An Exploration of the Correlation of Stock Prices of Representative Firms in Different Sectors

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Abstract: The analysis of correlations of different company stock prices and offer the investment suggestions are the key interest of this paper. In this paper, we re-examine the stock price of selected companies in the span of 2018-2023, and focused on exploring the variations of the price during the covid-19. The wavelet coherence method allow us to find out the correlation and distinct between the companies we choose. In this method, we can characterize how stock price relate in the time and frequency domains, simultaneously. We concentrate in the Exxon Mobil, Amazon, Nike, Apple, Tesla, Walmart and Berkshire Hathaway.

Keywords: Wavelet coherence,stock price,invest,investment portfolio,Covid-19

1.Introduction

With the gradual development of social productivity, all walks of life have developed significantly, and in the process of development, these industries have also given birth to leading companies in their industries. In this post, I have selected the leading company in the energy industry: ExxonMobil, the giant in the technology industry sector: Apple, the representative company in the retail industry: Amazon, the emerging representative company in the automotive industry: Tesla, and the giant in the sporting goods sector: Nike, and used wavelet correlation method to do the correlation analysis between them in order to explore the connection of the share prices between them. In terms of time, I used data from January 2018 to September 2023, so that the timeline, which includes both the pre-epidemic timeline and covers the time period during and after the epidemic, is chosen in a way that is conducive to seeing how sensitive the industries are to the market and how well or poorly the relevant companies have responded to the market during this very specific time period of the epidemic.

Share price correlations between different companies can be effect by multiply factors, including the industry, market factors, the company's business model and global economic factors. Understanding these correlations and influencing factors is critical to investment decision-making and risk management. Based on the study, we find that the following conclusions are drawn. In 2020 and 2023, there is a strong correlation between ExxonMobil and Amazon, suggesting a strong interdependence between the two companies. The correlation between the two companies is weak from 2021 to 2022, especially at a time scale of 64, mainly due to the impact of the COVID-19 pandemic on the economy and the industry, as well as ExxonMobil's business being hit by a demand decline, while Amazon has benefited from the growth of e-commerce. The stock price correlation between Tesla and Apple is primarily a long-

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term correlation that manifests itself more in the long term than the short term. Possible reasons include technological dependence, investor sentiment, and technology and industry crossover. There is a strong long-term correlation between Nike and Walmart, especially in the timeframe leading up to 2021.Possible reasons include the cyclical nature of the retail business, supply chain and raw material prices, consumer trends, and global economic factors.

The remainder of this paper is organized as follows. Section 2 describes the related literature and research motivations Section 3 illustrates the data and methodology. Finally, Empirical analyse and Conclusion and Implications for investors and write in section 4 and 5 respectively.

2.Related Literature and Research Motivations

In the essay, we reconsider the stock price co-movement among the several leading company through a original approach, wavelet coherence. This method constitutes a very outstanding tool as is represents a refinement in terms of analysis in the sense that both time and frequency domains are taken into account. Although wavelet coherence have already prevalence in signal and image processing, physics, and so forth, many researcher employed this method to analysis stock price correlation, [5][6]Ramsey, J. B., & Zhang, Z. (1996). The application of wave form dictionaries to stock market index data. In Predictability of complex dynamical systems (pp. 189-205). Berlin, Heidelberg: Springer Berlin Heidelberg.The pioneer work of [7]Ramsey, J. B., & Lampart, C. (1998). Decomposition of economic relationships by timescale using wavelets. Macroeconomic dynamics, 2(1), 49-71. employ wavelet coherence to find out the relationship among different macroeconomic factors for example, [8]Crowley, P. M. (2007). A guide to wavelets for economists. Journal of Economic Surveys, 21(2), 207-267.for a survey. [1]Aloui, C., & Hkiri, B. (2014). Co-movements of GCC emerging stock markets: New evidence from wavelet coherence analysis. Economic Modelling, 36, 421-431. In particular, wavelet analysis provides a unified framework to measure co-movement in the time–frequency space.

In the paper, A large number of scholars provide several applications, which are related to wavelet correlation. [2]Rua, A., & Nunes, L. C. (2009). International comovement of stock market returns: A wavelet analysis. Journal of Empirical Finance, 16(4), 632-639.used wavelet squared correlation to analyse the co-movement of stock composite indices in several major international markets between 1973 and 2007, including Japan, the United States, Germany and the United Kingdom. The authors concluded that frequency is the determinant of cross-correlation between stocks. Furthermore, they show that co-movements are stronger at lower frequencies. This also evidences that portfolio diversification may be more essential from a financial perspective in the short term. The same approach can be used to analyse sectoral indices. The authors find that some specific sectors, such as technology and consumer goods, show strong cross-correlations at specific frequencies and time periods.

