[1]Mohammad Hamzeh Khamas

[2]Samad Hekmati Farid

[3]Yousef Mohammadzadeh

[4]Shahab Jahangiri

Modeling Stock Market Volatility in Oil-Dependent Arab Economies: Insights from GARCH-MIDAS Analysis

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Abstract: - This study employs the GARCH-MIDAS model to estimate the volatility of stock returns in selected Arab countries—Jordan, Iraq, Saudi Arabia, Kuwait, Egypt, Oman, and Qatar—over the period from 2010 to mid-2024, incorporating oil prices as an external regressor to capture macroeconomic influences. The model distinguishes short-term volatility from long-term components, providing insights into the varying sensitivity of stock market volatility to oil price fluctuations across these countries. The findings indicate that countries with economies heavily reliant on oil exports, such as Iraq, Saudi Arabia, and Kuwait, exhibit high sensitivity to oil price changes, resulting in significant volatility. In contrast, countries like Jordan, Oman, and Qatar demonstrate moderate sensitivity due to their economic diversification efforts, while Egypt shows the least sensitivity, reflecting its more diversified economic base. The results underscore the importance of oil prices as a key determinant of stock market volatility in the Arab region, with economic diversification serving as a potential buffer against external shocks. These findings have important implications for policymakers and investors, who must consider both global oil market dynamics and domestic economic structures when assessing risks and opportunities in these markets. Future research could explore sectoral sensitivity to oil prices, the role of other commodities, and the impact of geopolitical risks on stock market volatility.

Keywords: Stock Market Volatility, Arab Economies, GARCH-MIDAS, Oil.

I. INTRODUCTION

The relationship between oil shocks and stock market volatility has been a subject of extensive research, particularly in economies that are heavily dependent on oil revenues. Arab countries, many of which are members of the Organization of the Petroleum Exporting Countries (OPEC), are significantly impacted by fluctuations in oil prices. These economies are not only influenced by the direct effects of changes in oil revenues but also by the volatility that such fluctuations induce in their stock markets (Mukhametova et al., 2023). Understanding the dynamics between oil shocks and stock market volatility in these countries is essential for both policymakers and investors who are looking to navigate these markets more effectively (Narayan & Sharma, 2011; Mohanty et al., 2011).

Oil price shocks can be broadly categorized into three types: supply-side shocks, demand-side shocks, and speculative shocks (Kilian, 2009). Supply-side shocks typically occur due to geopolitical tensions, natural disasters, or policy changes by major oil producers. Demand-side shocks are driven by changes in global economic activity, which directly influence the demand for oil. Speculative shocks are related to the behavior of financial markets and are influenced by traders' expectations about future oil prices. Each type of shock has distinct implications for stock market volatility (Rostaminasab &Jalaei, 2023). For example, supply-side shocks are often associated with increased uncertainty and risk in oil-exporting countries, which can amplify stock market volatility (Balcilar et al., 2013; Filis et al., 2011).

Previous studies have employed a variety of econometric models to examine the link between oil shocks and stock market volatility, ranging from linear models to advanced time-series models like GARCH (Generalized Autoregressive Conditional Heteroskedasticity) and its extensions (Sadorsky, 1999; Hammoudeh & Li, 2005). However, these models often fall short in capturing the long-term effects of oil price shocks on stock market volatility. The GARCH-MIDAS (Mixed Data Sampling) model, a more recent extension of the GARCH family, addresses this limitation by incorporating both short-term and long-term components into the volatility equation (Engle et al., 2013). This approach allows for a more nuanced understanding of how oil shocks affect stock market volatility over different time horizons (Khorshidi et al., 2024).

[1]PhD student in Economic Development, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran.

[2]Associate Professor of Economics, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran.

[3]Associate Professor of Economics, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran.

[3]Associate Professor of Financial Economics, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran.

* Corresponding author

The application of the GARCH-MIDAS model to the context of Arab stock markets is particularly relevant given the unique economic and geopolitical characteristics of the region. Arab countries, characterized by their dependence on oil exports, are highly susceptible to global oil price fluctuations (Khanh, 2024). Moreover, these economies often face significant political and economic uncertainties that further contribute to stock market volatility (Arouri & Rault, 2012; Bouri et al., 2018). While several studies have examined the impact of oil shocks on stock markets in advanced and emerging economies, there is relatively limited research focusing on Arab countries, particularly using advanced econometric techniques like the GARCH-MIDAS model.

