Comparative Analysis of Price Dynamics for Shares of Technology Companies in Japan: Canon Inc, Hitachi Ltd, Sony Corp., Alps Electric Co., Tokyo Electric Power Co.

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Abstract: *Comparative analysis is one of the tools for studying economic dynamics. Comparative analysis allows you to reveal existing trends and evaluate some of the influencing factors that indirectly affect the dynamics under study. Among the applications of using comparative analysis, we single out the financial market. We emphasize that individual segments of the financial market are determined by the movement of stock prices. This is due to the fact that the stock price underlies the definition of many stock indices, various indicators. Based on this, we conduct a comparative analysis of the price dynamics of the shares of a number of technology companies in Japan. The paper presents the dynamics of stock prices for a number of technology companies in Japan: Canon Inc, Hitachi Ltd, Sony Corp., Alps Electric Co., Tokyo Electric Power Co. We also provide various statistical characteristics for the dynamics of stock prices of such companies. To conduct a comparative analysis, we use the methodology of wavelet analysis. We consider wavelet coherence estimates. This makes it possible to assess the mutual dynamics of stock prices and to give appropriate estimates of such dynamics. The paper presents many graphs and charts that allow you to understand the course of this study, evaluate possible investment decisions.*

Keywords—dynamics; stock; price; statistics; comparative analysis; technology companies; wavelet analysis; wavelet coherence

1. INTRODUCTION

The financial market plays an important role in the formation, functioning and development of the country's economy, its international economic relations. Through various instruments of the financial market, the accumulation and redistribution of resources takes place, the movement of various financial flows is carried out and maintained [1]-[4]. This contributes to the functioning and development of the economy as a whole, supporting economic relations between different market participants. The directions of such development, the stability of economic relations are determined by various instruments, among which a special place is given to securities [5]-[7].

Shares are one of the types of securities that indicate the share of ownership of the company and secure the rights of its owner to receive part of the profits of the joint-stock company in the form of dividends [6], [8], [9]. Shares are one of the investment instruments that are actively used in the respective markets. At the same time, the price of shares of different companies forms the basis for calculating the corresponding stock indices [10], [11]. Thus, stocks reflect the dynamics of the movement of financial flows and play an important role in the formation of the overall financial market [12], [13]. Shares can be considered as primary instruments with which various segments of the financial market operate. It is the dynamics of share prices that determines the main trends in the functioning and development of individual segments of the financial market.

The stock market is diverse and significant. In the stock market, there is a diverse movement of the corresponding financial flows. This affects the dynamics of share prices, the value of stock indices, determines the mood of investors and the direction of their subsequent investments. Thus, a comparative analysis of the dynamics of stock prices is one of the key areas in the study of the corresponding segment of the financial market, an investment analysis tool.

For the corresponding analysis, both classical methods and approaches [14], [15] and tools that are used in other areas of research [16]-[20] can be used. At the same time, in a comparative analysis, it is important to take into account the time horizons, the sphere of circulation of the relevant shares and the market in which such shares are quoted. This is important for taking into account the factors that determine the dynamics of stock prices.

Thus, the main purpose of this study is to conduct a comparative analysis of a number of technology companies in Japan. This choice is based on the fact that it is technology companies that have a significant impact on the sustainability of economic development and determine its future directions for successful operation.

2. RELATED WORKS

There are many works that deal with various issues of stock price dynamics. At the same time, it is possible to single out works where attention is paid to general issues of stock price dynamics, as well as works where individual groups of companies and the dynamics of prices for their shares are considered. Below is a brief overview of such works.

M. Akbar, F. Iqbal and F. Noor consider the relationship between the dynamics of gold prices, stocks and the exchange rate for the Pakistani market [21]. First of all, the authors note that this study is of great importance for both investors, researchers, and politicians. The authors are searching for the best model for Bayesian inference. To compare the effectiveness, the authors use the classical VAR model. Cointegration tests were also used: the JJ test without taking into account a structural gap, the GH test with one unknown structural gap, and the HJ test, which allows for two unknown structural gaps when no long-term relationship between variables is found [21]. A Bayesian VAR model with independent normal inverse Wishart priors is selected as the best model, which is then used to perform impulse response analysis [21]. At the same time, the paper shows that a direct relationship between the nominal interest rate and the exchange rate in Pakistan corresponds to the international theory of the Fisher effect [21].