[3]Ranta, M. (2013). Contagion among major world markets: a wavelet approach. International Journal of Managerial Finance, 9(2), 133-149. uses the same methodology to examine contagion in major world stock markets over the last 25 years. The authors provide strong evidence of co-movement on different time scales. As a result, the correlation on the short-term scale increased during several major crises, while the correlation on the long-term scale remained more or less unchanged. The findings of [3]Ranta, M. (2013). Contagion among major world markets: a wavelet approach. International Journal of Managerial Finance, 9(2), 133-149.are very similar to the

conclusions given by [4]Sharkasi, A., Crane, M., Ruskin, H. J., & Matos, J. A. (2006). The reaction of stock markets to crashes and events: A comparison study between emerging and mature markets using wavelet transforms. Physica A: Statistical Mechanics and its Applications, 368(2), 511-521. These authors propose a new methodology called Discrete Wavelet Transform's (DWT) to assess the common volatility of international stock markets by reconstructing the volatility components. The authors conclude that emerging financial markets react differently to financial crises than developed markets. Developed markets need to recover in less than one month, whereas emerging markets may take up to two months. In addition, they report that developed stock markets had a higher degree of co-volatility during the recent financial crisis, which was attributed to the strong cooperative behaviour of shareholders in selling and buying shares [4]Sharkasi, A., Crane, M., Ruskin, H. J., & Matos, J. A. (2006). The reaction of stock markets to crashes and events: A comparison study between emerging and mature markets using wavelet transforms. Physica A: Statistical Mechanics and its Applications, 368(2), 511-521.

Given that our chosen time span covers the very important period of the Covid-19 pandemic, the impact of the outbreak on the company's share price was also taken into account. Lately, a wide variety studies have issued to report the effect of covid-19. For example, the influence of the pandemic on stock markets ([10]Zhang, D., Hu, M., & Ji, Q. (2020). Financial markets under the global pandemic of COVID-19. Finance research letters, 36, 101528.; [11]Akhtaruzzaman, M., Boubaker, S., & Sensoy, A. (2021). Financial contagion during COVID–19 crisis. Finance Research Letters, 38, 101604.; [12]Shehzad, K., Xiaoxing, L., & Kazouz, H. (2020). COVID-19's disasters are perilous than Global Financial Crisis: A rumor or fact?. Finance research letters, 36, 101669.;[13]Leduc, S., & Liu, Z. (2020). The uncertainty channel of the coronavirus. FRBSF Economic Letter, 7, 1-05.; [14]Sharif, A., Aloui, C., & Yarovaya, L. (2020). COVID-19 pandemic, oil prices, stock market, geopolitical risk and policy uncertainty nexus in the US economy: Fresh evidence from the wavelet-based approach. International review of financial analysis, 70, 101496.), they mainly concentrate investigating the negative effects of the COVID-19 pandemic on the economy. In particular, the characteristics of the pandemic are discussed in comparison to the global financial crisis (GFC) of 2008 (e.g [12]Shehzad, K., Xiaoxing, L., & Kazouz, H. (2020). COVID-19's disasters are perilous than Global Financial Crisis: A rumor or fact?. Finance research letters, 36, 101669.; [15]Laing, T. (2020). The economic impact of the Coronavirus 2019 (Covid-2019): Implications for the mining industry. The extractive industries and society, 7(2), 580-582.; [16]Yarovaya, L., Matkovskyy, R., & Jalan, A. (2021). The effects of a "black swan" event (COVID-19) on herding behavior in cryptocurrency markets. Journal of International Financial Markets, Institutions and Money, 75, 101321.). In terms of investment portfolio, [9]Levy, H., & Sarnat, M. (1970). International diversification of investment portfolios. The American Economic Review, 60(4), 668-675. suggested in they paper that the international diversification has the salutary effect toward improving the overall gain of a investment portfolio. In our paper, we try to use wavelet coherence method to find out the relationship between selected company and provide some instructions to the investor, and Broadly analysing the impact of the epidemic on individual companies

3.Data And Methodology

3.1 Data

The data, presenting in fig 1, was selected to include the closing stock prices of seven leading

companies in various sectors, including Amazon, Walmart, Tesla, ExxonMobil, Berkshire Hathaway, Nike and Apple. The source of all the data is a well-known financial website, Yahoo Finance. The data spans January 2018 to August 2023. For the selection of companies, the companies I chose all play a sufficiently leading role in their respective fields, and can be considered as benchmarks in their respective fields, which can fully represent the field they belong to. At the same time, our choice of time also covers data from before and after the epidemic era, and the developmental stages of the epidemic, which can reflect the performance of each company and its field during the epidemic.