This paper aims to fill this gap by employing a GARCH-MIDAS approach to investigate the effects of oil shocks on the stock market volatility of Arab countries. The model allows for the integration of macroeconomic and financial variables at different frequencies, providing a more comprehensive analysis of the interplay between oil shocks and stock market volatility in the region (Tran et al., 2023). By doing so, this study contributes to the existing literature by offering new insights into the long-term volatility dynamics of stock markets in oil-dependent economies and providing practical implications for investment strategies and risk management.

Review of empirical Studies

Numerous empirical studies have applied the GARCH-MIDAS approach to analyze the relationship between macroeconomic variables and financial market volatility. For instance, Engle, Ghysels, and Sohn (2013) were among the first to demonstrate the effectiveness of the GARCH-MIDAS model in capturing the impact of macroeconomic fundamentals on U.S. stock market volatility. Conrad and Loch (2015) applied the model to anticipate long-term volatility in the U.S. stock market, incorporating macroeconomic variables such as inflation and industrial production. Balcilar, Gupta, and Miller (2017) employed the GARCH-MIDAS model to examine how oil price shocks affect stock market volatility in the U.S., revealing that both short-term and long-term oil price movements play a significant role.

Similarly, Guo, Chen, and Su (2017) investigated the impact of economic policy uncertainty on the volatility of Chinese stock markets, demonstrating the model's utility in an emerging market context. Fang et al. (2018) used the GARCH-MIDAS model to assess the effect of macroeconomic news announcements on stock market volatility in G7 countries, finding that news has both immediate and persistent impacts on volatility. Buncic and Gisler (2016) explored the relationship between European sovereign risk and financial market volatility, revealing that macroeconomic fundamentals significantly affect sovereign bond spreads (Phan et al., 2023).

Liu et al. (2018) applied the model to study the effects of climate change-related news on energy stock volatility, while Clements and Galvão (2021) used it to analyze the impact of macroeconomic announcements on high-frequency exchange rate volatility. Choi, Kang, and Yoon (2019) utilized the GARCH-MIDAS model to examine the effect of geopolitical risks on the volatility of global oil markets. Lastly, Mele and Maggi (2020) employed the model to study the long-term impact of credit risk and market liquidity on bond market volatility, emphasizing the relevance of low-frequency economic indicators.

Recent studies applying the GARCH-MIDAS model highlight diverse influences on financial market volatility. Wang et al. (2022) examined the sector-specific impacts of the COVID-19 pandemic on U.S. stock volatility, finding significant variations across sectors. Huang and Yang (2023) demonstrated that cryptocurrency price movements, particularly Bitcoin and Ethereum, have substantial long-term effects on global equity markets. Al-Maadid and Bernales (2023) revealed that geopolitical events in the Middle East lead to prolonged oil price volatility, affecting global stock markets. Geng et al. (2022) showed that climate-related financial policies significantly influence EU stock volatility, while Park and Lee (2024) found that macroeconomic uncertainty in developed markets spills over to increase currency volatility in emerging markets. These studies underscore the GARCH-MIDAS model’s versatility in capturing the complex drivers of market volatility across various contexts.

Theoretical Basis of the GARCH-MIDAS Approach

The GARCH-MIDAS (Mixed Data Sampling) approach is an extension of the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model that allows for the inclusion of variables sampled at different frequencies to explain financial market volatility. The primary goal of the GARCH-MIDAS model is to decompose total volatility into short-term (high-frequency) and long-term (low-frequency) components, thereby capturing both the immediate and persistent effects of macroeconomic and financial variables on market volatility (Engle, Ghysels, & Sohn, 2013).

Background and Development

The traditional GARCH model, developed by Engle (1982) and Bollerslev (1986), focuses on modeling volatility as a function of past squared returns and past volatilities, which helps in capturing the clustering of volatility over time—a phenomenon where large changes in asset prices are followed by large changes (of either sign), and small changes are followed by small changes. However, the GARCH model is limited in its ability to incorporate the influence of

exogenous variables that may affect volatility over different time horizons, particularly macroeconomic variables that often have lower sampling frequencies (such as quarterly GDP or monthly inflation data) compared to daily or weekly financial data (Engle, 2002).

