unit root tests and two recent stationarity tests (including a new one) that account for structural discontinuities and non-linearity [28]. The paper shows that metal prices demonstrate structural shifts and non-linearity

International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 10, October - 2022, Pages: 223-230

during the period under study. This makes it easier to choose when to enter the respective markets.

Thus, we can note the importance of analyzing data on price dynamics in the solid goods market. Such an analysis helps to justify the appropriate investment decisions and choose the necessary time frame to enter such markets.

3. Data for Analysis and Their Statistical Characteristics

In this paper, we consider a group of non-precious metals such as: copper, tin, lead, zinc and nickel. In particular, we consider the dynamics of the values of futures contracts in the period from 01.01.2021 to 15.10.2022 on a weekly average. All data from investing.com.

It should also be noted that futures contracts for non-precious metals are traded on different platforms. Among such sites it should be noted: London Metal Exchange, Shanghai Metal Exchange, Tokyo Commodity Exchange, New York Mercantile Exchange. The dynamics of prices on such sites differ from each other. This is due to the opening time of the site, the specifics of the auction, the regional aspects of the trading platform. To unify data for analysis and accounting for the influence of the trading floor on price dynamics, we consider all data from the London Metal Exchange. At the same time, we consider the so-called streaming futures quotes.

On Fig. 1 shows the dynamics of prices for futures contracts for copper.

We can observe the rapid growth of quotations for copper on futures contracts. This growth is observed in the first third of the study period. Then comes the relative stabilization of prices with insignificant dynamics of fluctuations in such prices. Further, we observe a sharp drop in prices with a slight correction at the end of the studied period of time.

The dynamics of quotations for copper under futures contracts is characterized by the following statistical characteristics:

mean – 9170.247312;

median – 9427;

standard deviation – 863.1357318;

sample variance – 745003.2914;

kurtosis – -0.592679445;

skewness – -0.650525601

with confidence level – 95.0%.

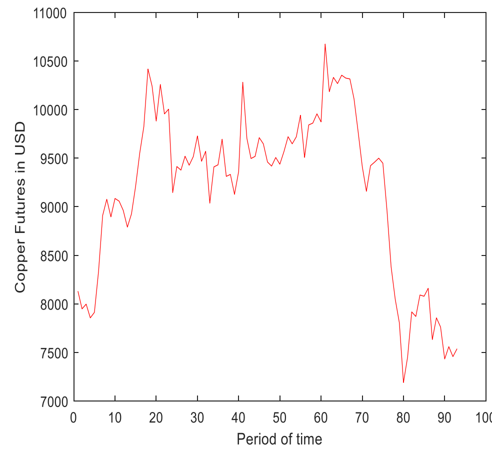

Figure 1: Dynamics of prices for futures contracts for copper

On Fig. 2 shows the dynamics of prices for futures contracts for tin.

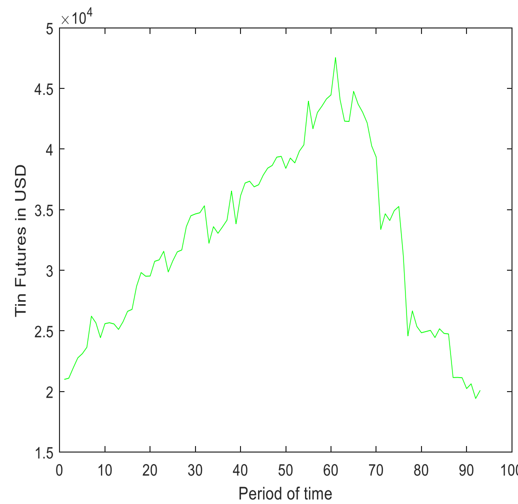

Figure 2: Dynamics of prices for futures contracts for tin

Quotes of futures contracts for tin has a pronounced maximum for the studied period of time (see Fig. 2). This maximum falls at the end of the second third of the time period that we are analyzing. At the same time, it should be noted that the growth of quotations for futures contracts is more moderate in comparison with a sharp drop in the corresponding quotations. Also noteworthy are the slight fluctuations in the prices of tin futures contracts, both during the growth of such prices and during their decline.

