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Interconnectedness of Arab Stock Markets, Oil, and Agricultural Commodities: Insights from a Frequency TVP-VAR Model

Anfal Ayad Hamood, Samad Hekmati Farid* and Shahab Jahangiri

PhD student in Economic Development, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran. mscanfal@gmail.com

Associate Professor of Economics, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran. Kh.jahangiri@urmia.ac.ir

Associate Professor of Financial Economics, Department of Economics, Faculty of Economics and Management, Urmia University, Urmia, Iran. s.hekmati@urmia.ac.ir

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ABSTRACT

This study investigates the interconnectedness between the stock markets of Arab countries (Saudi Arabia, Egypt, Qatar, the United Arab Emirates, Jordan, and Iraq) and the prices of oil and agricultural commodities, highlighting its implications for global economic stability and regional financial resilience. Employing the Frequency Time-Varying Parameter Vector Autoregressive (Frequency TVP-VAR) model, the analysis spans from 2010 to 2023 and reveals both short-term and long-term interdependencies among these markets. The findings show that oil-exporting countries are directly impacted by oil price volatility, which affects government revenues and economic growth, while oil-importing countries face inflationary pressures due to rising energy costs. The study also identifies agricultural commodities as both transmitters and receivers of risk, with complex spillover effects driven by external shocks, market conditions, and geopolitical tensions. These insights provide valuable guidance for portfolio management, investment strategies, and policy decisions in an environment characterized by high price volatility and uncertainty.

Keywords: *Frequency TVP-VAR, Stock Market, Oil, Agricultural Commodities*

1- INTRODUCTION

The interconnectedness between the stock markets of Arab countries and the prices of oil and agricultural commodities is a critical area of investigation due to its profound implications for global economic stability and regional financial resilience. Arab countries, such as Saudi Arabia, Egypt, Qatar, the United Arab Emirates, Jordan, and Iraq, are pivotal players in global energy production and increasingly exert significant influence over agricultural markets (El-Masry et al., 2021). Understanding the dynamic relationships between their stock markets, oil prices, and agricultural commodity prices is crucial for investors, policymakers, and researchers, as it provides insights into risk management, investment strategy formulation, and economic policy adjustments in these volatile markets (Arouri & Rault, 2012).

The relationship between oil prices and the stock markets of these countries is complex and multifaceted. For oil-exporting nations like Saudi Arabia, Qatar, and Iraq, fluctuations in oil prices have a direct impact on government revenues, foreign exchange reserves, and overall economic growth (Taghizadeh-Hesary et al., 2018; Bhattacharya et al., 2020). Studies have shown that sharp declines in oil prices can lead to budget deficits and economic contraction in these countries, further transmitting negative shocks to their stock markets (Al-Maadid et al., 2020). Conversely, oil-importing countries such as Egypt and Jordan are more vulnerable to inflationary pressures due to rising energy costs, which can destabilize their stock markets and overall economic conditions (Antonakakis et al., 2020a; Sharma et al., 2019). The interconnectedness is further complicated by agricultural commodity prices, which are influenced by global factors such as climate change, supply chain disruptions, and trade policies (Parker, 2017; Koirala et al., 2022).

Recent empirical research employing advanced econometric models, such as the Time-Varying Parameter Vector Autoregressive (TVP-VAR) model, has revealed that the relationship between energy and agricultural commodities encompasses both short-term and long-term interdependencies (Zhu et al., 2022). Furuoka et al. (2023) demonstrated that oil prices have a limited but significant transmission effect on agricultural commodity prices, with variations often driven by external shocks like geopolitical conflicts and pandemics. This finding aligns with earlier studies by Awartani et al. (2013), who examined the directional spillover effects from oil prices to stock markets in the Gulf Cooperation Council (GCC) countries, highlighting the asymmetric nature of these relationships.

Furthermore, the role of agricultural commodities as both transmitters and receivers of risk has gained increased recognition in recent literature (Gong & Xu, 2022; Umar et al., 2021). Gong and Xu (2022) identified bi-directional spillover effects between the energy and agricultural markets, suggesting a complex interplay influenced by market conditions, trade policies, and external shocks. Diebold and Yilmaz (2012) also noted that the degree of market connectedness tends to intensify during periods of financial crises or geopolitical tensions, such as the ongoing Russia-Ukraine conflict, which has significantly disrupted both energy and agricultural markets globally (Bentzen, 2023).