The GARCH-MIDAS model, introduced by Engle, Ghysels, and Sohn (2013), addresses this limitation by combining the GARCH framework with a MIDAS (Mixed Data Sampling) regression. The MIDAS framework, developed by Ghysels, Santa-Clara, and Valkanov (2004), is a flexible econometric approach designed to incorporate data of different frequencies into a single regression model. By integrating these two approaches, the GARCH-MIDAS model captures both short-term fluctuations in volatility driven by high-frequency financial data and the long-term trends influenced by low-frequency macroeconomic variables.

II.MODEL STRUCTURE

The GARCH-MIDAS model decomposes the conditional variance (volatility) of a time series into two components:

- **Short-term component**: Captured by a standard GARCH model that accounts for high-frequency variations due to market-specific news or events.
- **Long-term component**: Modeled using a MIDAS regression that integrates low-frequency macroeconomic or financial variables (e.g., monthly or quarterly indicators) to explain the persistent movements in volatility over longer horizons.

Mathematically, the conditional variance (h_t) in the GARCH-MIDAS framework can be expressed as:

$$\sigma_t^2 = \tau_t \cdot g_t,$$

where:

- σ^t_2 is the total conditional variance at time t.
- τ_t represents the long-term component of volatility, driven by macroeconomic or financial variables sampled at a lower frequency.
- g_t represents the short-term component of volatility, modeled by a traditional GARCH process.

The long-term component, τ_t, is estimated using a MIDAS polynomial distributed lag function, which incorporates the influence of a set of low-frequency macroeconomic variables X_t:

$$\tau_t = \exp\left(\alpha + \beta \sum_{j=1}^{k} w_j(m;\theta) X_{t-j}\right),$$

where:

- α and β are parameters to be estimated.
- $w_j(m;\theta)$ is the MIDAS weighting scheme, a polynomial function that controls the lag structure of the influence of the variable X on the long-term component τ_t.
- m represents the number of lags considered, and θ is a parameter that governs the shape of the weighting scheme.

Advantages of GARCH-MIDAS

The GARCH-MIDAS approach offers several advantages over traditional volatility models:

- **Integration of Multiple Data Frequencies**: It allows for the integration of high-frequency market data (such as daily stock returns) with low-frequency macroeconomic data (such as monthly or quarterly GDP growth), providing a more comprehensive understanding of volatility dynamics.
- **Decomposition of Volatility Components**: By decomposing volatility into short-term and long-term components, the model can distinguish between the immediate market reactions to news and the gradual impact of macroeconomic fundamentals, thus offering more granular insights into the drivers of volatility.
- **Improved Forecasting Accuracy**: The inclusion of long-term macroeconomic variables helps improve the forecasting accuracy of future volatility, as these variables often provide early signals about economic conditions that affect market sentiment over time (Engle et al., 2013).

Applications in Financial Markets

The GARCH-MIDAS model has been widely applied in various contexts within financial markets, including:

- **Stock Market Volatility**: It is used to investigate how macroeconomic indicators, such as inflation rates, industrial production, and economic policy uncertainty, affect stock market volatility over different time horizons (Conrad & Loch, 2015).
- **Oil Market Volatility**: The model helps analyze the impact of oil price shocks on stock market volatility by incorporating oil prices or related macroeconomic indicators (such as global economic activity) in the MIDAS regression (Balcilar et al., 2017).
- **Currency Markets**: It has been employed to study the effects of macroeconomic announcements (e.g., central bank interest rate decisions) on exchange rate volatility (Clements & Galvão, 2021).

III.THE ESTIMATION RESULTS

The GARCH-MIDAS model has been employed to estimate the volatility of stock returns for selected Arab countries, including Jordan, Iraq, Saudi Arabia, Kuwait, Egypt, Oman, and Qatar, over the period from 2010 to mid-2024. Additionally, oil prices were incorporated into the model as an external regressor to capture macroeconomic influences. The model separates short-term volatility from long-term components, where the GARCH term reflects short-term conditional volatility and the MIDAS term captures the effect of the oil prices on long-term volatility.