R. Greenwood, S. G. Hanson, and G. Y. Liao explore the impact of asset price dynamics in partially segmented markets [22]. The authors consider a model in which capital moves rapidly within an asset class but moves slowly between asset classes. This allows you to assess the level of risk to a change in the price of shares in the event of a major shock. The authors note that in the long term, capital flows lead to the fact that risk prices become closer to each other [22]. Therefore, this study is important.

L. Gardini, D. Radi, N. Schmitt, I. Sushko, and F. Westerhoff analyze the issues of stock market stability in the case of multidirectional movement of stock prices [23]. The authors developed a behavioral model of the stock market, in which a market maker regulates stock prices in accordance with the orders of chartists, fundamentalists, and sentiment traders [23]. The paper shows that stock prices either demonstrate endogenous oscillatory dynamics or converge to non-fundamental fixed points. This allows you to determine the feasibility of investing in a particular asset, as well as the time frame for such investment. At the same time, the authors emphasize the importance of conducting a mutual analysis of the dynamics of stock prices.

G. Fischer considers dynamic hedging and its impact on stock price dynamics [24]. The author considers the German market for options and discount certificates. In this case, the influence of such securities on the autocorrelation of changes in prices for German shares is investigated. The paper notes that the demand for hedging on the part of option issuers has a positive effect on the autocorrelation of returns, while the opposite is observed for certificate issuers [24]. For such an analysis, a comparative mutual analysis of the dynamics of prices for shares of various companies is important.

R. I. Ahmed, G. Zhao and U. Habiba explore the dynamics of the relationship between returns and asymmetric volatility spillovers in Asian emerging stock markets [25]. Here we also see the importance of cross-analysis of data. The paper considers the stock markets of China, Hong Kong, Japan, Malaysia, Pakistan and South Korea as Asian markets. The authors use the two-dimensional EGARCH model. The paper shows that own lag spillovers are statistically significant in all cases at the level of one percent. The paper also notes the relationship of individual markets. Therefore, it is important to consider the side effect, since they can save the financial sector from unexpected financial shocks [25].

J. Sirignano and R. Cont explore the universal features of pricing in financial markets [26]. To do this, the authors use a large-scale deep learning approach. For this, a database containing billions of market quotes and transactions for US stocks is used. The analysis also used standard data normalization based on volatility, price level, or average spread [26]. However, this does not improve learning outcomes. At the same time, the inclusion of the history of prices and the flow of orders for many past observations improves the accuracy of the forecast, indicating the presence of a dependence in price dynamics [26]. Thus, an important aspect is the analysis of mutual dynamics.

P. Yu and X. Yan explore the issues of stock price forecasting [27]. For these purposes, deep neural networks are used. The authors note that financial data contains complex, incomplete and fuzzy information. Therefore, forecasting their development trends is an extremely difficult task. Also, financial data depends on many interrelated, constantly changing factors [27]. Here we have to face non-linear problems. Therefore, the method of deep neural networks was chosen to solve them. At the same time, a DNN-based forecasting model is developed based on the PSR method and long-term and short-term memory networks (LSTM) for DL and is used to predict stock prices [27]. The paper notes that the proposed prediction model has a higher prediction accuracy. In this case, an important point is to conduct a comparative analysis.

D. Shah, H. Isah, and F. Zulkernine presented an overview of various stock market forecasting methods [28]. The authors note that forecasting stock prices is challenging due to the large number of variables involved. At the same time, the application of machine learning methods and other algorithms for the analysis and forecasting of stock prices is an area that shows great promise [28]. To justify the application and selection of certain methods and approaches, the paper analyzes the technical, fundamental, short-term and long-term aspects used to analyze stocks. In such a discussion and comparison, one of the important aspects is the mutual analysis of data.