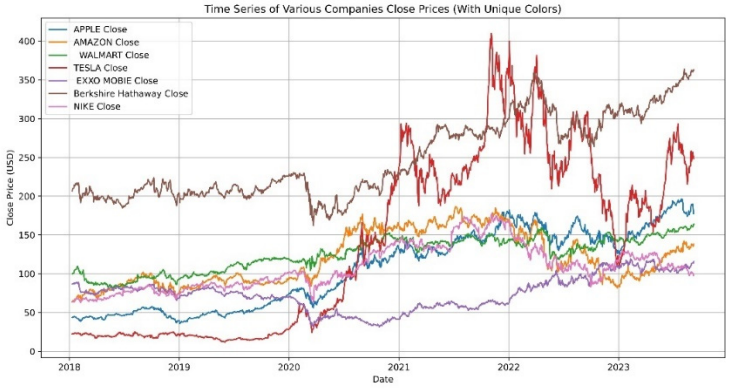

Fig 1 Time series of various companies close prices

3.2 The wavelet coherence (WC)

The link between these seven companies can be analysed over time scales by considering a widely implemented methodology that does not take into account the time series, i.e. wavelet coherence. In fact, the cross-wavelet power and cross-wavelet transform (CWT) were first defined. Torrence and Compo (1998) pointed out that the cross wavelet transform can be expressed in terms of the dual time series a(t) and b(t) to clarify as:

$$.N_{ab}(p,q) = N_{a(p,q)}N^{*}_{b(p,q)} \quad (1).$$

where $N_{ab}(p,q)$ and $N_b(p,q)$ denote two successive transformations of a(t) and b(t), respectively, p denotes the position indicator, q denotes the measure, and the composite conjugate is denoted by (*). The cross-wavelet transform can be used to calculate the wavelet power by $|N_a(p,q)|$. The cross-wavelet power spectrum separates, relative to the time series under consideration, the portion of the domain that shows a strong concentration of energy (a cumulus cloud of suppressed variance) in the domain associated with the time-frequency. The Wavelet Phase Thousand Technique (WCT) allows the identification of specific parts of the time-frequency domain where unexpected and significant changes in the observed co-motion patterns of the time series occur. The adjusted wavelet phase thousand coefficient equation determined by Torrance and Webster (1998) is as follows:

$$W^2(p,q) = \frac{|M(M^{-1}Nab(p,q)^2|}{M(M^{-1}|Na(p,q)|^2)M(M^{-1}|N_{b(p,q)}|^2)} \quad (2)$$

where M is the smoothing mechanism. Where $0 \leq W^2(p,q) \leq 1$ denotes the square van country of the wavelet phase thousand coefficients. Close to zero indicates that the correlation does not exist, while close to unity indicates high correlation. Monte Carlo methods were used to test the hypothetical assignment of wavelet phase chirality.

4.Empirical Analysis

In this section, we present the wavelet coherency between different companies for each sector to investigate the interdependence between them.

Fig present the estimated wavelet coherence and the relative phasing of two series represented by arrows. Time and frequency are presented on the horizontal (time period from January 2019 to September 2023) and the vertical axis, respectively. Frequency is limited to days. On the wavelet coherence plots, the black contour shows the 5% significance level, and regions with strong co-movements are represented by warmer colors (red), whereas colder colors (blue) represent regions with weak co-movements. The arrows provide the direction of interdependence and causality relationships. Arrows pointing to the right (→) indicate that xxx and xxx are positively correlated. Arrows pointing to the left (←) indicate that two compare companies are negatively correlated. The (↗) and (↙) arrows mean that the former company in the graph is leading of the latter company, whereas the (↘) and (↖) arrows indicate that one leads another. The straight up (↑) and down (↓) arrows imply that the front company is leading and lagging, respectively.