This study leverages data from early 2010 to the end of 2023 to empirically assess the connectedness between the stock markets of the selected Arab countries (Egypt, Iraq, Kuwait and Saudi Arabia), oil prices, and agricultural commodities. Utilizing the TVP-VAR model framework, the study aims to provide a comprehensive analysis of both the short-term and long-term dynamics. By doing so, it seeks to offer critical insights into portfolio management and policy decisions in these interconnected markets, especially during periods of high price volatility and uncertainty.

2- REVIEW OF LITERATURE

The relationship between the stock markets of Arab countries and the prices of oil and agricultural commodities has been a subject of growing interest among economists and financial analysts due to the unique economic structure of these countries and their significant roles in global energy and agricultural markets. Arab countries, such as Saudi Arabia, Egypt, Qatar, the United Arab Emirates, Jordan, and Iraq, have diverse economic profiles, with some being major oil exporters and others dependent on agricultural imports. Understanding the dynamic relationships between their stock markets, oil prices, and agricultural commodity prices is crucial for making informed investment decisions and formulating effective economic policies.

Several studies have explored the relationship between energy markets, agricultural commodities, and financial markets, using various econometric models and approaches to understand the nature and extent of these interdependencies.

Diebold and Yilmaz (2012) made a seminal contribution by developing a framework for measuring volatility spillovers across financial markets. Their work, which uses a vector autoregressive (VAR) model to analyze return and volatility spillovers among stock, bond, foreign exchange, and commodity markets, has been widely applied in subsequent research to understand how shocks in one market can impact others. In their study, Diebold and Yilmaz demonstrated that financial crises tend to amplify volatility spillovers, suggesting that the degree of market connectedness intensifies during periods of economic stress.

Building on this framework, Awartani and Maghyreh (2013) investigated the spillover effects between the US stock market and six stock markets in the Gulf Cooperation Council (GCC) countries from 2004 to 2012. They found that there were significant volatility spillovers from the US market to GCC markets, particularly during the 2008 global financial crisis. Their findings also highlighted that oil price movements had substantial spillover effects on GCC stock markets, given these countries' heavy dependence on oil exports.

Taghizadeh-Hesary et al. (2018) examined the linkage between energy prices and food security, particularly focusing on how price volatility in energy markets can impact agricultural commodity prices. Their study found that energy price shocks, particularly in oil, tend to trigger co-movement in agricultural commodity prices, as both sectors are interconnected through production and transportation costs. This co-movement is more pronounced in periods of high volatility, such as during geopolitical conflicts or global economic downturns.

Antonakakis et al. (2020a) extended the analysis of connectedness between different markets by refining the measures of dynamic connectedness based on time-varying parameter vector autoregressions (TVP-VAR). This approach allows for a more flexible analysis of the dynamic and evolving nature of market interdependencies, capturing both the short-run and long-run connectedness. They applied this methodology to explore the relationships between oil prices and various asset classes, demonstrating that oil price shocks can have varying impacts on different markets, depending on the underlying economic conditions and time horizons.

Further expanding on the concept of market connectedness, Gong and Xu (2022) analyzed the spillover effects among five types of commodity markets: energy, precious metals, industrial metals, agriculture, and livestock products, from 2008 to 2020. They identified that energy, precious metals, and industrial metals are net providers of spillover effects, while agricultural and livestock products are net receivers. This study underscores the importance of understanding bi-directional spillover effects in commodity markets and how these effects can vary over time and across different market conditions.

Moreover, Adekoya et al. (2022a) applied an asymmetric TVP-VAR model to examine the connectedness between crude oil prices and Islamic sectoral stocks. Their findings suggest that asymmetric effects are present in these markets, with negative oil price shocks having a more substantial impact on sectoral stocks than positive shocks. This asymmetry in market behavior is crucial for understanding risk management and investment strategies, particularly in periods of high market uncertainty.

Furuoka et al. (2023) focused specifically on the transmission of risks between energy and agricultural commodities using a frequency time-varying VAR model. Their research found that only 32.52% of the connectedness in oil prices and 31.38% in natural gas prices are transmitted to agricultural commodities, indicating a weak tendency of these energy markets to influence agricultural markets. However, the study also showed that certain agricultural commodities, such as corn, wheat, and flour, are net transmitters of risk to oil and natural gas markets, especially during periods of market uncertainty, such as the COVID-19 pandemic and the 2022 Russia-Ukraine conflict. This finding highlights the complexity of the relationships between these markets and the importance of considering both short-run and long-run dynamics.