Thus, we see that benchmarking is an important aspect of studying the dynamics of stock prices. Various methods and approaches can be used here. At the same time, cross-analysis of data is a key aspect of such research.

3. STATISTICAL CHARACTERISTICS OF THE DYNAMICS OF STOCK PRICES OF MAJOR TECHNOLOGY COMPANIES IN JAPAN

One aspect of comparative analysis is to select data that is from the same time period and is affected by roughly the same factors. Based on this, consider the dynamics of stock prices of the largest technology companies in Japan. Among such companies we consider: Canon Inc, Hitachi Ltd, Sony Corp, Alps Electric Co., Tokyo Electric Power Co. Below is the dynamics of the corresponding prices for the shares of such companies in the period from 01.01.2021 to 27.11.2022. All data are presented on a weekly average (from investing.com).

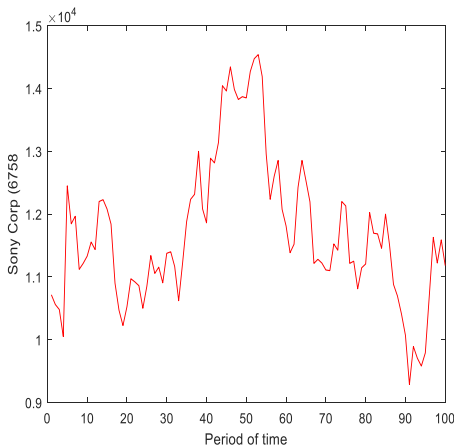Fig. 1 shows the dynamics of stock prices for technology company Sony Corp.

Figure 1: Tech company Sony Corp stock price performance

It should be noted a pronounced maximum in the dynamics of prices for shares of technology company Sony Corp. This maximum is observed in the middle of the studied period of time. Thus, in the first half of the period under study, we observe an increase in the share price of the technology company Sony Corp. In the second half – the dynamics of prices for shares of technology company Sony Corp is decreasing.

The main statistical indicators of the dynamics of prices for shares of technology company Sony Corp are as follows: mean – 11703.76; median – 11445; mode – 11215; standard deviation – 1163.513636; sample variance – 1353763.982; kurtosis – 0.163123459; skewness – 0.642552491.

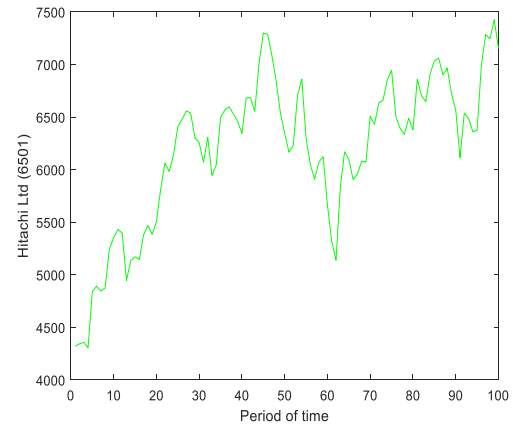Fig. 2 shows the dynamics of stock prices for technology company Hitachi Ltd.

Figure 2: Tech company Hitachi Ltd stock price performance

We see that the dynamics of prices for the shares of technology companies Sony Corp and Hitachi Ltd are different. Share prices for Hitachi Ltd, a technology company, are broadly bullish on the back of some price fluctuations. At the same time, some decline in such quotations can be noted. This decline occurs at the beginning of the second time period that we are exploring.

The main statistical indicators of the dynamics of prices for shares of technology company Hitachi Ltd are as follows: mean – 6177.56; median – 6344; mode – 6539; standard deviation – 728.0048607; sample variance – 529991.0772; kurtosis – 0.113475938; skewness – -0.778051282.

