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Comparative Analysis of Price Dynamics for Shares of HelloFresh SE, Danone SA, Coca-Cola Co and McDonald's

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Abstract: *Comparative analysis is one of the data mining methods. Such an analysis allows not only comparison between different data, but also to evaluate the dynamics of such data. Thus, there is a comparison of the dynamics of changes in various data. This is an important point in the analysis of the processes and phenomena that we study. This aspect of the analysis is of particular importance when considering economic dynamics, where it is important to know the various details of the development of the relevant processes or phenomena. Based on this, the paper considers the issues of a comparative analysis of the dynamics of prices for shares of various business entities. This direction of research was chosen because the stock market plays an important role in the development of the economy, as a separate country, and in the development of economic relations between countries. At the same time, the dynamics of prices for shares of individual companies determines the overall dynamics of the corresponding stock indices. This allows us to say that the analysis of the dynamics of stock prices is the analysis of primary data. Such an analysis allows obtaining additional information and expanding the field of research. To conduct the relevant analysis, we consider the dynamics of stock prices for HelloFresh SE, Danone SA, Coca-Cola Co and McDonald's Corporation. The paper presents the corresponding graphs of the dynamics of stock prices, which allow you to understand and consider the general trends of a certain segment of the stock market. To conduct a comparative analysis, we use the wavelet methodology. Among the various wavelet methodology approaches, we use wavelet coherence. This allows a comparative analysis of data for different time horizons. The paper shows estimates of wavelet coherence for various data that describe the dynamics of prices for the corresponding shares. Such estimates are presented in the form of graphic diagrams that help to understand the logic of the study and interpret the results. The obtained results also allow us to formulate various strategies for potential investors.*

Keywords—comparative analysis; stock; price; wavelet methodology; wavelet coherence; dynamics; stock market

1. INTRODUCTION

The analysis of economic data is one of the areas to which close attention is paid. For such an analysis, both primary and secondary data can be used. As a result, such an analysis allows us to describe and explore the economic dynamics of various complex processes [1], [2]. This allows us to understand the processes and phenomena that occur in the sphere of economic relations. As a result, it becomes possible to influence economic development in the required direction. Then it is possible to raise the level of economic relations, the effectiveness of mutual influence on various economic processes, and achieve sustainable development. Among such processes and phenomena may be the analysis of banking [3]-[5], the movement of financial flows [6]-[9], the relationship between individual business entities [10], international relations [11], [12], and much more. This determines the relevance and importance of this study.

At the same time, among the objects of study that describe various economic relations, processes in the stock markets should be singled out. These studies make it possible to assess the relationship between different business entities, the processes of pricing for various goods, the movement of individual financial flows, the formation of investor sentiment, and the development of international relations [12]-[14]. This is due to the fact that the stock market is able to attract free financial resources and redistribute such resources among all participants in market relations [13], [14].

First of all, the stock market ensures the movement of securities of various business entities in the conditions of free market relations. A reflection of this movement of securities is the values of various stock indices. At the same time, it should be taken into account that the formation of the values of stock indices depends on the price dynamics for the corresponding securities included in such indices. Thus, the analysis of the dynamics of prices for securities of various business entities is an analysis of primary data. Such an analysis allows you to understand the basics of the dynamics of stock indices, to obtain additional information for deeper research. In this case, various methods and approaches that have found application in other areas of research can be used [15]-[19].

Thus, the main purpose of this work is to study the dynamics of prices for shares of individual business entities. At the same time, an important point is also the analysis of the mutual dynamics of share prices from the point of view of different business entities (companies, firms).

2. RELATED WORK

Many works have been devoted to the analysis of price dynamics in the stock market. This indicates the interest that this topic causes among researchers. Thus, this highlights the importance of an appropriate analysis, which is defined for the purposes of our work. Before proceeding to a brief analysis of existing works on the research topic, we note that such works can be divided into two large groups:

one of these groups considers the dynamics of shares of various companies on the stock market, the interaction of the prices of such shares with other stock market instruments;

another group studies the dynamics of changes in the values of stock indices, where company shares form the basis of certain stock indices.

