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Quantile Analysis of Oil Price Shocks and Stock Market Performance: A European Perspective

Marc Audi[1], Marc Poulin[1], Khalil Ahmad[2], Amjad Ali[1]*

[1]Abu Dhabi School of Management, Abu Dhabi, UAE, [2]Department of Economics, Government Islamia Graduate College Civil Lines, Lahore, Pakistan. *Email: chanamjadali@yahoo.com

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ABSTRACT

This study investigates the interplay between oil price variations and stock market performance in Europe over the period 1991–2023. By analysing Europe as a cohesive economic entity, the research provides a unified view of how trends in energy markets and broader macroeconomic factors affect equity outcomes. The methodology combines ordinary least squares and quantile regression to robustly capture average impacts and variations across different segments of stock returns. Findings reveal that rising oil prices typically exert downward pressure on European equities by increasing production costs in petroleum-reliant industries. However, abrupt oil price shifts have nuanced effects: some segments exhibit heightened sensitivity, while others remain resilient, suggesting that adaptive industries may fare better than energy-intensive ones. Additionally, strong economic growth often intensifies fears of inflation, interest rate hikes, and market overheating, creating a negative association with stock performance. Inflation challenges equities, with higher-performing stocks especially vulnerable to price increases. The shift toward renewable energy appears to have short-term adverse effects, largely due to capital redistribution and transitional hurdles affecting traditional energy sectors. These results offer guidance for stakeholders. It underscores the need to align energy strategies with equity markets. Policymakers can enhance market resilience by addressing oil price volatility through transparency and risk mitigation, and by clearly communicating monetary policies to reduce inflation-induced uncertainty. While accelerating renewable adoption is vital for sustainability, careful management is needed to minimize disruptions to established sectors. Firms should hedge against energy price risks and invest in cleaner technologies to remain competitive in a changing landscape.

Keyword: Stock Market Performance, Oil Price Shocks, Inflation, Renewable Energy Consumption
JEL Classifications: G10, Q41, E31, Q20

1. INTRODUCTION

Stock market performance serves as a critical indicator of economic health, capturing investor confidence, corporate profitability, and overall economic stability (Fama, 1970; Schwert, 1990; Payne and Apergis, 2021; Liu et al., 2023). A well-functioning stock market enhances the efficiency of capital allocation by channeling resources toward firms with the highest growth potential, thereby fostering innovation and supporting long-term economic development (Levine, 1991; Pagano, 1993; Beck, 2023). Additionally, fluctuations in stock market performance influence consumer and investor sentiment, which can shape spending behaviors and inform macroeconomic policy decisions (Baker and Wurgler, 2006; Aloui et al., 2020).

The relationship between stock market performance and oil prices has garnered increasing attention among researchers and industry practitioners, particularly because oil serves as a critical input for economic growth and development (Sardar and Sharma, 2022). Fluctuations in oil prices can directly influence production costs, consumer spending, and corporate profitability, thereby shaping the overall performance of equity markets (Balcilar et al., 2023). Moreover, oil price shocks have been linked to broader macroeconomic indicators, such as inflation, exchange rates, and interest rates, highlighting its central role in global financial stability.

Recent years have witnessed several dramatic shifts in the oil market, leading to heightened economic uncertainty and market turbulence. One of the most notable episodes was the collapse in oil prices in 2020, triggered by a convergence of oversupply and a drastic reduction in demand due to the COVID-19 pandemic (Fattouh, 2020). In April 2020, Brent crude oil prices plunged below USD 20 per barrel, reflecting an unprecedented shock for both producers and consumers. This downturn not only disrupted major oil-exporting economies but also sent shockwaves through financial markets worldwide, underlining the interconnectedness of energy markets and stock exchanges. Although partial recoveries in late 2020 and throughout 2021 were driven by production cuts and a gradual increase in economic activity, the resurgence of volatility in 2022–2023—amid renewed geopolitical tensions and persistent supply chain bottlenecks—emphasized the vulnerability of global markets to energy-related shocks. For policymakers, understanding the nexus between stock market performance and oil prices is vital for formulating strategies to stabilize financial systems, while for investors, such insights inform asset allocation and risk management.

The COVID-19 pandemic exerted an unprecedented impact on the oil market, as global demand plummeted when governments worldwide imposed strict lockdowns to contain the spread of the virus. With transportation networks severely curtailed and industrial operations scaled back, the demand for oil products fell drastically, triggering one of the most dramatic collapses in oil prices in recent history (Baffes and Nagle, 2022). At the height of the disruption, the West Texas Intermediate crude oil price not only experienced a sharp drop but even turned negative for the first time in April 2020, indicating that producers were effectively paying buyers to take oil off their hands due to storage constraints (Huang and Li, 2022). This sudden price collapse contrasted starkly with the pre-pandemic equilibrium, where oil prices had soared above USD 100 per barrel during periods of heightened global economic activity. Moreover, the onset of a "price war" between Russia and Saudi Arabia compounded the volatility, as both parties vied to maintain market share despite collapsing demand (Ma et al., 2021). In addition to these geopolitical factors, the crisis underscored the vulnerability of oil-dependent economies to external shocks, especially when production cuts cannot keep pace with rapidly changing demand conditions (Muhieddine, 2018; Farghali et al., 2023). Although prices recovered as lockdown measures eased and industrial production gradually resumed, the pandemic-induced downturn remains a cautionary tale for policymakers and market participants who must brace for abrupt disruptions in the future (Rakot, 2019).

Since the dramatic lows of 2020, the oil market has gradually stabilized around USD 80 per barrel in many global benchmarks. Nonetheless, uncertainty persists, as industry analysts caution about the potential for another crash sparked by unpredictable geopolitical factors, evolving supply-demand dynamics, and broader macroeconomic pressures (Adejumobi, 2019; Chang et al., 2023). This rise in oil prices has fueled concerns about inflation, as higher energy costs permeate various sectors of the economy, compelling central banks to modify interest rates and other policy tools to preserve price stability (Sina, 2019; Schnabl, 2024). Political developments have remained central to oil price movements, exemplified by tensions between the United States (US) and Iran, and by OPEC+, a coalition of the Organization of the Petroleum Exporting Countries (OPEC) and its allies—enacting production cuts to bolster prices (Imran et al., 2019; Känzig, 2021; Audi and Al-Masri, 2020). At the same time, a shift toward renewable energy sources continues to reshape the global energy landscape, as governments and businesses invest in cleaner alternatives to meet environmental objectives (Osabuohien, 2021; Ali et al., 2021; Mustapha, 2022; Ali et al., 2022; Modibbo and Saidu, 2023; Dumitru and William, 2023; Ashiq et al., 2023; Chen et al., 2024; Audi et al., 2024). This move toward sustainability has prompted questions regarding the oil industry's long-term prospects, signifying that accelerating green transitions may significantly alter investment patterns, technological innovation, and the structure of energy markets (Rehman and Ahmad, 2024). Given the significant role of the oil market in driving the global economy and its recent volatility, understanding its effects is paramount for policymakers, investors, and suppliers. Oil price fluctuations can have far-reaching consequences, influencing transportation costs, raw material expenses, and energy production, ultimately affecting profit margins, consumer behavior, and trade flows (Degiannakis and Filis, 2023; Ahmad and Shah, 2024). Modern economies remain highly interconnected, allowing oil market shocks to spread quickly across regions and industries, amplifying both risks and opportunities. This underscores the need for sound strategies that mitigate adverse impacts and capitalize on potential gains (Roussel and Audi, 2024; Nili and Asadi, 2024).