The dynamics of quotations for tin under futures contracts is characterized by the following statistical characteristics:

mean – 32245.03226;

median – 33055;

standard deviation – 7498.766457;

sample variance – 56231498.38;

kurtosis – -1.139044762;

skewness – 0.061872213

with confidence level – 95.0%.

On Fig. 3 shows the dynamics of prices for futures contracts for lead.

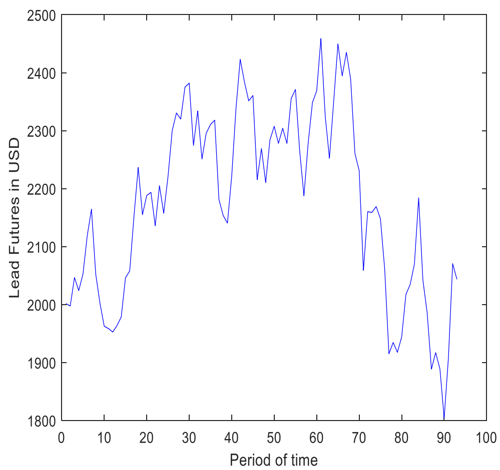

Figure 3: Dynamics of prices for futures contracts for lead

We can talk about the growth of quotes for futures contracts for lead for the first and second third of the period under study. At the same time, there are significant fluctuations in lead prices, when we can see several highs. The last third of the analyzed period of time is characterized by a decrease in quotations for futures contracts for lead. There are fluctuations in lead prices here as well. However, such fluctuations are not as sharp as for the previous time period (see Fig. 3).

The dynamics of quotations for lead under futures contracts is characterized by the following statistical characteristics:

mean – 2174.790323;

median – 2187.5;

standard deviation – 159.5413147;

sample variance – 25453.4311;

kurtosis – -0.970272854;

skewness – -0.23725489

with confidence level – 95.0%.

On Fig. 4 shows the dynamics of prices for futures contracts for zinc.

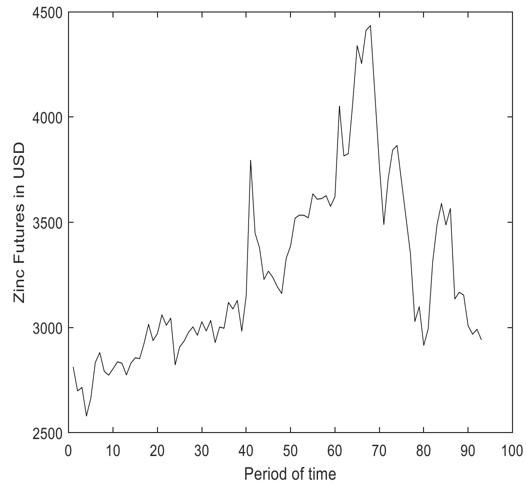

Figure 4: Dynamics of prices for futures contracts for zinc

On Fig. 5 shows the dynamics of prices for futures contracts for nickel.

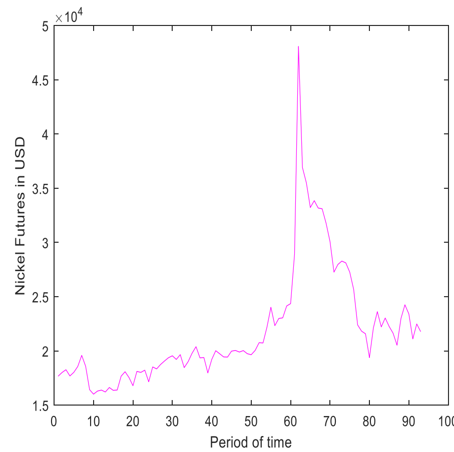

Figure 5: Dynamics of prices for futures contracts for nickel

The dynamics of quotations for futures contracts for zinc is characterized by growth in the first two thirds of the study period. This is somewhat similar to the dynamics of quotations for futures contracts for tin (see Fig. 2). However, quotes for zinc in the first two thirds have two pronounced highs. For the first third, the growth of quotations for zinc is more moderate than for the second third. Decrease in quotations for zinc is characterized by sharp jumps in prices (see Fig. 4).