K. H. Al-Yahyaee, W. Mensi and S. M. Yoon in their study conduct a comparative analysis of the stock market, currency, gold and bitcoins [20]. The authors consider the efficiency, multifractality and long-term memory properties of the relevant stock market instruments. For such a study, the MF-DFA approach was applied [20]. The paper shows that signs of long memory and multifractality are characteristic of all segments of the stock market. This indicates the presence of a relationship between such market segments.

J. Sirignano and R. Cont consider various issues of pricing in financial markets [21]. At the same time, the key direction of this study is to conduct a comparative analysis, which allows us to identify the characteristic features of such pricing. To do this, the authors use a large-scale deep learning approach applied to a high-frequency database containing billions of market quotes and transactions for US stocks [21]. The paper also shows that a generic model trained on data for all stocks outperforms asset-specific models trained on the time series of any particular stock [21]. This allows you to draw generalized conclusions, which helps in the activities of potential investors. At the same time, the paper shows that standard data normalization does not improve the results.

D. P. Gandhmal and K. Kumar in their study conduct a systematic analysis, give a detailed overview of various methods for forecasting the stock market [22]. At the same time, special attention is paid to a comparative analysis of the dynamics of indicators of various stock market instruments. Among the various methods for analyzing and forecasting the stock market, the authors distinguish: a Bayesian model, a fuzzy classifier, artificial neural networks, a support vector classifier, and machine learning methods [22]. The authors also conclude that the analysis and forecasting of the stock market is a very difficult task, and for a more accurate and efficient forecasting of the future market, various factors should be taken into account [22].

R. Ren, D. D. Wu and T. Liu analyze the dynamics of prices in the stock market [23]. To do this, the authors take into account the mood of potential investors, and also use the support vector machine. The work also takes into account the time factor of entering the stock market. In general, this approach allows making optimal decisions for potential investors.

C. Kwofie and R. K. Ansah consider the relationship between the dynamics of prices in the stock market and inflation, the dynamics of the exchange rate in Ghana [24]. For such an analysis, we used autoregressive analysis and the method of cointegration with distributed delay. We also use the parameterization of the ARDL model with error correction [24]. The result of the study showed that there is a significant long-term relationship between market returns and inflation. However, there was no significant short-term relationship between them. The result also showed a significant long-term and short-term relationship between GSE market returns and the exchange rate [24]. This data is important for potential investors, adopting the most effective stock market entry strategies.

P. Chen conducts a study of price movements in the international stock market [25]. At the same time, such a study is carried out in a comparison of developed and emerging markets. The author uses the Bayesian dynamic model of the latent factor to study the accompanying movements of stock markets simultaneously throughout the world and in different regions [25]. The paper shows that the common global factor is an important source of fluctuations for most markets. At the same time, the author notes that the role of global and regional factors differs significantly in the stock markets in different regions, as well as between developed and emerging markets [25]. These results are important in decision making for potential investors.

X. Xu, S. Huang and H. An consider the relationship between stock prices and exchange rate dynamics [26]. For analysis, the authors use modified methods VAR, GARCH. At the same time, a more flexible non-linear model is used to study the dynamic moderating effect of the exchange rate market on the relationship with stock and oil prices [26]. The authors consider different scenarios of the mutual influence of the dynamics of exchange rates on the dynamics of stock prices. This is an important point in decision making for potential investors.

K. A. L. E. Süleyman, M. H. Eken and İ. G. Kaya explore the relationship between banking efficiency and stock returns on the Turkish stock market [27]. In this case, the authors use a two-stage model. The Malmquist Performance Index is used to measure various aspects of performance. Static and dynamic panel data models are then used to investigate the impact of efficiency changes [27]. This approach allows us to explore more deeply the relationship between banking efficiency and stock returns. This allows you to make more efficient decisions.

S. Liu, G. Liao and Y. Ding explore the issues of stock price volatility, which is a very difficult task, since such a process is a complex nonlinear dynamic system [28]. To do this, the authors use a recurrent neural network in time, which

is suitable for processing and predicting important interval events and large delays in time series [28]. This allows you to get more accurate results, make informed decisions.

We see that various methods and approaches are used to analyze stock prices. At the same time, comparative analysis is an important aspect. This allows you to more deeply explore the dynamics of stock prices and make optimal decisions.

3. Wavelet Coherence as a Tool for the Analysis of Empirical Data

First of all, it should be noted that the dynamics of stock prices can be represented as a time series. Such a series will describe the dynamics of prices on different time horizons.