Fig. 3 shows the dynamics of stock prices for technology company Canon Inc.
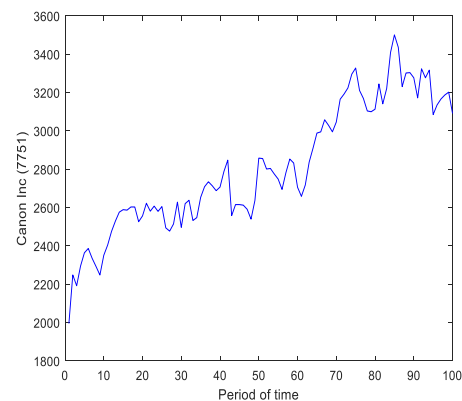

Figure 3: Tech company Canon Inc stock price performance

The share price dynamics of the technology company Canon Inc is increasing. There are no pronounced highs and lows. At the same time, in the last period of time, there has been some decline in the corresponding quotations.

The main statistical indicators of the dynamics of prices for shares of technology company Canon Inc are as follows: mean – 2809.8; median – 2726; mode – 2603; standard deviation –

333.4874038; sample variance – 111213.8485; kurtosis – -0.848875607; skewness – 0.114067086.

Fig. 4 shows the dynamics of stock prices for technology company Alps Electric Co.
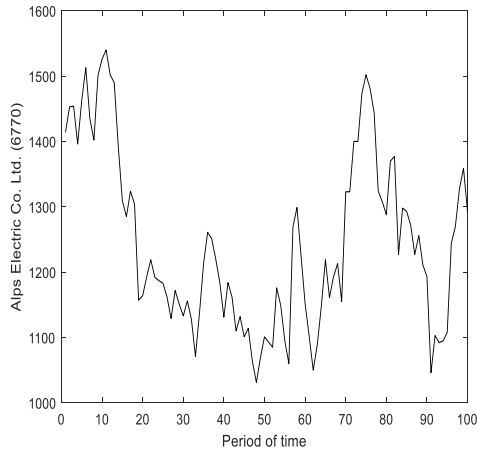
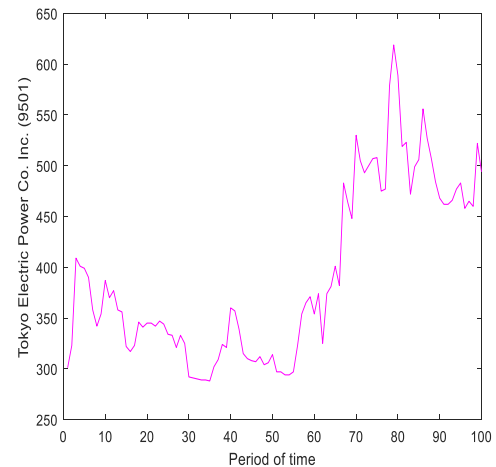**Figure 4:** Tech company Alps Electric Co stock price performance

First of all, it should be noted that Alps Electric Co, a technology company's share price, differs from previous data for other companies. We can also talk about two pronounced highs in such quotes. However, it should also be noted that between these highs, the share prices of the technology company Alps Electric Co are negative with a significant decrease in quotes. Although here we can note some positive bursts of quotes. In general, the share price dynamics of technology company Alps Electric Co is inconsistent in relation to the dynamics of share prices of other companies.

The main statistical indicators of the dynamics of prices for shares of technology company Alps Electric Co are as follows: mean – 1244.26; median – 1216; mode – 1193; standard deviation – 134.8324527; sample variance – 18179.7903; kurtosis – -0.743579411; skewness – 0.54497575.

Fig. 5 shows the dynamics of stock prices for technology company Tokyo Electric Power Co.

The dynamics of prices for shares of technology company Tokyo Electric Power Co in the first two thirds of the study period have some uniform value. Then there is a sharp increase in the stock prices of the company. As a result, the company's stock quotes are slightly reduced.

The main statistical indicators of the dynamics of prices for shares of technology company Tokyo Electric Power Co are as follows: mean – 391.4; median – 358; mode – 323; standard deviation – 85.62120006; sample variance – 7330.989899; kurtosis – -0.761709802; skewness – 0.658154086.

**Figure 5:** Tech company Tokyo Electric Power Co stock price performance

In general, we see a different dynamics of quotations for the shares of technology companies that we study. This is also confirmed by statistical indicators for each dynamics of the corresponding quotes. Thus, it is of some interest to analyze the joint price dynamics of the shares of the various companies that we study.