Overall, these studies contribute to a deeper understanding of the dynamic relationships between energy and agricultural commodity markets and their impact on stock markets in Arab countries. This study will build on these findings by using data from Investing.com and applying a refined TVP-VAR model to capture both the short-term and long-term interdependencies between these markets. It will provide empirical evidence to help policymakers and investors better understand the complexities of these interconnected markets, especially in the context of the ongoing global challenges posed by geopolitical tensions and economic volatility.

3- METHODOLOGY

The paper employs a Frequency Time-Varying Parameter Vector Autoregressive (Frequency TVP-VAR) model to analyze the short-run and long-run connectedness between selected stock markets, energy and agricultural commodities. This methodology allows for capturing dynamic relation over different time horizons, incorporating both short-term fluctuations and long-term trends. The Frequency TVP-VAR model extends the standard TVP-VAR framework by decomposing the connectedness into different frequencies.

The estimation of the Frequency TVP-VAR model typically involves a two-step process:

1. **Decomposition into Frequency Components:** The time series data is first decomposed into different frequency bands using techniques such as Fourier transforms or wavelet transforms. This step allows the model to distinguish between the different cyclical behaviors (e.g., high-frequency fluctuations corresponding to short-term variations and low-frequency components related to long-term trends).
2. **Time-Varying Parameter Estimation:** After decomposition, the parameters of the VAR model are estimated for each frequency component. This is commonly done using Bayesian estimation techniques, such as the Kalman filter or the Markov Chain Monte Carlo (MCMC) methods, which are well-suited to handle the complexity of time-varying parameters and the high dimensionality of the frequency-domain data.

The study investigates how the stock markets of Arab countries, specifically Saudi Arabia, Egypt, Kuwait and Iraq are influenced by the prices of oil and agricultural commodities such as wheat, coffee, and corn. Oil, being a primary energy source, is considered a key indicator of the overall energy market, while agricultural commodities represent essential goods whose prices fluctuate based on global supply and demand dynamics.

- **Oil Prices as a Key Driver:** The analysis focuses on Brent crude oil prices, which are seen as a primary driver influencing the stock markets in oil-exporting Arab countries. Brent prices have exhibited significant volatility from 2010 to 2022, particularly during economic crises and geopolitical events.
- **Agricultural Commodity Prices:** Commodities like coffee, wheat, and corn also show significant price variations influenced by factors such as climate change, geopolitical tensions, and economic policies. These commodities' price fluctuations affect stock market performance, especially in countries that are major importers or exporters of these goods.

4- Descriptive Statistics

The descriptive statistics, such as mean, variance, skewness, kurtosis, and the Jarque-Bera test, provide insights into the distribution and volatility of returns for different markets.

Table1: Descriptive Statistics

Variable	stock Egyptian market index	Iraqi stock market index	Kuwait stock market index	Saudi Arabia stock market index	Brent crude oil	coffee	wheat	corn
mean	0.054	0.054	0.021	0.025	0.023	0.027	0.018	0.011
Variance	2.037	2.037	0.615	1.111	4.483	3.725	3.752	2.39
kurtosis	-0.435	-0.435	-1.547	-0.795	-0.682	0.836	1.887	-1.182
Skewness	5.042	5.042	9.017	11.324	22.984	13.333	36.878	18.447
Jarque-Bera Test	3734.039	3734.039	3707.305	19308.969	75630.035	25761.894	196057.843	49346.257
unit root	0.02	0.02	0.059	0.042	0.016	0.047	0.042	0.043
Serial correlation	165.824	165.824	46.95	97.235	61.45	37.096	74.486	55.007
Q2 test	742.965	742.965	270.432	1199.242	1059.772	133.547	156.661	126.5

this table provides a comprehensive statistical summary that highlights the unique distributional properties, stationarity, and autocorrelation characteristics of various stock market indices and commodity prices, aiding in the modeling and forecasting of these time series.

As can be seen in the table, Brent crude oil shows the highest variance, indicating substantial volatility. Among the stock market indices, the Egyptian and Iraqi markets show the highest average returns (0.054), but also relatively high variance (2.037), indicating more risk and potential reward. All variables have high Jarque-Bera test values, suggesting they are not normally distributed, which is common in financial time series data. Most variables show low p-values for the unit root test, indicating stationarity, which is often a prerequisite for many econometric models. High values in the serial correlation and Q2 test rows suggest that many of these time series exhibit serial dependence and volatility clustering, characteristics often observed in financial data.

5- RELATIONSHIP OF VARIABLES

This section of the table presents three types of inter-market communication: overall communication, short-term communication, and long-term communication.