One of the tools for time series analysis is the wavelet methodology [29]-[31]. This methodology allows you to explore the time series, taking into account different time horizons. Wavelet coherence should be singled out among such methodology. Wavelet coherence is widely used to analyze economic data, which are presented as time series [32]-[34]. Wavelet coherence makes it possible to evaluate the mutual dynamics of different time series. This is an important point in conducting a comparative analysis. At the same time, such a comparison can be made for different time periods. This makes it possible to understand the dynamics of mutual changes in the data being studied.

So if we have two series of data ($f(t)$ and $h(t)$), each of which reflects the dynamics of an indicator over time t, then we can determine the value of wavelet coherence between the following series of data using the following formula [35]-[37]:

$$Q^2(a,b) = \frac{\left|\Xi(a^{-1}W_{f(t)h(t)}(a,b))\right|^2}{\Xi(a^{-1}\left|W_{f(t)}(a,b)\right|^2)\Xi(a^{-1}\left|W_{h(t)}(a,b)\right|^2)}$$

where:

$W(a,b)$ – values of transverse wavelet spectra,

a,b – the scale and center of time localization that determine the scale of the wavelet transform,

$f(t)$, $h(t)$ – series of data that we study,

Ξ – smoothing operator,

$Q^2(a,b)$ – square of the wavelet coherence coefficient. $0 \le Q^2(a,b) \le 1$. If these values tend to zero, then we have a weak correlation. Otherwise we have a strong correlation [38]-[40].

4. Data for Analysis

Consider the dynamics of stock prices of some companies. In this case, we will consider companies that belong to the same field of activity. Among such companies for our study, we have chosen:

HelloFresh SE (HFGG) – German public food and grocery delivery company;

Danone SA (DANO) – French food company, manufacturer of dairy products and other food products;

Coca-Cola Co (KO) – American food company, the world's largest manufacturer and supplier of concentrates, syrups and soft drinks;

McDonald's Corporation (MCD) – American food service corporation and the world's largest chain of fast food restaurants.

We consider the data for the period from 03.01.2021 to 19.06.2022 on a weekly average. All data from the site https://www.investing.com/.

On Fig. 1 shows the stock price dynamics of HelloFresh SE (HFGG).

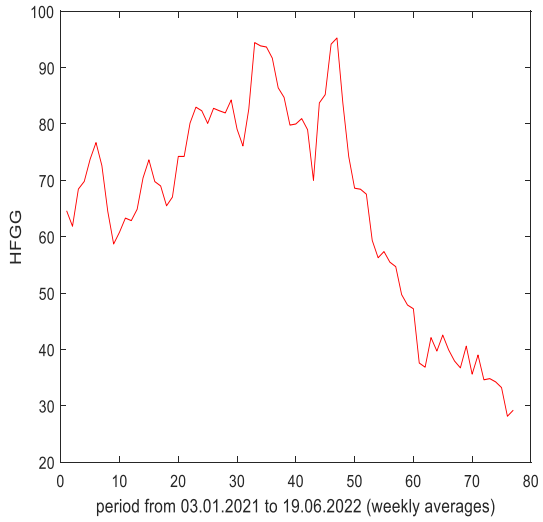

Figure 1: HelloFresh SE (HFGG) stock price performance

We can see that HelloFresh SE (HFGG) stock price performance is up in the first half of the period we are examining. At the same time, such growth in share prices is variable. In the second half of the period that we study, there is a decrease in the prices of the respective shares. At the same time, such a decrease is sharp and significant.

On Fig. 2 shows the stock price dynamics of Danone SA (DANO).

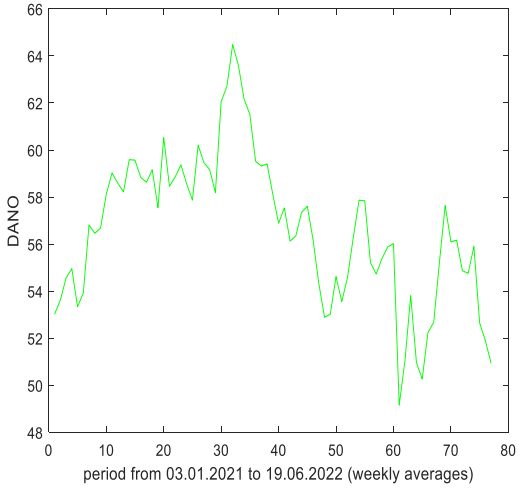

Figure 2: Danone SA (DANO) stock price performance

We see that Danone SA (DANO) share prices are generally variable. First, there is a price increase, then there is a price decrease, and again a slight increase. At the same time, Danone SA (DANO) share price dynamics differs from HelloFresh SE (HFGG) share price dynamics. This is because these are slightly different segments of the same market, as well as different spheres of influence, which are determined by the origin of the main companies.