4. ANALYSIS OF THE MUTUAL DYNAMICS OF PRICES FOR SHARES OF TECHNOLOGY COMPANIES IN JAPAN

One of the approaches that have found wide application for the analysis of economic data is based on the methodology of wavelet analysis [29]-[34]. This approach uses wavelet coherence estimates [35], [36]. It allows you to compare the dynamics of various data and draw certain conclusions for both different horizons of analysis and their depth. Below are some wavelet coherence estimates for the individual data we are considering. Such assessments are presented in the form of separate diagrams. At the same time, we analyze only the relationships between the data and evaluate the strength of such relationships. At the same time, wavelet coherence also makes it possible to estimate the direction of influence of such connections. In this study, we do not consider these areas.
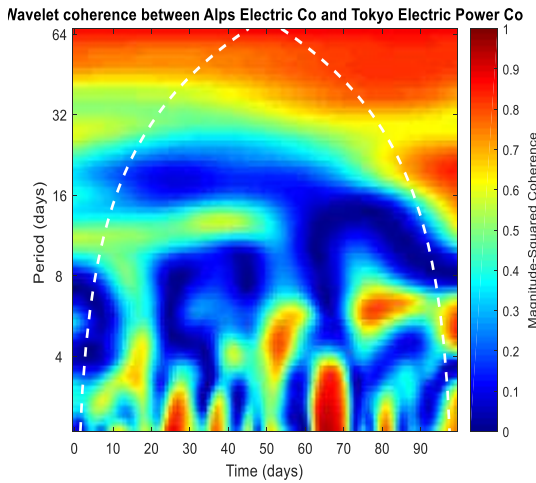
Fig. 6 shows an estimate of the wavelet coherence between the dynamics of prices for shares of technology companies Sony Corp and Hitachi Ltd.

We see that the consistency in share prices for technology companies Sony Corp and Hitachi Ltd is significant in the last third of the time period we study. At the same time, such consistency is also significant in terms of the depth of the corresponding relationships. This can be used to develop various investment strategies, the choice of investment instruments in order to minimize risks.
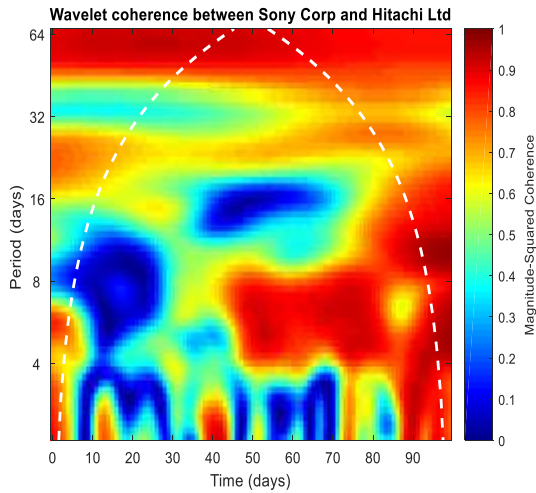
Figure 6: Evaluation of wavelet coherence between the price dynamics of the shares of technology companies Sony Corp and Hitachi Ltd

Fig. 7 shows an estimate of the wavelet coherence between the dynamics of prices for shares of technology companies Alps Electric Co and Tokyo Electric Power Co.
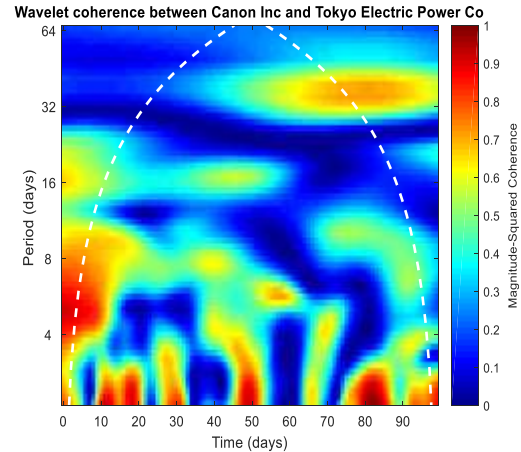

Figure 7: Evaluation of wavelet coherence between the price dynamics of the shares of technology companies Alps Electric Co and Tokyo Electric Power Co

Overall, there is little consistency in share prices for technology companies Alps Electric Co and Tokyo Electric Power Co. At the same time, it should be noted the fragmentation of consistency in the dynamics of prices for shares of technology companies, which we consider in this case. This fragmentation manifests itself in small bursts of high consistency in the share prices of technology companies Alps Electric Co and Tokyo Electric Power Co over the time period

we study. This can be used to determine the time to enter the relevant segment of the stock market.