The figure 1 and 2 provided support that how movements in oil prices are tied to stock market fluctuations. In line with Kilian and Park (2009) also show how oil prices influence stock markets through multiple channels, notably production costs and consumer spending. Over time, these linkages can vary according to the broader economic backdrop and specific shock events, such as the 2020 downturn spurred by COVID-19 (Marc, 2024). Despite numerous studies investigating the relationship between oil prices and stock market returns using varied econometric methods, the European context remains relatively underexplored (Diaz et al., 2023). As a major economic region and significant oil consumer, Europe's energy demands influence global oil trade, while its policy initiatives—such as carbon pricing and emissions targets—can reshape supply and demand patterns (Bürgin, 2023;

Figure 1: Aggregate stock market returns

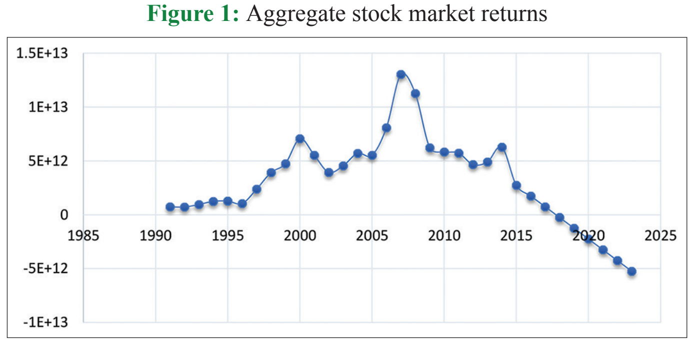
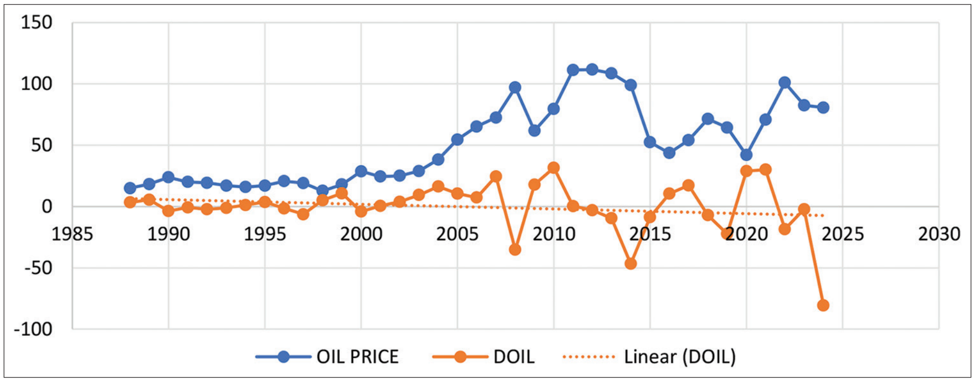


Figure 2: UK Brent crude oil prices



Marc, 2024). European sectors like transportation, manufacturing, chemicals, and utilities are especially susceptible to fluctuating oil costs, prompting supply chain adjustments and affecting competitiveness on the global stage (Aloui et al., 2023; Marc, 2024). In tandem with the wider push for sustainable development, discerning short-term oil price volatility from the longer-term shift toward clean energy is crucial for guiding strategic decisions related to growth, investment, and environmental stewardship (Ali and Audi, 2016; Audi et al., 2020).

This study explores the relationship between oil prices, oil price shocks, and European stock market performance using least squares and quantile regression analyses on data from 1991 to 2023. It uniquely examines the quantile effects of oil prices on European markets, treating Europe as a single entity. The research utilizes a detailed dataset encompassing all European countries, offering new insights into the dynamics of this complex relationship. The study also integrates stock market performance indicators, enhancing the understanding of financial impacts.

The structure of the study includes several key sections: Next, the literature review summarizes existing research related to the topic. The theoretical framework and empirical methodology section provide detailed methodological approach, model, and dataset. The results and discussion section discuss empirical findings, particularly recent trends in oil prices and their impact on the European stock market. Finally, the conclusions and suggestions section provide policy recommendations, highlighting the need to address the economic effects of oil price fluctuations in Europe and suggesting ways to lessen their negative impacts.

2. LITERATURE REVIEW

There is extensive academic work exploring how oil price fluctuations affect stock returns, with research employing diverse methods and datasets leading to varied results over different periods. Early US-focused investigations include Kilian and Park (2009), who use a VAR model with global oil output, economic activity, oil costs for refiners, and the CRSP equally weighted index (1973–2006). Findings reveal that oil price shocks can vary in their impact depending on whether changes originate from supply or demand, accounting for 22% of long-term US real stock return fluctuations. More recent studies broaden this analysis. Känzig (2021) examines shifts in oil supply expectations with OPEC high-frequency data (2003–2017), while Sardar and Sharma (2022) assess the nonlinear interplay between oil prices and US stock returns near the zero lower bound (1987–2020), observing higher returns under ZLB conditions. Shahzad et al. (2022) employ wavelet analysis to identify medium- to long-term correlations between the Bloomberg commodity index and WTI, though not at shorter horizons. Meanwhile, Mutascu et al. (2022) find that weekly gasoline and diesel prices in Germany, France, and Italy (2005–2021) co-move across all frequencies. Kilian and Park (2009), however, argue that oil demand and supply shocks are equally relevant in explaining US real stock returns. Foroni et al. (2017), analyzing 1973–2015 data, show that the US oil price–equity return link shifts over time, becoming clearer after the financial crisis. Their findings demonstrate that oil-specific demand shocks positively affect equities, while oil supply shocks have been limited since 2008.