On Fig. 3 shows the stock price dynamics of Coca-Cola Co (KO).

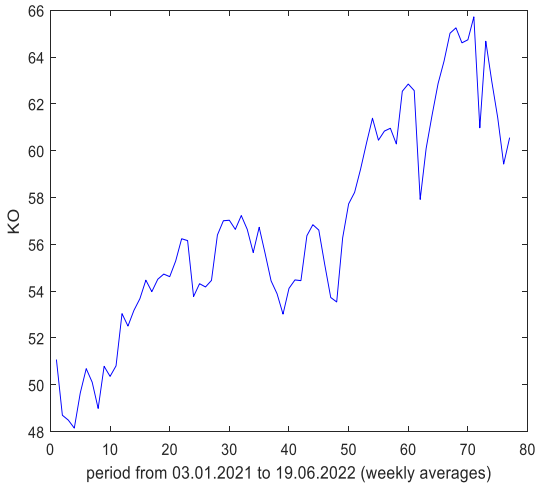

Figure 3: Coca-Cola Co (KO) stock price performance

Coca-Cola Co (KO) share price action differs from HelloFresh SE (HFGG) share price action and Danone SA (DANO). We can see an overall rise in Coca-Cola Co (KO) stock prices. But you can also observe periods when there is a decrease in the price of shares of Coca-Cola Co (KO).

On Fig. 4 shows the stock price dynamics of McDonald's Corporation (MCD).

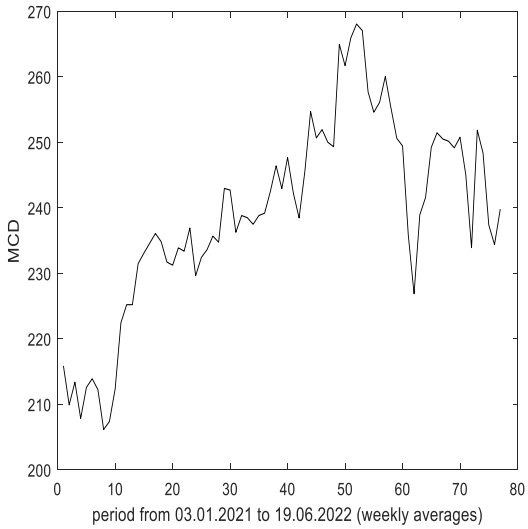

Figure 4: McDonald's Corporation (MCD) stock price performance

We see McDonald's Corporation (MCD) share prices moving up in the first two-thirds of the period we are looking at. Next, we see a decline in McDonald's Corporation (MCD) stock prices.

Thus, the presented graphs of the dynamics of prices for the shares of some companies generally differ from each other. But it is also possible to single out some periods when we observe approximately the same trends in the dynamics of stock prices of the companies that we study. This is an important factor for an appropriate comparative analysis.

5. Wavelet Coherence Estimates as a Result of Comparing the Dynamics of Stock Prices

The basis of a comparative analysis of the dynamics of stock prices is the analysis of wavelet coherence estimates. To do this, we consider wavelet coherence estimates for each pair of the corresponding stock price dynamics and analyze them.

On Fig. 5 shows wavelet coherence estimates for HelloFresh SE (HFGG) and Danone SA (DANO).

We see that a stable relationship in the dynamics of stock prices for HelloFresh SE (HFGG) and Danone SA (DANO) is observed in the middle of the study period. Such a stable relationship was typical for short time intervals. Also, a stable relationship is observed at the beginning and at the end of the period that we are studying. However, this relationship is short-lived.