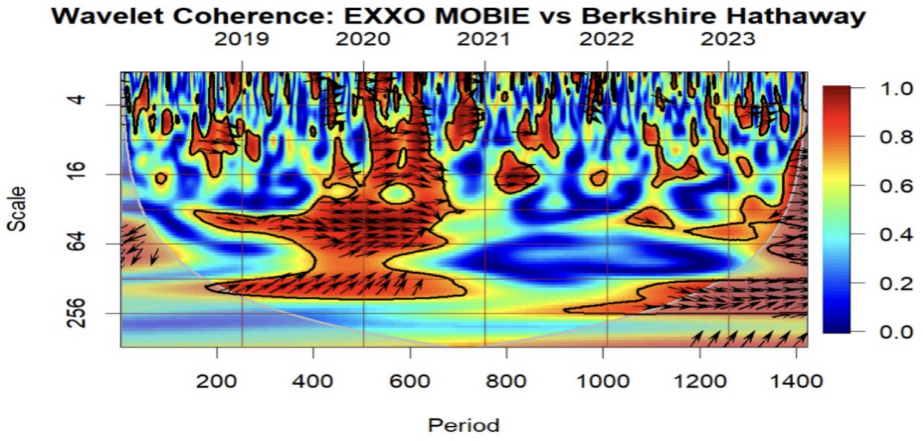

Fig 2 Exxo Mobile verse Berkshire Hathaway wavelet coherence

In the figure 2 , the red area on the middle and the right of the wavelet coherence indicates strong interdependence, while the bule area is distributed in the central part. In other words, we can see that these two companies have very strong intercorrelation in 2020 and 2023. However, during the period of 2021 to 2022 (covid-19 pandemic breaking off), the interconnection between this two companies are very weak, especially in the time scale of 64. In the light to the EXXO

MOBILE's main business is oil and gas, and largely urge slump of oil products, a phenomenon called demand destruction show up. Therefore, lots of oil production have no place to go, because the oil product container capacity can not meet the surplus of the manufacture. So EXXO MOBIE's experienced Sharp drop in share price during that time. However, in consideration of Berkshire Hathaway is a investment company ruling by Famed investor Warren Buffett, who is good at changing company's investment portfolio to Resist market risks, so the share price of that wasn't affected as much as Exxon Mobil.

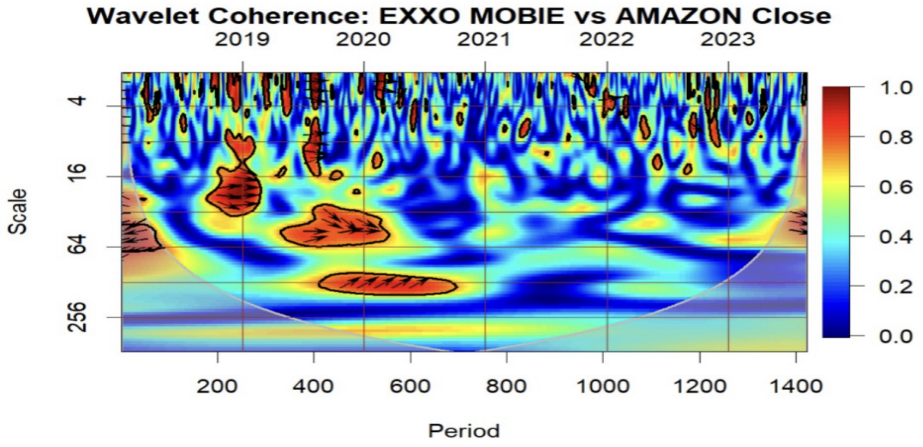

Fig 3 Exxo Mobile verse Amazon wavelet coherence

In the figure 3 , the intercorrelation of EXXO MOBIE and AMAZON are very weak in most area in the picture after 2020, this largely because EXXO MOBIE's stock price slumping as the result of the pandemic. We all known that during the 2020 and 2023, there was a very widespread and far-reaching epidemic, which directly induce the oil price slumping into an extremely low price. So that this slump results the EXXO MOBIE, major business is oil and gas, directly proportional down with oil price. By contrast, AMAZON's stock price increased during that time, because the industry, e-commerce in which their company operates experienced an unprecedented development, so, many technology company enjoyed the dividends of this revolution. So, in the picture, the area with the highest correlation is in the year before 2021, especially in three areas, which were scale of 16 in 2019, scale of 64 in 2020, and scale of middle side of 256 and 64 in 2020. Basically, because the different business model, professional work and main business, these two companies these two companies have multiple discrepancies in sentiment reflection toward the market.