European research often focuses on sector-specific responses. Arouri et al. (2011) applies linear and asymmetric methods to illustrate that shifts in oil prices have distinct effects across European sectors. Similarly, Sadorsky (1999) uses a VAR-GARCH approach to show that oil prices negatively affect European stock returns, confirmed through impulse-response functions. Cunado and De Gracia (2014) find that global oil production used as a proxy reveals a negative link between oil prices and country-level European returns. Park and Ratti (2008), examining 1986–2008 data, use BEKK-GARCH and DCC-GARCH, concluding that oil prices explain about 6% of stock return volatility in Europe. Kang et al. (2015) incorporate uncertainty measures (e.g., Google search data, CPI) into a VAR framework, showing that oil-specific demand shocks account for 30% of economic uncertainty after 24 months and 58% over the long run. Their time-varying VAR also indicates oil-specific demand shock effects rose from 5% in the 1970s to 15% by 2007, while oil supply shock influence declined from 17% to 5%. Mokni (2020), using SVAR and time-varying parameter regression (1999–2018), identifies generally negative and limited oil supply shocks, but oil-specific demand shocks benefit exporting countries' stocks and harm importing countries' stocks.

A separate perspective is offered by Bein and Mehmet (2016) study Nordic countries (1995–2015) via DCC-GARCH, connecting Brent and WTI prices with European indices. Arouri et al. (2011) detect both aggregate and sectoral relationships in Europe (1998–

2008) using a VECM with asymmetric cointegration. Arouri et al. (2010) use a VAR on 12 European sectors (1998–2008), pinpointing a strong short-term correlation between oil prices and stock returns. Degiannakis et al. (2013), through a multivariate ARCH framework, show a time-varying oil–stock relationship in European industrial sectors (1992–2010). Degiannakis et al. (2014), deploying an SVAR model with a sectoral index, global oil production, and Brent prices (1999–2010), find that aggregate demand shocks depress oil price volatility, while specific oil demand shocks do not significantly influence the Euro Stoxx 50. Later, Degiannakis et al. (2018), via a time-varying VAR (1990–2015), reinforce the notion of evolving oil–stock interactions. Park and Ratti (2008) also incorporate macroeconomic indicators, using a VAR (1986–2005) with interest rates, real oil price changes, and industrial production for 13 EU nations. Their findings suggest that oil prices substantially shape oil-importing nations' markets, but oil-exporting countries experience weaker oil price impacts relative to interest rates, and monetary policy appears unresponsive to oil price changes.

Causality studies add further insights. Katsampoxakis et al. (2022), employing a VAR with Granger tests (2019–2020), show that market volatility during COVID-19 impacts Brent–European stock index causal links, which are absent in low-volatility periods but appear when volatility rises. Before COVID-19, only Norway's OBX index exhibited a symmetric causal link with oil prices. During vaccination, the DAX and CAC40 influenced oil prices, and post-vaccination, OBX, RTS, and CAC40 drove oil prices. Agarwalla et al. (2021) use a VECM for India (2005–2015), indicating Granger causality. Tawfeeq et al. (2019), with VAR and VECM (2001–2015), find that oil-to-stock short-term causality exists in several Middle Eastern countries, with IRFs confirming a price–valuation relationship. Abubakirova et al. (2021), studying Brazil, Russia, India, China, and South Africa (2010–2019), observes symmetrical causality from oil to stocks in Brazil, Russia, and South Africa, but asymmetric or negative bidirectional feedback in Russia, India, and China. Daradkah and Al-Hamdoun (2021) detect oil-to-stock causality in Egypt, Morocco, and Jordan (2005–2018). Atif et al. (2022), applying panel VAR (2019–2020), show a symmetric relationship in major economies, while Angosto-Fernández and Ferrández-Serrano (2022) find that the Russian-Ukrainian conflict strongly affects 77 global markets in the short run, influenced by geopolitical factors. Lastly, Raifu (2023) confirms a bidirectional, time-varying causal interaction between oil yields and stock returns in Norway (2011–2021), contingent on data frequency, underscoring the intricacy of these financial dynamics.

Recent studies have increasingly examined the connection between oil markets and stock performance, highlighting how macroeconomic factors and policy interventions can shape financial outcomes. In a study by Li et al., (2024), investigates the influence of geopolitical tensions on both oil prices and investor sentiment, stressing that political stability often underpins energy market equilibrium. Research by Xu et al. (2024) further demonstrates that carbon neutrality efforts can introduce heightened volatility into traditional energy markets, complicating valuation processes for oil-dependent firms.

Meanwhile, Wu et al., (2023) shows that unexpected oil price shocks can spill over into broader macroeconomic indicators, prompting adjustments in monetary policies and reshaping capital flows. In examining policy uncertainty within U.S. energy markets, Umair et al., (2024) explores how innovative oil price prediction methods may stabilize investment decisions during volatile periods. Another line of inquiry is presented by Zhu et al., (2024), who applies large-scale data analytics to track abrupt changes in oil prices, providing clearer signals to both individual and institutional market participants. Similarly, Liu et al., (2024) contends that well-crafted governmental measures can mitigate the adverse effects of oil market shocks, thus supporting greater resilience in stock markets.

Işık et al., (2023) explore how fluctuations in exchange rates and oil prices jointly affect domestic equities, suggesting that currency volatility can often amplify energy-related shocks. In the Latin American context, Lopez Herrera et al., (2021) highlight the importance of country-specific frameworks when confronting oil price risk, implying that standardized policies may fail to capture distinctive regional dynamics. Chen (2024) underscores the role of trade connections in transmitting oil price pressures across multiple markets, underlining the international scope of energy-related financial risks. Haq and Rashid (2023) address renewable energy adoption, proposing that a long-term shift away from fossil fuels can reduce sensitivity to oil price volatility, although technological barriers and uneven policy uptake may impede progress.

Sun et al., (2023) takes a closer look at how oil production levels factor into industrial returns, suggesting that reductions in output can trigger both immediate and longer-term adjustments in investor behavior. However, much of the literature—spanning machine learning applications, policy-driven strategies, and geographic case studies—tends to concentrate on single countries, emerging economies, or broad cross-continental samples without dedicating a cohesive focus to Europe as a single entity. Taken together, these studies underscore the nuanced ways in which oil price fluctuations, policy maneuvers, and technological shifts interact to shape stock market dynamics. Nevertheless, the majority offer either narrowly defined national analyses or generalized global perspectives. This gap suggests a pressing need to assess how oil price fluctuations and shocks affect stock market performances specifically within Europe—a region that, despite being economically and institutionally interconnected, has not been thoroughly investigated in a holistic manner.