The dynamics of quotations for zinc under futures contracts is characterized by the following statistical characteristics:

mean – 3259.682796;

median – 3128.5;

standard deviation – 427.1621522;

International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 10, October - 2022, Pages: 223-230

sample variance –

182467.5043;

kurtosis – 0.157412389;

skewness – 0.877730165

with confidence level – 95.0%.

The dynamics of quotations on futures contracts for nickel also has a pronounced maximum. This maximum falls on the second third of the time period that we are analyzing. At the same time, at first we observe a moderate increase in nickel prices, and then a sharp jump. The last third of the analyzed period of time is characterized by falling quotes for nickel (see Fig. 5).

The dynamics of quotations for nickel under futures contracts is characterized by the following statistical characteristics: mean – 21862.65591; median – 19979; standard deviation – 5455.70891; sample variance – 29764759.71; kurtosis – 5.597205705; skewness – 2.06863485 with confidence level – 95.0%.

Thus, in general, we can talk about different dynamics of quotations for futures contracts for different metals. At the same time, a characteristic feature of such quotes is:

change in trends in quotes at the end of the second third of the period under study;

growth of quotes in the first two thirds of the time period that we are analyzing. Although the dynamics of such growth for each metal differs from one another;

the decline in quotations is sharper than their growth. Here, one can also note the different dynamics of such a decrease depending on the type of metal.

All this indicates the need for a more detailed analysis of the processes of metal trading, where the analysis of the mutual dynamics of the corresponding quotations is especially important.

4. Analysis of Mutual Price Dynamics for Non-Precious Metals

Correlation analysis can be used to study the mutual price dynamics. Such an analysis allows us to present a general picture of the interaction of various quotes, which in this case are represented by different time series.

The corresponding calculations show that the value of the correlation coefficient is:

between the values of quotes on copper and tin – 0.82; copper and lead - 0.79; copper and zinc - 0.47; copper and nickel - 0.27;

between quotes on tin and lead – 0.84; tin and zinc, 0.71; tin and nickel, 0.51;

between quotes on lead and zinc – 0.52; lead and nickel – 0.31;

between the quotes for zinc and nickel – 0.81.

We see that some data series have high mutual values of correlation coefficients; some data series have insignificant values of correlation coefficients. However, these values of the correlation coefficients give only a general picture of the dynamics that we are studying. Moreover, we cannot have information about such a dependence on different time horizons, which we consider as a whole.

To solve such a problem, it is advisable to use the methodology of wavelet analysis [29]-[31]. One of the methods of such a methodology is wavelet coherence, which can be used to obtain appropriate estimates and conduct additional analysis. In general, wavelet coherence makes it possible to evaluate the mutual dynamics of different data series on different time horizons from the general period that we are studying [32]-[37].

On Fig. 6 shows estimates of the wavelet coherence between quotes in the futures market on tin and lead.

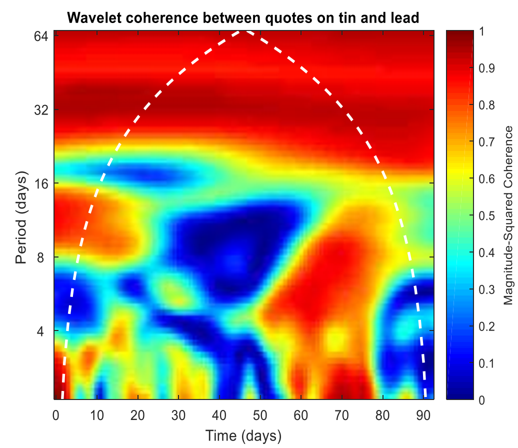

Figure 6: Estimates of the wavelet coherence between quotes in the futures market on tin and lead

First of all, we note that the value of the correlation coefficient between quotes in the futures market on tin and lead is maximum. According to Fig. 6 we can also observe a large interdependence between quotes in the futures market on tin and lead. At the same time, the significance of such interdependence increases in the last third of the time period that we are analyzing.

This is consistent with the previous conclusion about a sharp drop in metal prices in the last third of the time period we are analyzing. Therefore, the same factors act on such a fall.