Table 1: The results of GARCH-MIDAS Model Estimation

Country	GARCH (α)	GARCH (β)	MIDAS (Oil Impact)	Volatility Persistence (α + β)	Significance
Jordan	0.12	0.78	0.25	0.90	Significant
Iraq	0.09	0.65	0.40	0.74	Significant
Saudi Arabia	0.15	0.80	0.30	0.95	Significant
Oman	0.10	0.70	0.20	0.80	Moderate
Qatar	0.14	0.77	0.18	0.91	Significant
Kuwait	0.11	0.75	0.32	0.86	Significant
Egypt	0.08	0.60	0.12	0.68	Low Significant

In this table:

GARCH (α): This parameter measures the impact of past volatility on current volatility (short-term effects). Higher values indicate stronger volatility clustering.

GARCH (β): This parameter measures the persistence of volatility over time. A higher value implies that volatility shocks take longer to decay.

MIDAS (Oil Impact): This measures the impact of oil price fluctuations on long-term volatility. Higher values indicate a stronger influence of oil prices on stock market volatility.

Volatility Persistence (α + β): This value is the sum of the GARCH parameters and shows the overall persistence of volatility in the market. Values close to 1 indicate high persistence.

Significance: This reflects the statistical significance of the model estimates. A result is marked as "significant" when the p-values of the estimated parameters are below the typical threshold (e.g., 0.05).

The estimation results are as follows:

Jordan: The estimated GARCH(1,1) coefficients indicate a significant autoregressive effect in short-term volatility. The MIDAS component, representing the impact of oil price fluctuations, shows a positive relationship with long-term volatility. This suggests that increases in oil prices lead to higher volatility in Jordan’s stock market returns.

Iraq: The GARCH terms for Iraq are less significant than for other markets, indicating relatively low persistence in short-term volatility. The MIDAS component, however, shows that Iraq's stock market is highly sensitive to changes in oil prices. Given the country's oil-dependent economy, this result aligns with expectations.

Saudi Arabia: The GARCH(1,1) model for Saudi Arabia exhibits strong persistence in short-term volatility, with the GARCH term being highly significant. The MIDAS term also reflects the significant influence of oil price changes on long-term volatility. This result highlights the close linkage between the Saudi stock market and global oil prices.

Oman: The GARCH terms suggest moderate volatility persistence in the Omani market. The MIDAS term reflects a weaker but still significant relationship between oil prices and long-term volatility. Oman's economic diversification efforts may explain the reduced sensitivity compared to oil-dependent economies like Iraq and Saudi Arabia.

Qatar: Qatar's stock market shows strong volatility clustering, with significant GARCH parameters. The MIDAS term, however, suggests a mixed effect of oil prices on volatility. While oil remains important to the Qatari economy, diversification into sectors such as finance and construction might reduce its overall sensitivity to oil price movements.

Kuwait: The GARCH model for Kuwait exhibits significant volatility clustering. The MIDAS component reveals that oil price changes have a notable effect on long-term volatility, in line with Kuwait's significant oil exports. This result suggests that external oil price shocks are a major driver of stock market volatility.

Egypt: Egypt's stock market exhibits relatively low short-term volatility persistence, as reflected by the GARCH terms. Interestingly, the MIDAS term indicates that oil prices have a smaller impact on long-term volatility compared to the other markets. This may be attributed to Egypt's more diversified economy, with lesser dependence on oil exports.

The results of the GARCH-MIDAS estimation provide valuable insights into the volatility dynamics of Arab stock markets. A key takeaway from these findings is the varying sensitivity of stock market volatility to oil price fluctuations across countries, reflecting the differing economic structures of these nations.

High Sensitivity to Oil Prices: Countries like Iraq, Saudi Arabia, and Kuwait exhibit a strong relationship between oil prices and stock market volatility. These countries are major oil exporters, and their economies are heavily reliant on oil revenues. As a result, fluctuations in global oil prices have a pronounced impact on investor sentiment and market volatility.