3. THEORETICAL LINKS AND EMPIRICAL METHODOLOGY

Oil price volatility has long been recognized as a pivotal factor influencing macroeconomic stability and financial markets. Early contributions, such as Hamilton (1983), established that oil shocks were associated with recessions, inflation, and shifts in consumer sentiment. More recent studies underscore the transmission from oil price fluctuations to equity markets, emphasizing the channels of production costs, risk premiums, and investor psychology (Jones and Kaul, 1996; Sadorsky, 1999). When oil prices increase, firms reliant on petroleum-based inputs face higher costs, which can compress profit margins and dampen stock market returns. Conversely, falling oil prices may benefit certain sectors, providing a temporary stimulus through reduced operational expenses and heightened consumer spending (Kilian and Park, 2009). An important aspect of this linkage is the asymmetry in how price shocks affect different sectors and countries. For instance, oil-importing economies often view rising oil prices as detrimental, whereas oil-exporting nations might initially see higher revenues and improved fiscal balances (Narayan and Narayan, 2010). In the context of the European Union (EU), the net-importer profile of most member states suggests that oil price hikes could generate inflationary pressures and currency depreciations relative to major oil-exporting countries. Over time, these dynamics spill over into stock market performance, as changes in real economic activity, monetary policy decisions, and exchange rates interact with investor risk appetites (Park and Ratti, 2008).

Recent research has also highlighted the nonlinear or regime-dependent nature of these relationships. Kilian (2009) demonstrated that not all oil price shocks are alike; demand- and supply-driven shocks can have different impacts on macroeconomic indicators. This insight motivates the inclusion of both levels of oil prices and changes or shocks in oil prices within empirical models to capture differential responses across various stages of market development (Lescaroux and Mignon, 2008). Moreover, the reliance on a single measure (such as price in levels) could obscure important dynamics that manifest when prices rise or fall more sharply than expected. Studies focusing on the nonlinear response of the economy to oil price shocks, propose that stock markets respond differently in bullish and bearish conditions, further underscoring the importance of distribution-sensitive tools like quantile regression. By examining how oil price movements influence stock markets at different quantiles of the return or value distribution, analysts can detect heterogeneous effects that simple mean-based methods overlook.

The accelerating global transition towards renewable energy consumption adds a new dimension to the energy–finance nexus. The notion that renewable energy plays a stabilizing role has gained traction in both policy and academic circles (Sadorsky, 2012). For one, as countries invest in alternative energy technologies and diversify away from fossil fuels, their vulnerability to oil price fluctuations may diminish over time. Renewable energy adoption can serve as a hedge against volatile oil markets, thereby reducing systemic risk within the broader economy (Chang and Serletis, 2018). In the European Union context, strong commitments to reducing carbon emissions, coupled with supportive policy frameworks, have accelerated the adoption of wind, solar, hydro, and other renewable technologies. This structural shift has the potential to modulate the impact of oil price shocks on stock markets by lowering fossil-fuel dependency (Omri, 2013). Indeed, companies investing heavily in renewables or demonstrating environmental, social, and governance leadership may exhibit greater resilience to oil market disruptions. Consequently, increased renewable energy consumption could act either as a buffer that reduces market volatility or as a catalyst for new investment opportunities, depending on how companies and investors adapt. Nonetheless, the relationship between renewable energy consumption and stock market dynamics is not unidirectional. There can be phases where rapid shifts in energy policy, carbon taxes, or technological breakthroughs unsettle equity markets. Market participants, uncertain about the speed and regulatory framework guiding the green transition, might react strongly to announcements or political events. Hence, to understand the full picture, one must account for both conventional drivers of stock market returns (i.e., macroeconomic factors) and renewable energy trends (Sadorsky, 2012).

In addition to oil prices and renewable energy consumption, macroeconomic control variables—natural resource rents, inflation, and real economic activity—provide a more nuanced understanding of financial market dynamics. Natural resource rents capture the extent to which an economy depends on resource extraction for its GDP (van der Ploeg and Poelhekke, 2009). Higher natural resource rents may correlate with elevated risks of the "resource curse," wherein over-reliance on extractive industries impedes diversification, thereby exacerbating vulnerability to external price shocks. Inflation can erode real returns on equities, influencing investor decisions about portfolio allocations. Persistent high inflation may also signal macroeconomic instability and cause central banks to tighten monetary policy, which, in turn, impacts stock valuations (Chen et al., 1986). Conversely, real economic activity is a proxy for aggregate demand, indicating how robustly consumers and businesses are spending. During periods of strong real economic growth, firms often enjoy higher cash flows, boosting stock prices (Fama, 1990).

Integrating these variables allows researchers to separate out the pure effects of oil price movements and renewable energy adoption from other concurrent macroeconomic forces. Moreover, by examining multiple quantiles of stock market outcomes, it is possible to explore whether, for example, inflation only matters under lower-tail conditions (bearish markets) or if real economic activity exerts a greater influence during upper-tail conditions (bullish markets). This multifaceted approach is essential for painting an accurate picture of how energy prices and renewable transitions shape financial outcomes under varying market scenarios (Koenker and Hallock, 2001). Table 1 summarizes the main variables and the features of the dataset.

Given the time-series nature of the dataset, stationarity is a key concern (Maddala, 1998). To ensure that spurious regression problems do not contaminate the results, the analysis includes four well-established tests: Augmented Dickey-Fuller (Dickey and Fuller, 1979), DF-GLS (Elliott et al., 1992), Phillips-Perron (Phillips & Perron, 1988 and Phillips, 1988), and Ng-Perron (Ng and Perron, 2001). Since the current study primarily focuses on the short- to medium-run impact of oil price movements and renewable energy shifts on stock market values, differencing the relevant variables and including them in both levels and differenced forms is sufficient for robust inference.