Fig. 8 shows an estimate of the wavelet coherence between the dynamics of prices for shares of technology companies Canon Inc and Tokyo Electric Power Co.

Figure 8: Evaluation of wavelet coherence between the price dynamics of the shares of technology companies Canon Inc and Tokyo Electric Power Co

Fig. 9 shows an estimate of the wavelet coherence between the dynamics of prices for shares of technology companies Hitachi Ltd and Alps Electric Co.
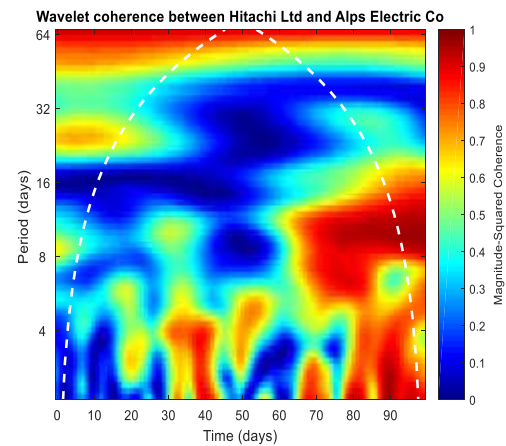
Figure 9: Evaluation of wavelet coherence between the price dynamics of the shares of technology companies Hitachi Ltd and Alps Electric Co

We see that the consistency in share prices for technology companies Canon Inc and Tokyo Electric Power Co is also fragmented. But this fragmentation is more significant than in the previous case. At the same time, the greatest consistency in the dynamics of prices for shares of technology companies

Canon Inc and Tokyo Electric Power Co can be observed at the beginning, in the middle and at the end of the study period.

The greatest manifestation of consistency in the price dynamics of technology companies Hitachi Ltd and Alps Electric Co is typical in the last days of the time period we are considering. Therefore, this fact can also be used to build appropriate investment strategies.

5. CONCLUSION

The paper provides a comparative analysis of the dynamics of prices for shares of technology companies in Japan. Among such companies we consider: Canon Inc, Hitachi Ltd, Sony Corp, Alps Electric Co., Tokyo Electric Power Co. We looked at the dynamics and statistical performance of the stock prices of the relevant technology companies. We also examined the mutual price dynamics of shares of technology companies in Japan. For this, we used wavelet coherence estimates.

The analysis carried out can be useful in developing investment strategies and determining the time to enter the relevant segment of the stock market. The results of the analysis can also be used when choosing investment instruments in the form of shares of technology companies.

6. REFERENCES

[1] Kuzemin, A., & Lyashenko, V. (2008). Analysis of Spatial-temporal Dynamics in the System of Economic Security of Different Subjects of Economic Management. International Journal Information Technologies and Knowledge, 2(3), 234–238.

[2] Kuzemin, A., & et al.. (2005). Analysis of movement of financial flows of economical agents as the basis for designing the system of economical security (general conception). In Third international conference «Information research, applications, and education (pp. 27-30).

[3] Азаренкова, Г., & Ляшенко, В. (2009). Відношення переваг у порівняльній оцінці діяльності банків. Банківська справа, 5, 65-72.

[4] Ляшенко В. В. (2007). Интерпретация и анализ статистических данных, описывающих процессы экономической динамики. Бизнес Информ, 9(2), 108-113.

[5] Bech, M. L., & et al.. (2020). On the future of securities settlement. BIS Quarterly Review, March.

[6] Maume, P., & Fromberger, M. (2018). Regulations of initial coin offerings: reconciling US and EU securities laws. Chi. J. Int'l L., 19, 548.