On Fig. 7 shows estimates of the wavelet coherence between quotes in the futures market on copper and nickel.

International Journal of Academic Multidisciplinary Research (IJAMR)
ISSN: 2643-9670
Vol. 6 Issue 10, October - 2022, Pages: 223-230

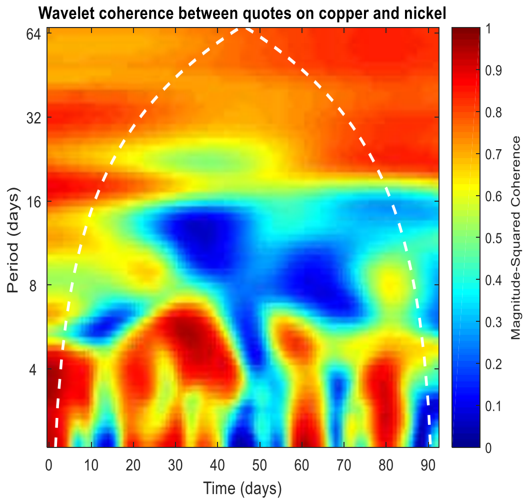

Figure 7: Estimates of the wavelet coherence between quotes in the futures market on copper and nickel

The value of the correlation coefficient for quotes between copper and nickel is the lowest (see data above). But we can note that in general we have significant estimates of wavelet coherence for quotes between copper and nickel. This suggests that the dynamics of quotations are affected by the same factors, despite the fact that such dynamics in general may differ from each other.

Let's consider a couple more estimates of wavelet coherence for data where the value of the correlation coefficient is at the average level.

For such an analysis, consider

the relationship of quotes between lead and zinc, where the corresponding value of the correlation coefficient is 0.52;

between tin and nickel, where the corresponding value of the correlation coefficient is 0.51.

On Fig. 8 shows estimates of the wavelet coherence between quotes in the futures market on lead and zinc.

Here we can also note the significance of the estimates between lead and zinc quotes. At the same time, this significance is greatest for the last third of the period that we are analyzing. This confirms our conclusions about the influence of the same factors on the process of formation of quotations in the metals market.

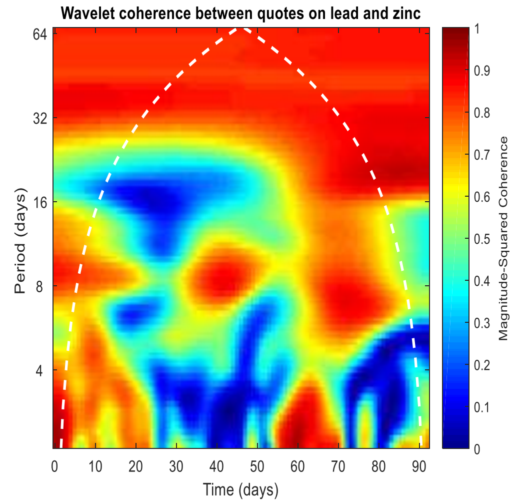

Figure 8: Estimates of the wavelet coherence between quotes in the futures market on lead and zinc

On Fig. 9 shows estimates of the wavelet coherence between quotes in the futures market on tin and nickel.

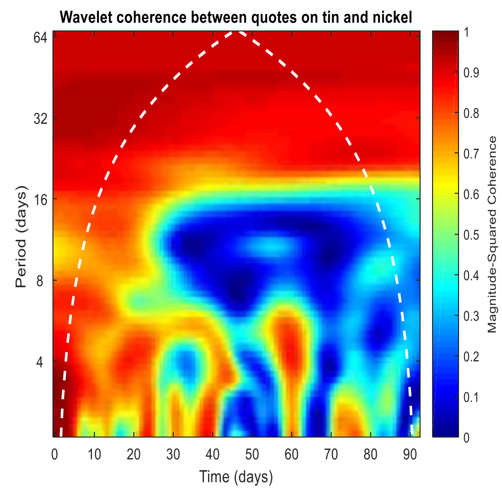

Figure 9: Estimates of the wavelet coherence between quotes in the futures market on tin and nickel

There is also a significant relationship between the corresponding quotes for metals. Moreover, such a relationship manifests itself in the first third of the time period that we are analyzing. Thus, we can build various estimates of wavelet coherence, which, in general, can help in choosing appropriate investment strategies and determining the moment of entering certain metal markets.