Before employing more sophisticated estimators, here are two baseline models estimated via ordinary least squares. These serve

Table 1: Descriptions of the variables and data sources

Variables	Definition	Sources
STV	Aggregate Stocks traded, total value (current US$)	World Development Indicators (WDI)
DOIL	Oil prices shock Europe Brent (Dollars per Barrel)	Energy Information Administration (EIA)
OILP	Europe Brent oil Price FOB (Dollars per Barrel)	Energy Information Administration (EIA)
NRR	Total natural resources rents (% of GDP)	World Development Indicators (WDI)
INF	Inflation, consumer prices (annual %)	World Development Indicators (WDI)
REC	Renewable energy consumption (% of total final energy consumption)	World Development Indicators (WDI)
ECO	Real economic activity index	Federal Reserve Bank of Dallas

to investigate average effects of oil prices and their shocks on stock market activity. Specifically, we estimate:

$$STV_t = \alpha_0 + \alpha_1 OILP_t + \alpha_2 NRR_t + \alpha_3 INF_t + \alpha_4 REC_t + \alpha_5 ECO_t + \varepsilon_t \quad (1)$$

$$STV_t = \beta_0 + \beta_1 DOIL_t + \beta_2 NRR_t + \beta_3 INF_t + \beta_4 REC_t + \beta_5 ECO_t + \eta_t \quad (2)$$

Although OLS provides a useful starting point, it may mask heterogeneous effects across the distribution of stock market outcomes (Koenker and Bassett, 1978). A single mean estimate cannot capture whether oil prices exert a disproportionate effect during bear markets (lower quantiles) versus bull markets (upper quantiles). To address this limitation, we employ quantile regression, which estimates the conditional quantiles (e.g., 20th, 40th, 50th, 60th, and 80th) of the dependent variable, STV. This allows us to explore how extreme market conditions might amplify or dampen the impact of energy variables and macroeconomic controls (Koenker and Hallock, 2001).

We estimate two quantile regression models paralleling our OLS setups—one model includes oil price levels, and the other uses oil price shocks. Formally, the quantile regression for the τ-th quantile can be written as:

$$Q^{\tau}(STV_t \mid X_t) = \gamma_0(\tau) + \gamma_1(\tau)\,OILP_t + \gamma_2(\tau)\,NRR_t + \gamma_3(\tau)\,INF_t + \gamma_4(\tau)\,REC_t + \gamma_5(\tau)\,ECO_t \quad (3)$$

$$Q^{\tau}(STV_t \mid X_t) = \delta_0(\tau) + \delta_1(\tau)\,DOIL_t + \delta_2(\tau)\,NRR_t + \delta_3(\tau)\,INF_t + \delta_4(\tau)\,REC_t + \delta_5(\tau)\,ECO_t \quad (4)$$

Where,

$Q^{\tau}(STV_t \mid X_t)$ is the conditional τ-quantile of STV given a vector of regressors X_t. Unlike OLS, quantile regression does not assume a homogenous effect across the entire distribution, making it a valuable tool for capturing distributional heterogeneity in financial data (Engle and Manganelli, 2004).

To ensure the reliability of our quantile regression results, we adopt robust standard errors that account for possible heteroskedasticity. Furthermore, we perform sensitivity analyses by dropping potential outliers and re-estimating the model to verify that the main conclusions remain intact. This procedure is particularly relevant for financial data, where extreme values can arise due to crises or exogenous shocks (Sadorsky, 2012). Finally, we examine model adequacy and fit using measures analogous to R^2 in OLS—namely, the pseudo-R^2 metric in quantile regression—to verify how well each specification captures variation in the dependent variable.

4. RESULTS AND DISCUSSIONS

An examination of the descriptive statistics in Table 2 provides several insights into the distribution and scale of the variables under consideration. These summary measures are valuable for understanding the basic characteristics of each variable—such as central tendency, variability, and shape of the distribution—before conducting more sophisticated econometric analyses. Stock market performance has a mean of 40.98720 and a standard deviation of 22.15488, indicating a reasonably high level of variability. Its distribution exhibits positive skewness (0.909856) and a kurtosis slightly above 3 (3.523866), pointing to a moderately right-skewed distribution with some heavier tails compared to a normal distribution. This moderate skewness is not unusual in financial time series data, where a few periods of unusually high trading volumes can inflate both the mean and the distribution's tail. The descriptive statistics signal considerable heterogeneity across selected variables, aligning with the multifaceted and sometimes volatile nature of financial, energy, and macroeconomic indicators. The patterns observed—such as skewed distributions, outliers, and high volatility—underscore the need for modeling techniques robust to non-normality and potential heteroskedasticity, including quantile regression and other advanced econometric approaches. Understanding these preliminary characteristics can help anticipate challenges in empirical analysis, interpret estimation outputs more carefully, and design policy interventions that acknowledge the dynamics of both the stock market and the broader economic environment.

The results in Table 3 report four complementary unit root tests—Augmented Dickey-Fuller (ADF), Dickey-Fuller Generalized Least Squares (DF-GLS), Phillips-Perron (PP), and Ng-Perron (NG-Perron)—for both levels and first differences of the selected variables. These tests help determine whether each variable is stationary in levels or becomes stationary only after differencing, a key consideration for econometric modeling (Enders et al., 2015). A key takeaway is that oil price shocks appears to be stationary at levels under all four tests, as indicated by the statistically significant test statistics at the 1% level. This result implies that unexpected changes or "shocks" in oil prices follow a process that does not require differencing to achieve stationarity—often consistent with the high-frequency, mean-reverting dynamics that characterize oil price surprises. The real economic activity also

Table 2: Descriptive statists

Variables	STV	DOIL	OILP	NRR	INF	REC	ECO
Mean	40.98720	1.827273	53.45455	0.232498	2.876371	13.10886	12.26854
Median	37.30595	0.530000	52.32000	0.193986	2.510666	11.75928	9.602376
Maximum	97.66596	31.65000	111.6300	0.540304	8.833699	21.76421	197.7464
Minimum	10.18977	−46.65000	12.76000	0.091001	−0.061645	7.195621	−73.34625
Std. Dev.	22.15488	16.95669	32.73521	0.104458	1.955711	4.936894	61.03870
Skewness	0.909856	−0.634806	0.384035	1.228178	0.957889	0.412992	1.037954
Kurtosis	3.523866	4.043097	1.797858	3.972569	4.080683	1.669660	3.968682
Jarque-Bera	4.930454	3.712451	2.798231	9.596919	6.652359	3.371577	7.215643
Probability	0.084990	0.156261	0.246815	0.008242	0.035930	0.185298	0.027111
Sum	1352.578	60.30000	1764.000	7.672436	94.92024	432.5925	404.8617
SumSq. Dev.	15706.84	9200.940	34291.01	0.349168	122.3938	779.9335	119223.1
Observations	33	33	33	33	33	33	33