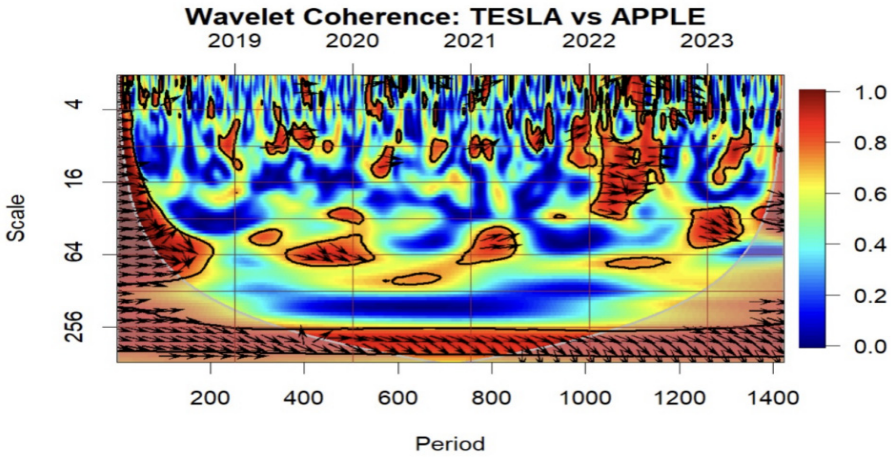

Fig 4 Tesla verse Apple wavelet coherence

Most area in the figure 4 are red, this means TESLA's stock price correlation with Apple frequently. Moreover, the correlation are reflected in long term more often than short term. This largely because the company as TESLA and APPLE will invest a large amount of money into product development, which need to long time to get the pay. So, in the long-run, these two company have very strong correlation in stock price. Meanwhile, I suppose that there are three possible reasons could explain why there have so strong long term correlation. 1. Technology dependence: both Tesla and Apple are technology companies that rely on advanced technology to power their products and services. Tesla is an electric car manufacturer, while Apple is a company that makes electronic devices and develops software. This shared technological dependence exposes them to similar market trends and challenges in some respects.2. Investor Sentiment: both Tesla and Apple are highly regarded and admired brands that attract a large number of ambitious investors. The success stories and leading figures of these companies (Tesla's Elon Musk and Apple's Tim Cook) are often in the media spotlight, fueling investor sentiment and speculative behaviour. This may lead to some degree of correlation between their share prices.

3. Technology and industry crossover: There is some technology and industry crossover between Tesla and Apple. For example, Apple's CarPlay system is related to Tesla's car entertainment system, which means they share some supply chain and technology partners to some extent. This crossover could lead to their share prices being similarly affected by the market at the same time in some cases.