[7] Sushko, V., & Turner, G. (2018). The implications of passive investing for securities markets. BIS Quarterly Review, March.

[8] Brounen, D., & Eichholtz, P. M. (2003). Property, common stock, and property shares. The journal of portfolio management, 29(5), 129-137.

[9] Rappaport, A., & Sirower, M. L. (1999). Stock or cash?. Harvard business review, 77(6), 147-147.

[10] Ratanapakorn, O., & Sharma, S. C. (2002). Interrelationships among regional stock indices. Review of Financial Economics, 11(2), 91-108.

[11] Sutcliffe, C. M. (2018). Stock index futures. Routledge.

[12] 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.

[13] Lyashenko, V., Bril, M., & Shapran, O. (2021). Dynamics of World Indices as a Reflection of the Development World Financial Market. Dynamics, 5(10), 30-35.

[14] Wen, M., Li, P., Zhang, L., & Chen, Y. (2019). Stock market trend prediction using high-order information of time series. Ieee Access, 7, 28299-28308.

[15] Kijewski, M., & Ślepaczuk, R. (2020). Predicting prices of S&P500 index using classical methods and recurrent neural networks. Work. Pap. Fac. Econ. Sci. Univ. Wars.

[16] 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.

[17] 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.

[18] Lyashenko, V., & et al.. (2018). Defects of communication pipes from plastic in modern civil engineering. International Journal of Mechanical and Production Engineering Research and Development, 8(1), 253-262.

[19] Matarneh, R., & et al.. (2017). Building robot voice control training methodology using artificial neural net. International Journal of Civil Engineering and Technology, 8(10), 523-532.

[20] Lyashenko, V. V., Babker, A. M. A. A., & Kobylin, O. A. (2016). The methodology of wavelet analysis as a tool for cytology preparations image processing. Cukurova Medical Journal, 41(3), 453-463.

[21] Akbar, M., Iqbal, F., & Noor, F. (2019). Bayesian analysis of dynamic linkages among gold price, stock prices, exchange rate and interest rate in Pakistan. Resources Policy, 62, 154-164.

[22] Greenwood, R., Hanson, S. G., & Liao, G. Y. (2018). Asset price dynamics in partially segmented markets. The Review of Financial Studies, 31(9), 3307-3343.

[23] Gardini, L., & et al.. (2022). Causes of fragile stock market stability. Journal of Economic Behavior & Organization, 200, 483-498.

[24] Fischer, G. (2019). How dynamic hedging affects stock price movements: Evidence from German option and certificate markets (No. B-35-19). Passauer Diskussionspapiere-Betriebswirtschaftliche Reihe.

[25] Ahmed, R. I., Zhao, G., & Habiba, U. (2022). Dynamics of return linkages and asymmetric volatility spillovers among Asian emerging stock markets. The Chinese Economy, 55(2), 156-167.

[26] Sirignano, J., & Cont, R. (2019). Universal features of price formation in financial markets: perspectives from deep learning. Quantitative Finance, 19(9), 1449-1459.

[27] Yu, P., & Yan, X. (2020). Stock price prediction based on deep neural networks. Neural Computing and Applications, 32(6), 1609-1628.

[28] Shah, D., Isah, H., & Zulkernine, F. (2019). Stock market analysis: A review and taxonomy of prediction techniques. International Journal of Financial Studies, 7(2), 26.

[29] Gallegati, M. (2008). Wavelet analysis of stock returns and aggregate economic activity. Computational Statistics & Data Analysis, 52(6), 3061-3074.

[30] Aloui, C., Hkiri, B., Hammoudeh, S., & Shahbaz, M. (2018). A multiple and partial wavelet analysis of the oil price, inflation, exchange rate, and economic growth

nexus in Saudi Arabia. Emerging Markets Finance and Trade, 54(4), 935-956.

[31] 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.

[32] 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.

[33] 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.

[34] Shelud′ko, N., & et al.. (2020). Gold and Bitcoin Price Dynamics as a Reflection of Investor Sentiment. Journal La Bisecoman, 1(4), 19-25.

[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.