Table 3: Results of unit root

	Test statics at levels			
	ADF	DF-GLS	PP	NG-Perron
STV	−2.857	−1.7044	−2.1631	−4.4891
DOIL	−5.3065***	−5.369***	−5.4397***	−15.975***
OILP	−1.5807	−1.3825	−1.5921	−3.4881
NRR	−2.1948	−2.1764	−2.1757	−7.3172**
INF	−2.3890	−2.0513	−2.2791	−6.7295**
REC	1.3661	0.7130	1.2041	1.2041
ECO	−4.0744**	−4.1418**	−4.3087**	−10.451**
First difference test statics				
STV	−6.501***	−3.6267***	−4.1319***	-10.821***
DOIL	−7.580***	−5.3693***	−20.770***	−58.3618***
OILP	−5.6536***	−5.7234***	−5.6955***	−15.4659***
NRR	−6.3452***	−6.2689***	−6.7048***	−15.1816***
INF	−5.3823***	−5.4525***	−5.9565***	−72.6162***
REC	−4.1549***	−4.1931***	−4.1479***	−4.1479***
ECO	−6.4840***	−9.2986***	−10.646***	−14.680***

***, ** shows the level of significant at 1% and 5% respectively

emerges as stationary at levels, evidenced by significant ADF, DF-GLS, PP, and NG-Perron statistics. This finding indicates that while economic activity can fluctuate substantially, its underlying data series in this sample does not exhibit a persistent unit root process. By contrast, all other variables fail to reject the presence of a unit root in levels across most of the tests. Whereas, once differenced, these series exhibit strongly significant test statistics across all or most tests at conventional levels, confirming that they become stationary in first differences.

Table 4 presents the ordinary least squares estimates for the relationship between stock market performance and several explanatory variables, namely Oil Price, availability of natural resources, Inflation, renewable energy consumption, and real economic activity. A notable finding is the negative and statistically significant coefficient on Europe Brent oil price, suggesting that higher oil prices tend to dampen trading activity by eroding corporate profitability and increasing uncertainty (Sadorsky, 2021). Firms facing rising production and transportation costs may experience tighter profit margins, undermining investor confidence and diminishing stock trading volumes. Meanwhile, the coefficient for availability of natural resources is positive but statistically insignificant, indicating that—within this specific dataset—variations in resource endowments do not directly drive changes in the stock market, although prior research has shown that natural resource wealth can shape financial market dynamics differently across regions and contexts (Batten et al., 2017).

Inflation demonstrates a highly significant and negative impact on European stock market performance. This finding aligns with the longstanding view that elevated inflation undermines purchasing power and injects volatility into real returns, resulting in a cooler investment climate (Liu et al., 2023). Investors may pull back from equities during inflationary episodes, particularly when cost pressures intensify. Renewable energy consumption exerts a significant negative effect, reflecting that, in the near term, growing reliance on renewables can reallocate capital to new technologies and green sectors at the expense of fossil-fuel-based firms with substantial market capitalization (Liu et al., 2023). This shift may diminish overall trading activity if incumbent energy companies face transitional risks or slower growth. Real economic activity also shows a negative and significant coefficient, which appears counterintuitive since robust economic conditions typically coincide with greater equity investment. However, structural or lagged responses, including potential overvaluation concerns or alternative investment options, may explain why a stronger economy sometimes prompts investors to diversify away from public equity markets (Batten et al., 2017). These nuances underscore how growth trajectories, investor expectations, and sectoral transformations influence stock trading.

The coefficient on oil price shocks is negative and highly significant, affirming that when oil prices spike abruptly, participants may temper equity trading due to heightened uncertainty and cost pressures (Sadorsky, 2021). Such shocks can hinder risk-taking, especially if markets suspect that elevated energy costs will curtail corporate earnings. In the first model, natural resources remain insignificant, reinforcing that resource availability exerts limited direct effects on everyday trading volume in this setting (Batten et al., 2017). Notably, inflation becomes marginally less robust ($P = 0.0738$) once oil price shocks are considered, hinting that these shocks might encompass some of the uncertainty typically associated with inflation's impact on equities (Liu et al., 2023). A key difference between the models lies in the coefficients for renewable energy use: −0.121689 under the oil price level framework versus −0.948698 under the shock-based model, both significant. Controlling for oil price shocks thus appears to magnify the negative relationship between renewables and trading volume, suggesting that in the context of abrupt oil price changes, investors might redirect capital from conventional energy companies to renewable ventures, reducing trading in large, incumbent fossil-fuel-related stocks. Both models concur that expanding clean energy correlates negatively with trading volume, possibly reflecting transitional uncertainties or realignments in capital flows (Liu et al., 2022).

Regarding broader macroeconomic indicators, real economic activity remains negative and significant across both specifications, and is even more negative in the second (−1.80912) than in the first (−0.766047). Though counterintuitive, such a result could materialize when vigorous economic expansion fuels direct investments beyond the public equity space or fosters caution among investors wary of potential overvaluation. The more pronounced coefficient in the second model implies that once unexpected oil price shifts are factored in, economic growth exerts additional downward pressure on trading volumes—underscoring the interplay between macroeconomic trends, sudden energy market developments, and investor sentiment (Sadorsky, 2021). These insights highlight the importance of distinguishing between oil price levels and shocks when evaluating stock market outcomes, while also illuminating how the transition to renewable energy intersects with equity market activity.

The quantile regression results (Table 5) indicate that oil price exerts a consistently negative and statistically significant effect on stock returns across all quantiles, reinforcing the notion that higher oil prices tend to depress equity performance by raising firms' input costs and eroding consumer purchasing power (Sadorsky, 2021). Interestingly, the magnitude of this effect varies across quantiles, the coefficient is smaller in absolute value for the 40th, 50th, and 60th quantiles, yet it becomes notably larger in the 20th and 80th quantiles. This pattern suggests that stocks in the lower and upper tails of the return distribution are more vulnerable to oil price fluctuations, potentially due to factors such as lower resilience among underperforming firms and heightened sensitivity to cost shocks in high-growth or high-volatility sectors.

Natural Resources does not exhibit a statistically significant relationship with stock returns in any quantile, implying that fluctuations in a country's resource-based revenues are not a primary determinant of immediate equity performance in this context (Batten et al., 2017). This finding may reflect the fact that investors focus more on near-term market and economic signals—such as oil price dynamics or inflation—than on broad resource wealth indicators, at least in the short run. In contrast, inflation becomes significantly negative at the median (50th quantile) and above, suggesting that inflationary pressures erode returns for mid- and higher-performing stocks more than for those in the lower tail of the distribution (Liu et al., 2023). As inflation accelerates, companies face rising production and borrowing costs, while investors often demand higher returns to offset the erosion of purchasing power, creating downward pressure on stock prices.