5. Conclusion

The paper considers the statistical aspects of the analysis of existing trends in trade in the world markets for non-precious metals. For analysis, we consider quotes on the futures market for such metals: copper, tin, lead, zinc and nickel.

We use descriptive statistics to study current trading trends in the base metals markets. The paper presents the relevant charts and statistical characteristics for quotes for various metals.

We also look at the relationship between different metal quotes. For this, we use wavelet coherence estimates. We come to the conclusion about the influence of the same factors on the process of forming quotes for different types of metals.

6. References

[1] Xu, Z., & et al.. (2020). Impacts of international trade on global sustainable development. Nature Sustainability, 3(11), 964-971.

[2] Azmeh, S., Foster, C., & Echavarri, J. (2020). The international trade regime and the quest for free digital trade. International Studies Review, 22(3), 671-692.

[3] Trigg, A. B. (2020). Marx, say's law and commodity money. Contributions to Political Economy, 39(1), 23-41.

[4] Kuijpers, M. H., & Popa, C. N. (2021). The origins of money: Calculation of similarity indexes demonstrates the earliest development of commodity money in prehistoric Central Europe. PLoS One, 16(1), e0240462.

[5] Lordkipanidze, R. (2019). Confirmations about Need of Real World Market. International Charity Scientific-Research Partnership of Physical Persons, 16.

[6] Lauter, T., & Prokopczuk, M. (2022). Measuring commodity market quality. Journal of Banking & Finance, 145, 106658.

[7] Seth, N., & Sidhu, A. (2020). Price discovery and volatility spillovers in commodity market: a review of empirical literature. International Journal of Financial Markets and Derivatives, 7(3), 291-314.

[8] Ming, J., & et al.. (2018). Analysis models of technical and economic data of mining enterprises based on big data analysis. In 2018 IEEE 3rd International Conference on Cloud Computing and Big Data Analysis (ICCCBDA) (pp. 224-227). IEEE.

[9] Gontar, A. A., & et al.. (2019). Methods of data intellectual analysis in assessment of economic security level. In Ubiquitous Computing and the Internet of Things: Prerequisites for the Development of ICT (pp. 455-464). Springer, Cham.

[10] Kuzemin, A., & Lyashenko, V. (2009). Methods of comparative analysis of banks functioning: classic and new approaches. Information Theories & Applications, 16(4), 384-396.

[11] Javanmardi, E., & Liu, S. (2019). Exploring grey systems theory-based methods and applications in analyzing socio-economic systems. Sustainability, 11(15), 4192.

[12] Matarneh, R., & et al.. (2019). Improving Fuzzy Network Models For the Analysis of Dynamic Interacting Processes in the State Space. International Journal of Recent Technology and Engineering, 8(4), 1687-1693.

[13] Babker, A. M., & et al.. (2019). Information technologies of the processing of the spaces of the states of a complex biophysical object in the intellectual medical system health. International Journal of Advanced Trends in Computer Science and Engineering, 8(6), 3221-3227.

[14] Tvoroshenko, I., & et al.. (2020). Modification of models intensive development ontologies by fuzzy logic. International Journal of Emerging Trends in Engineering Research, 8(3), 939-944.

[15] Mustafa, S. K., & et al.. (2020). Using wavelet analysis to assess the impact of COVID-19 on changes in the price of basic energy resources. International Journal of Emerging Trends in Engineering Research, 8(7), 2907-2912.

[16] Rabotiahov, A., & et al.. (2018). Bionic image segmentation of cytology samples method. In 2018 14th International Conference on Advanced Trends in Radioelecrtronics, Telecommunications and Computer Engineering (TCSET) (pp. 665-670). IEEE.

[17] Orobinskyi, P., & et al.. (2019). Novel Approach to Computer-Aided Detection of Lung Nodules of Difficult Location with Use of Multifactorial Models and Deep Neural Networks. In 2019 IEEE 15th International Conference on the Experience of Designing and Application of CAD Systems (CADSM) (pp. 1-5). IEEE.