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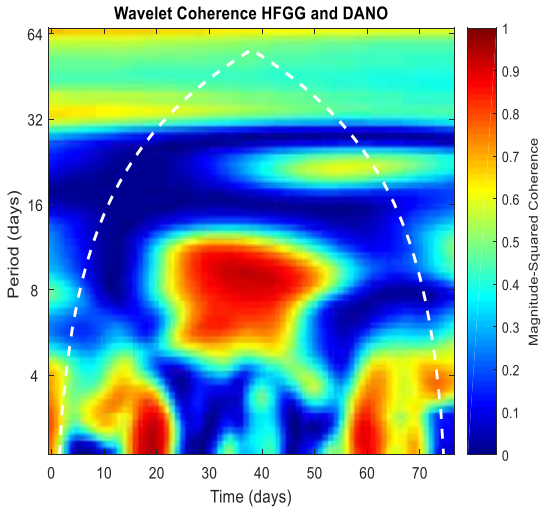

Figure 5: Wavelet coherence estimates for HelloFresh SE (HFGG) and Danone SA (DANO)

On Fig. 6 shows wavelet coherence estimates for HelloFresh SE (HFGG) and Coca-Cola Co (KO).

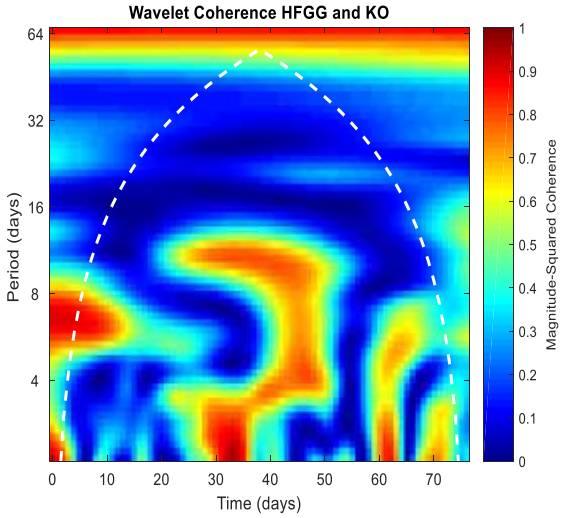

Figure 6: Wavelet coherence estimates for HelloFresh SE (HFGG) and Coca-Cola Co (KO)

The wavelet coherence estimate for HelloFresh SE (HFGG) and Coca-Cola Co (KO) is structurally similar to the previous estimate. However, shorter periods of association between HelloFresh SE (HFGG) and Coca-Cola Co (KO) should be pointed out. At the same time, such periods can cover the manifestation of the relationship in wider time horizons.

On Fig. 7 shows wavelet coherence estimates for HelloFresh SE (HFGG) and McDonald's Corporation (MCD).

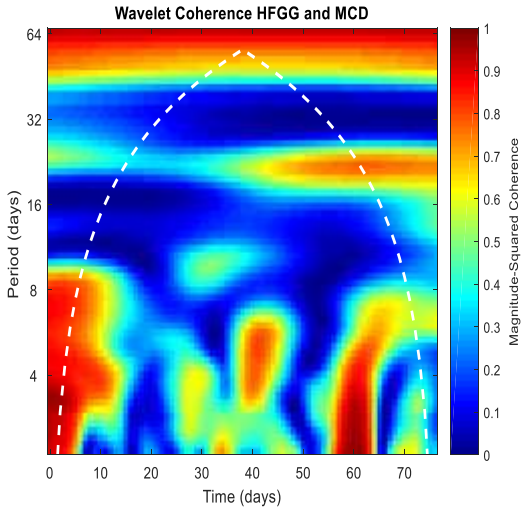

Figure 7: Wavelet coherence estimates for HelloFresh SE (HFGG) and McDonald's Corporation (MCD)

We see that the estimates of wavelet coherence between HelloFresh SE (HFGG) and McDonald's Corporation (MCD) are less significant than those considered earlier. The relationship between HelloFresh SE (HFGG) and McDonald's Corporation (MCD) was greatest at the end of the study period. At the same time, we can note some structural similarity between the wavelet coherence estimates that we considered above.

On Fig. 8 shows wavelet coherence estimates for Danone SA (DANO) and Coca-Cola Co (KO).