Renewable energy consumption consistently exhibits a negative and significant impact across all quantiles, but the magnitude is particularly large at the 20th and 40th quantiles. This pattern may stem from the more pronounced vulnerability of underperforming or risk-averse stocks to shifts in the energy sector, as the economic landscape pivots toward renewables, investors could rotate out of traditional energy firms, many of which have historically commanded substantial market capitalization (Liu et al., 2023). For stocks at the median and higher quantiles, the negative coefficient remains significant but less pronounced, suggesting that stronger-performing firms may be either less reliant on fossil fuels or better positioned to adapt to a changing energy mix.

Table 4: Least square outcomes

Variables	Least squares oil prices			Least squares oil prices shocks		
	Coefficients	T. test	Prob value	Coefficients	T. test	Prob value
OILP	−0.710888	−3.409950	0.0021	----	----	----
NRR	1.13243	0.073306	0.9421	0.057560	0.372012	0.7131
INF	−1.91372	−13.26481	0.0000	−1.4400	0.8738	0.0738
REC	−0.121689	−3.537828	0.0015	−0.948698	−0.044063	0.0000
ECO	−0.766047	−9.902517	0.0000	−1.80912	−8.828288	0.0000
DOIL	----	----	----	−0.586630	−7.88738	0.0000
R-squared		Durbin-Watson stat		R-squared	Durbin-Watson stat	
0.969636		2.108960		0.957660	2.308960	

Table 5: Quantile regression analysis

Variables	Stock Return: Dependent Variable				
	Quantiles				
	20th	40th	50th	60th	80th
OILP	−0.8064***	−0.5909***	−0.5866***	−0.58214***	−0.8946***
	[−37.134]	[−74.463]	[−37.887]	[−17.682]	[−2.5450]
NRR	−0.1768	−0.34882	0.001589	0.0054	0.0126
	[0.7498]	[0.5172]	[0.9142]	[0.8385]	[0.8432]
INF	0.003175	0.005430	−3.4405**	−9.69123**	−0.1028**
	[0.1269]	[0.2326]	[−0.1604]	[−0.0979]	[−0.0758]
REC	−15.443***	−15.395***	−1.8091***	−1.026***	−0.1300***
	[−21.895]	[−23.280]	[−8.828]	[−4.9377]	[−0.42404]
ECO	−15.445***	−15.395***	−1.8091***	−1.026***	−0.1300***
	[−21.89532]	[−23.28050]	[−8.9377]	[−4.9377]	[−0.424040]

[ ] Represents the t-statics values of the estimated coefficients. ***,**Shows the level of significant at 1% and 5% respectively

A similar dynamic emerges for real economic activity, which is significantly negative across all quantiles but especially large in the lower tail (20th and 40th). While conventional wisdom often associates an expanding economy with favorable stock returns, certain structural or temporal factors—such as increased interest rates, competition from real investment alternatives, or fears of market overheating—can lead to a negative correlation between growth indicators and stock returns. The reduced magnitude in the upper quantiles could reflect greater resilience or diversification strategies among higher-performing firms, dampening the adverse effects of macro-level growth on their share prices.

Taken together, these quantile-specific estimates reveal important heterogeneity in how macroeconomic variables influence stock returns, with oil prices, renewable energy consumption, and economic activity exhibiting pronounced negative associations across the distribution of returns. The fact that inflation only becomes significant in the median and upper quantiles suggests that some firms—particularly those with already higher stock returns—may be more exposed to inflationary risks. Equally, the strong and persistent negative effect of renewable energy consumption highlights how structural shifts in the energy landscape can weigh on equity markets, albeit to varying degrees depending on a firm's or sector's positioning (Sadorsky, 2021; Liu et al., 2023).

The quantile regression results in Table 6 offer further insights into how different segments of the stock return distribution respond to explanatory variables. Unlike mean-based estimations, quantile regression highlights how these explanatory variables can have non-uniform effects on the lower (20th), middle (40th, 50th, 60th), and upper (80th) ends of the stock return spectrum, thereby capturing distributional heterogeneity. Oil price shocks exhibits an intriguing pattern, taking negative and significant coefficients in the 20th, 50th, and 60th quantiles but switching to positive and significant effects for the 40th and 80th quantiles. These shifting signs suggest that underperforming or moderately performing stocks (20th, 50th, 60th quantiles) are more vulnerable to oil shock–induced volatility—perhaps due to narrower profit margins, heavier dependence on energy inputs, or risk aversion among investors (Sadorsky, 2021). Conversely, stronger and more stable stocks in the 40th or 80th quantiles may benefit from oil price shocks when investors pivot away from fragile or energy-intensive firms, channeling capital toward firms perceived as resilient or positioned to capitalize on shifting market conditions (Aloui et al., 2021).

Natural resources remain statistically insignificant across all quantiles, reinforcing the notion that short-term stock return movements may be more sensitive to immediate market and macroeconomic factors (e.g., oil price fluctuations, inflation, and sectoral shifts) than to a country's broad resource-based income (Batten et al., 2017). The coefficient on inflation appears significantly negative only at the 50th quantile, indicating that mid-performing stocks face reduced returns in the face of inflationary pressures. One explanation is that firms in the middle quantiles may lack the pricing power and cost-hedging strategies of top performers, while also lacking the lower profit expectations or "defensive" nature sometimes seen among underperformers (Liu et al., 2023). The lack of consistent inflation effects at other quantiles could reflect sectoral or regional differences in how inflationary shocks translate into equity valuations.

Renewable energy consumption exerts a consistently negative and statistically significant impact on stock returns across all quantiles. The larger negative values at higher quantiles (e.g., −0.1110*** at the 80th quantile) explain that top-performing stocks may see a more pronounced downdraft when the share of renewable energy use expands rapidly—possibly because many leading firms in traditional energy sectors still carry substantial weight in market indices. During periods of accelerated energy transition, these incumbents may face reduced demand or heightened regulatory scrutiny, driving down their valuations. At the same time, newer renewable energy companies may not be large enough in market capitalization to offset losses among legacy heavyweights (Liu et al., 2023). Finally, real economic activity shows a uniformly negative and significant relationship across the return distribution. This finding, while counterintuitive from a standard growth–returns viewpoint, is consistent with scenarios in which expanding real activity leads to tighter monetary conditions, intensifying concerns over potential overheating or higher financing costs that can weigh on equities. Additionally, rapid economic activity could encourage investment in real assets or private ventures rather than equities, thus depressing public stock returns (Batten et al., 2017). The especially large negative coefficients at the lower (20th) and upper (80th) quantiles suggest that both weaker and more volatile/higher-risk stocks are more sensitive to fluctuations in economic conditions, whereas mid-range stocks might be slightly shielded from such macroeconomic swings. Overall, these quantile-specific findings deepen our understanding of how macro-financial shocks, sectoral shifts, and policy-driven energy transitions differentially affect the equity market.