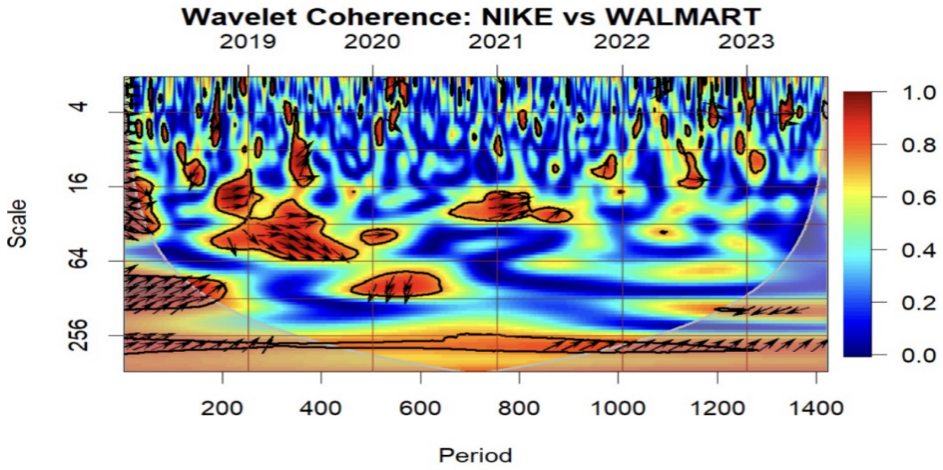

Fig 5 Nike verse Walmart wavelet coherence

In the figure 5 , we can see that most of the relevant areas are on the bottom side of this chart throughout all these five years. Also, there is a relatively strong correlation in different scales in the time period up to 2021. But after 2021, this correlation decreases in a big way, so we can see that most of the post-2021 regions appear in blue. We suppose that the reason why NIKE and WALMART have very strong long term correlation, partly because four possible reasons for this result: 1. Cyclical nature of the retail business: both Wal-Mart and Nike are in the retail industry, which is usually affected by economic cycles. In times of economic growth, people are more willing to shop, which helps to increase the sales and profitability of both companies, which in turn drives up their stock prices. In a recession, people may shop less, which can lead to lower sales and share prices. This economic cyclicality can lead to a correlation between the stock prices of these two companies. 2. Supply Chain and Raw Material Prices: Nike is a company that manufactures athletic shoes and clothing, while Wal-Mart is a retailer that sells these products. Raw material prices, manufacturing costs and supply chain issues may affect the cost structure and profitability of both companies. Therefore, when raw material prices increase or supply chain problems occur, the stock prices of these two companies may be negatively affected, resulting in a correlation.3. Consumer Trends: Both Wal-Mart's and Nike's businesses are affected by consumer trends. For example, changes in consumer preferences, the rise of online shopping, and sustainability trends can have an impact on the sales and stock prices of both companies. If consumers are more inclined to purchase athletic shoes and apparel, Nike's stock price may rise, while Wal-Mart's stock price may be affected to some degree because it sells these products. 4. Global Economic Factors: Both Wal-Mart and Nike are international companies, so global economic factors can also affect their stock prices. Currency exchange rate fluctuations, changes in international trade policies, and geopolitical events can have a significant impact on the business and stock prices of both companies.

5.Conclusion and Implications for investors

For the analyses of EXXO MOBILE and Berkshire Hathaway, the study suggests a strong interconnection between these two companies in 2020 and 2023, especially at a time scale of 64. However, in 2021-2022 (during the COVID-19 pandemic), the association between these two companies is very weak, especially during the epidemic. This is due to the fact that EXXO MOBILE is primarily engaged in the oil and gas business and during the COVID-19 pandemic, the demand for petroleum products declined significantly, leading to a sharp fall in its share price. In contrast, Berkshire Hathaway, an investment firm controlled by renowned investor Warren Buffett, specializes in adapting its portfolio to market risks, and therefore its share price was relatively less affected. Toward EXXO MOBILE and AMAZON, the study found that the correlation between the two companies has become very weak for most of the time period since 2020. This is mainly due to the fact that EXXO MOBILE's share price fell sharply during the COVID-19 pandemic, while AMAZON's share price rose during the same period. Due to the different business models and primary operations of the two companies, they have multiple differences in terms of market sentiment reactions. In terms of the correlation analysis of TESLA and Apple, the study shows that there is a strong correlation between their share prices, especially in the long run. This is mainly due to the fact that both companies invest a lot of money in product development, which takes a long time to pay off. In addition, there may be three reasons why there is such a strong long-term correlation between them: technology dependence, investor sentiment and technology crossover, among others. Regarding the association analysis of NIKE and WALMART, the study suggests that there is a strong long-term association between them on different time scales, especially until 2021. This correlation is partly due to the fact that they both belong to the retail sector, which is usually affected by economic cycles. In addition, supply chain and raw material prices, consumer trends, and global economic factors may also contribute to their share price correlation.

Through employing the Wavelet coherence method to analyse the integration between them, we find out several conclusion that could possibly provide some insights for the investor. Investors should pay close attention to global market trends related to the oil and gas business, particularly supply and demand relationships. Understanding the dynamics of the oil market will help better predict the performance of EXXO MOBILE's share price. For Berkshire Hathaway, consider its diversified portfolio and risk management strategy, which can help investors mitigate the impact of market volatility on its share price. Consider the company's primary business and industry characteristics. Understand how the company is affected by market events, especially during times of global crisis. Identify the different business models and market reactions between companies to better tailor portfolios to reflect the performance of different industries.Investors may consider investing for the long term as these two companies show strong share price correlation over the long term. This may be due to the fact that their product development and technology dependence will take time to become apparent.Watch out for factors such as technology dependence, investor sentiment and technology crossover, which could have an impact on the share prices of these two companies. Consider the impact of the economic cycle; investors may favor the retail sector during periods of growth and be more cautious during recessions. Keep an eye on supply chain issues and fluctuations in raw material prices, which could have an impact on the share prices of both companies. Be aware of consumer trends and

global economic factors such as exchange rate fluctuations, which can have a significant impact on a company's performance and share price.

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