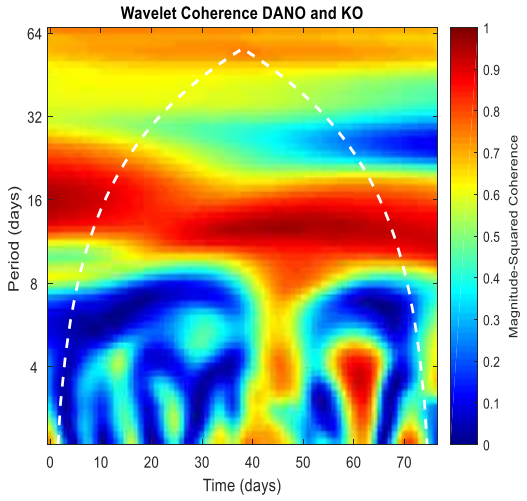

Figure 8: Wavelet coherence estimates for Danone SA (DANO) and Coca-Cola Co (KO)

The wavelet coherence estimates between Danone SA (DANO) and Coca-Cola Co (KO) are characterized by the presence of a relationship, taking into account longer time

intervals. This can be taken into account when determining a market entry strategy for potential investors.

On Fig. 9 shows wavelet coherence estimates for Danone SA (DANO) and McDonald's Corporation (MCD).

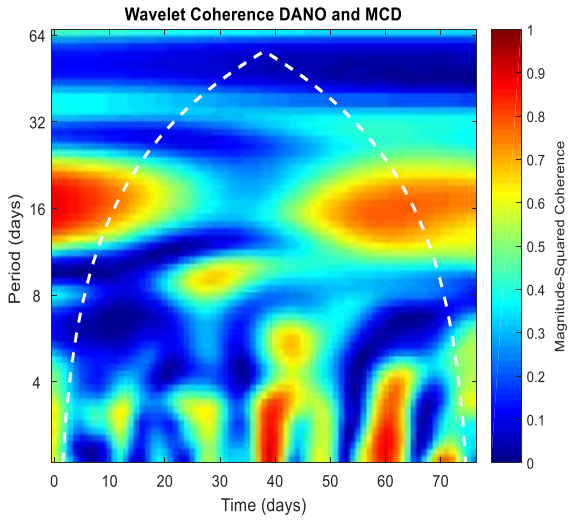

Figure 9: Wavelet coherence estimates for Danone SA (DANO) and McDonald's Corporation (MCD)

It should be noted that the relationship between Danone SA (DANO) and McDonald's Corporation (MCD) is fragmented.

On Fig. 10 shows wavelet coherence estimates for Coca-Cola Co (KO) and McDonald's Corporation (MCD).

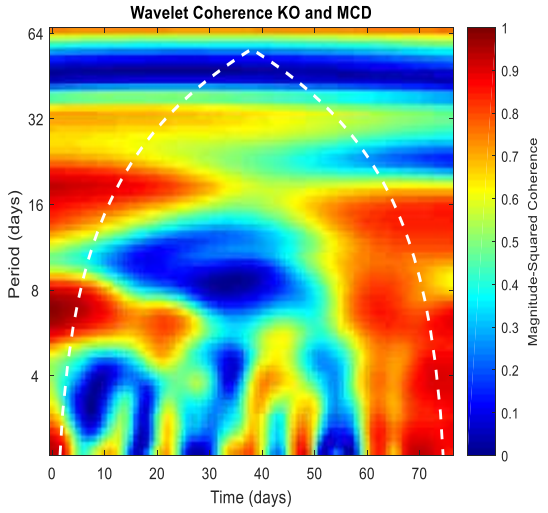

Figure 10: Wavelet coherence estimates for Coca-Cola Co (KO) and McDonald's Corporation (MCD)

We see that the wavelet coherence estimates between Coca-Cola Co (KO) and McDonald's Corporation (MCD) are the most significant for most of the periods in the interval we are examining. At the same time, this relationship is most pronounced in the last intervals of the period that we are studying. It is also important information for investors when choosing the appropriate market entry strategy.

6. Conclusion

The paper considers the issues of conducting a comparative analysis for economic data. Such a comparison was made for data representing the dynamics of stock prices. We look at the stock prices of HelloFresh SE, Danone SA, Coca-Cola Co and McDonald's Corporation.

For the analysis, we use wavelet coherence estimates. The paper presents the results of comparison in the form of graphic diagrams. This can be the basis for developing stock market entry strategies for potential investors.

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