Table 6: Quantile regression analysis Stock Return: Dependent variable

Variables	Quantiles				
	20th	40th	50th	60th	80th
DOIL	−0.2205***	2.409734***	−0.1350*	−0.155063***	1.071809*
	[−1.4387]	[12.027]	[−1.3442]	[−1.4366]	[2.36711]
NRR	0.131721	0.076711	0.027855	0.021334	0.027710
	[0.6124]	[1.1793]	[0.5726]	[0.4032]	[0.18914]
INF	1.059343	0.370864	−0.7257**	−1.556317	−0.39231
	[0.1269]	[0.2326]	[−2.1604]	[−0.0979]	[−0.0758]
REC	−0.03542***	−0.0360***	−0.0501***	−0.0715***	−0.1110***
	[−1.4173]	[−2.5155]	[−2.3145]	[−2.3486]	[−3.9835]
ECO	−1.289343***	−0.575467***	−0.524507***	−0.456176***	−1.306998***
	[−12.86207]	[−12.26050]	[−6.76377]	[−3.7710]	[−1.424040]

[ ] represents the t- statics values of the estimated coefficients. ***,**Shows the level of significant at 1% and 5% respectively

A comparison of the quantile regression findings in Tables 5 and 6 reveals notable differences in how stock returns respond to these two oil-related measures across varying points of the return distribution. Oil price maintains a uniform negative effect at all reported quantiles (20th through 80th), implying that higher oil prices consistently suppress stock returns regardless of whether stocks are performing poorly (lower quantiles) or relatively well (upper quantiles). Conversely, oil price shocks coefficients alternate between negative and positive across different quantiles, explaining that unanticipated oil price shocks can generate more diverse outcomes for stocks in distinct segments of the return distribution. For instance, at the 40th and 80th quantiles (Table 6) oil price shocks exerts a positive and significant impact, implying that certain groups of firms—perhaps those perceived as more resilient to or even benefiting from oil price volatility—can experience return gains under abrupt oil market movements, whereas those in lower or middle quantiles are more adversely affected.

A second major point of divergence lies in the behavior of inflation. Inflation becomes significantly negative at the 50th, 60th, and 80th quantiles (Table 5), indicating that mid and higher-performing stocks suffer more from inflationary pressures under the oil price specification. By contrast, inflation (Table 6) emerges as significantly negative primarily around the median (50th quantile) while losing significance elsewhere. This pattern shift might imply that once oil price shocks are explicitly captured, the role of inflation in explaining cross-quantile stock return differences becomes less uniform—highlighting the possibility that some inflationary effects, at least for certain quantiles, are subsumed by the volatility introduced by sudden oil price changes.

Regarding renewable energy consumption, both tables show negative and statistically significant impacts across quantiles, but Table 6 features somewhat larger coefficient magnitudes at certain points (such as the 80th quantile). This discrepancy suggests that, when controlling for oil price shocks rather than mere oil price levels, the transition toward renewable energy may pose an even greater challenge for high-return stocks, many of which could be tied to traditional energy value chains. In other words, these firms might confront sharper declines in valuation as the economy shifts away from fossil fuels, especially if abrupt oil market swings accelerate the realignment of investor preferences.

In both tables, natural resources remain statistically insignificant across all reported quantiles, implying that near-term stock returns are not strongly linked to a broader measure of resource-based income—even when considering the possibility of oil market fluctuations. This consistency highlights that resource abundance (as measured by rents) might be too distant or slow-moving a factor to shape the immediate distribution of stock returns, particularly when direct oil price movements or shocks command investor attention.

Finally, real economic activity exhibits a consistently negative and significant relationship in both tables. However, Table 6 sometimes captures larger absolute values at select quantiles, pointing to the heightened sensitivity of certain firms—particularly those at the low or high extremes of the return distribution—to changes in economic conditions under the oil price shocks specification. Thus, although real economic activity is robustly negative in both settings, incorporating unexpected oil price dynamics appears to accentuate the adverse effect of macroeconomic fluctuations on certain subgroups of stocks.

5. CONCLUSIONS AND SUGGESTIONS

This research explores the influence of oil prices, oil price shocks, natural resource availability, inflation, economic activity, and renewable energy consumption on European stock market performance between 1991 and 2023. By treating Europe as an integrated entity, the study provides a comprehensive perspective on the factors shaping equity market outcomes during both stable and volatile periods. A combination of least squares and quantile regression methods was employed, with the former establishing baseline average effects and the latter revealing how these variables impact various performance levels across the market spectrum. The results indicate that rising oil prices negatively affect European stock markets by increasing production costs and squeezing profit margins for companies dependent on petroleum inputs. However, unexpected oil price shocks yielded mixed effects, with certain market segments demonstrating resilience or even benefiting from abrupt price fluctuations. Economic activity exhibited a consistently negative relationship with stock market performance, possibly reflecting investor concerns over inflationary pressures, interest rate hikes, and other growth-related risks. Inflation also emerged as a critical variable, eroding purchasing power and raising borrowing costs, which further weighed on equity returns. The transition to renewable energy showed short- to medium-term negative effects on stock market performance. This is likely due to transitional challenges that diminish the value of traditional fossil-fuel-based industries before the renewable sector matures and gains broader market traction. Based on these findings, several actionable recommendations are suggested. Policymakers should establish robust mechanisms to mitigate the impacts of oil price volatility, such as enhancing transparency, expanding hedging options, and developing tools to stabilize markets during sudden price shifts. Monetary authorities must carefully monitor inflation risks, as persistent price pressures disproportionately affect specific market segments. Clear communication on interest rate policies and economic objectives can help maintain investor confidence. A measured, well-coordinated transition to renewable energy is also essential. Investing in green technologies is crucial for long-term sustainability, but a gradual approach can minimize disruptions to traditional energy sectors. Lastly, firms should focus on adaptive strategies, such as hedging against energy price volatility, diversifying energy sources, and prioritizing innovation in clean technologies to build resilience. By implementing these strategies, European stock markets can better withstand external shocks, support sustainable transitions, and foster a more stable investment environment.

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