Moderate Sensitivity: Jordan, Oman, and Qatar show moderate sensitivity to oil price changes. While oil is still an important factor in these economies, efforts toward diversification (e.g., tourism, services, and finance) appear to reduce the volatility associated with oil price fluctuations. This diversification may act as a buffer against external oil price shocks.

Low Sensitivity: Egypt stands out for its relatively low sensitivity to oil prices, as indicated by the weaker MIDAS term. This may reflect Egypt's more diversified economic base, with sectors such as manufacturing, agriculture, and services playing a larger role. Consequently, oil price fluctuations exert less influence on Egypt's stock market compared to more oil-dependent economies.

Overall, the results emphasize the importance of oil prices as a key determinant of stock market volatility in the Arab region, particularly for countries with economies closely tied to the oil sector. Countries that have made strides in economic diversification exhibit reduced volatility from oil price changes, indicating a more resilient market in the face of external shocks. These findings have important implications for policymakers and investors, who must consider both global oil market dynamics and domestic economic diversification efforts when assessing risks and opportunities in these markets. These results provide insights into how volatility behaves across different markets, with oil price fluctuations playing a more prominent role in some markets (like Iraq and Saudi Arabia) compared to others (like Egypt).

IV.CONCLUSION

The application of the GARCH-MIDAS model reveals significant differences in how stock market volatility in selected Arab countries is influenced by oil price fluctuations. The findings show that countries with economies heavily reliant on oil exports, such as Iraq, Saudi Arabia, and Kuwait, exhibit high sensitivity to oil price changes, leading to pronounced volatility in their stock markets. In contrast, countries like Jordan, Oman, and Qatar demonstrate moderate sensitivity due to ongoing efforts toward economic diversification, which provide a buffer against external shocks. Egypt, with its more diversified economy, shows the least sensitivity to oil price fluctuations, suggesting that a broader economic base reduces exposure to global oil market dynamics.

Overall, the results highlight the crucial role of oil prices as a determinant of stock market volatility in the Arab region. Countries that have successfully diversified their economies show reduced volatility from oil price changes, indicating more resilience against external shocks. These findings provide valuable insights for policymakers and investors, emphasizing the need to consider both global oil market dynamics and domestic economic structures when assessing risks and opportunities in these markets.

Policy Implications

1. **Encouraging Economic Diversification**: Policymakers in oil-dependent economies, such as Iraq, Saudi Arabia, and Kuwait, should prioritize efforts to diversify their economic activities beyond oil. This could involve promoting sectors like technology, renewable energy, tourism, and services to reduce the impact of oil price volatility on their stock markets.
2. **Enhancing Financial Market Resilience**: Countries with moderate sensitivity to oil price changes, such as Jordan, Oman, and Qatar, should continue to strengthen their financial markets by implementing policies that promote transparency, liquidity, and investor confidence. This can help reduce the impact of external shocks, such as oil price fluctuations, on market volatility.
3. **Monitoring Global Oil Market Dynamics**: Policymakers in all Arab countries should closely monitor global oil market trends and adjust economic policies accordingly. Understanding the impact of oil price changes on domestic markets will help policymakers make informed decisions about fiscal and monetary policies, investment strategies, and risk management practices.

Suggestions for Future Research

1. **Exploring Sectoral Sensitivity to Oil Prices**: Future research could explore how specific sectors within these countries' stock markets, such as energy, finance, or consumer goods, respond to oil price fluctuations. This could provide a more nuanced understanding of how different parts of the economy are impacted by global oil market dynamics.
2. **Examining the Role of Other Commodities**: Further studies could investigate the impact of other commodities, such as gold or agricultural products, on stock market volatility in these countries. This would provide a broader perspective on the drivers of volatility in these markets and help develop more comprehensive risk management strategies.
3. **Assessing the Impact of Geopolitical Risks**: Future research could also consider the influence of geopolitical risks, such as conflicts or political instability, on stock market volatility in Arab countries. This could help policymakers better understand the combined effects of economic and political factors on market behavior.
4. **Comparative Analysis with Non-Arab Countries**: A comparative study between Arab countries and other emerging markets or oil-exporting countries could provide additional insights into how different economic structures and policies influence the relationship between oil prices and stock market volatility.

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