[18] Matarneh, R., & et al.. (2018). Highlights methodology of time characteristics optimization for plastic products production. International Journal of Engineering and Technology (UAE), 7(1), 165-173.

[19] Dadkhah, M., & et al.. (2015). Developing expert system in order to detect the journal phishing attacks. Journal of Mathematics and Technology, 6(1), 70-73.

[20] Baranova, V., & et al.. (2020). Information system for decision support in the field of tourism based on the use of spatio-temporal data analysis. International Journal of Advanced Trends in Computer Science and Engineering, 9(4), 6356-6361.

[21] Narayan, P. K., & Sharma, S. S. (2018). An analysis of time-varying commodity market price discovery. International Review of Financial Analysis, 57, 122-133.

[22] Slobodianyk, A. N., Reznik, N. P., & Abuselidze, G. D. (2021). The Analysis of Hedging Instruments on the Exchange Commodity Market of Ukraine. In The Challenge of Sustainability in Agricultural Systems (pp. 379-385). Springer, Cham.

[23] Włodarczyk, B., & Miciuła, I. (2020). Empirical Analysis of Long Memory and Asymmetry Effects for the Effectiveness of Forecasting Volatility of Returns on the Commodity Market Based on the Example of Gold and Silver. E&M Economics and Management, 23(2), 126-143.

[24] Ahmed, W. M. (2022). On the higher-order moment interdependence of stock and commodity markets: A wavelet coherence analysis. The Quarterly Review of Economics and Finance, 83, 135-151.

[25] Abakah, E. J. A., Gil-Alana, L. A., & Tripathy, T. (2022). Stochastic structure of metal prices: Evidence from fractional integration non-linearities and breaks. Resources Policy, 78, 102910.

[26] Naeem, M., & et al.. (2019). Modeling volatility of precious metals markets by using regime-switching GARCH models. Resources Policy, 64, 101497.

[27] Ciner, C., Lucey, B., & Yarovaya, L. (2020). Spillovers, integration and causality in LME non-ferrous metal markets. Journal of Commodity Markets, 17, 100079.

[28] Wahab, B. A., & Adewuyi, A. O. (2021). Analysis of major properties of metal prices using new methods: Structural breaks, non-linearity, stationarity and bubbles. Resources Policy, 74, 102284.

[29] Zaremba, A., Umar, Z., & Mikutowski, M. (2019). Inflation hedging with commodities: A wavelet analysis of seven centuries worth of data. Economics Letters, 181, 90-94.

[30] Adebayo, T. S., & Beton Kalmaz, D. (2020). Ongoing debate between foreign aid and economic growth in Nigeria: a wavelet analysis. Social Science Quarterly, 101(5), 2032-2051.

[31] Wu, T. P., & Wu, H. C. (2020). A multiple and partial wavelet analysis of the economic policy uncertainty and tourism nexus in BRIC. Current Issues in Tourism, 23(7), 906-916.

[32] Vasiurenko, O., & et al.. (2020). Spatial-Temporal Analysis the Dynamics of Changes on the Foreign Exchange Market: an Empirical Estimates from Ukraine. Journal of Asian Multicultural Research for Economy and Management Study, 1(2), 1-6.

[33] Lyashenko, V., & et al.. (2021). Mutual Dynamics of Certain Types of Bitcoin: Data from Wavelet Coherence. Journal of Engineering, Technology, and Applied Science, 3(2), 58-65.

[34] Chetverykov, G., & et al.. (2019). Wavelets as a Tool for Data Mining Technology. Інформація, комунікація, суспільство, 249-250.

[35] Torrence, C., & Webster, P. J. (1999). Interdecadal changes in the ENSO–monsoon system. Journal of climate, 12(8), 2679-2690.

[36] Heil, C.E., & Walnut, D.F. (1989). Continuous and discrete wavelet transforms. SIAM review, 31(4), 628-666.

[37] Orhan, A., Kirikkaleli, D., & Ayhan, F. (2019). Analysis of wavelet coherence: service sector index and economic growth in an emerging market. Sustainability, 11(23), 6684.