- General: This section displays the percentage of variance in forecast errors that is attributable to shocks within the market itself. Internal elements (diagonal values) show the proportion of a market's variance

that is explained by its own shocks, while external elements (off-diagonal values) represent the variance due to interactions with other markets.

- Short-Term: This section indicates the extent of communication occurring over short periods. Each value represents the proportion of the variance in short-term forecast errors that can be attributed to price shocks in a particular market.
- Long-Term: This section measures the extent of communication over longer time periods. Each value shows how much of the variance in long-term forecast errors is attributable to price shocks from specific markets.

In the table:

- TO represents the amount of influence or shocks a market transmits to other markets. A high TO value indicates that the market is a significant transmitter of shocks, meaning it strongly impacts other markets.
- FROM represents the influence or shocks a market receives from other markets. A high FROM value suggests that the market is heavily affected by shocks and fluctuations originating from other markets.
- Total Communication Index (TCI) is displayed in the "FROM" column. This percentage value shows how much of the total variance of forecast errors across the entire network of markets is caused by inter-market connections.
- Net Pairwise Directional Connectedness (NPDC) measures the net directional relationship between pairs of markets. It represents the difference between the shocks a market sends to another market and the shocks it receives from that market.
 - For each pair of markets, the NPDC value identifies which market is a net sender and which is a net receiver of shocks. A positive NPDC value indicates that the first market (e.g., oil in the pair of oil and wheat) is the net sender of shocks, meaning it transmits more shocks to the second market than it receives. Conversely, a negative NPDC value means the first market is a net receiver, receiving more shocks from the second market than it transmits.

This information helps in understanding the dynamic interactions between different markets, identifying which markets are primary drivers or transmitters of shocks and which are more susceptible to external influences.

Table 2: Relation of variables in Iraq

General						
Variable	Stock market index	Brent crude oil	coffee	wheat	corn	FROM
Stock market index	94.87	3.32	0.46	0.72	0.61	5.13
Brent crude oil	2.61	95.17	0.78	1.04	0.4	4.83
coffee	0.75	0.78	92.15	3.37	2.95	7.85
wheat	0.58	1.09	2.53	70.63	25.17	29.37
corn	0.88	1.44	2.28	25.02	70.38	29.62
TO	4.83	6.64	6.05	30.15	29.14	76.81
Inc. Own	99.7	101.81	98.2	100.78	99.52	cTCI/TCI
Net	-0.3	1.81	-1.8	0.78	-0.48	19.20/15.36
NPDC	2	3	1	2	2	
Short term						
Stock market index	72.93	2.8	0.34	0.6	0.48	4.22

Brent crude oil	1.9	71.8	0.51	0.61	0.28	3.29
coffee	0.57	0.64	73.67	2.65	2.36	6.22
wheat	0.42	0.73	1.9	53.75	18.76	21.8
corn	0.7	1.03	1.81	18.64	53.15	22.19
TO	3.58	5.19	4.56	22.51	21.89	57.73
Inc. Own	76.51	76.99	78.23	76.25	75.04	cTCI /TCI
Net	-0.64	1.9	-1.66	0.7	-0.3	14.43/11.55
NPDC	2	4	0	2	2	
Long term						
Stock market index	21.94	0.53	0.12	0.12	0.13	0.9
Brent crude oil	0.71	23.36	0.27	0.43	0.12	1.54
coffee	0.19	0.14	18.47	0.72	0.59	1.63
wheat	0.17	0.37	0.63	16.88	6.41	7.57
corn	0.18	0.41	0.47	6.38	17.23	7.43
TO	1.24	1.45	1.5	7.64	7.25	19.08
Inc. Own	23.19	24.81	19.97	24.52	24.48	cTCI /TCI
Net	0.34	-0.09	-0.14	0.07	-0.18	4.77/3.82
NPDC	4	1	1	2	2	

Explanation of Each Section:

General Section

- **Diagonal Elements:** These numbers represent the percentage of variance in each market that is explained by its own shocks. For example, 94.87% of the variance in the stock market index is attributed to its own shocks, while 95.17% of the variance in Brent crude oil is due to its own market dynamics.
- **Off-Diagonal Elements:** These values indicate the percentage of variance in one market explained by shocks originating from another market. For instance, 3.32% of the variance in the stock market index is due to shocks from the Brent crude oil market.
- **TO (e.g., Stock market index):** Represents the total percentage of shocks or influence transmitted by each market to other markets. A high TO value indicates a strong transmitter of shocks. Here, wheat (30.15) and corn (29.14) have the highest TO values, meaning they transmit significant shocks to other markets.
- **FROM (e.g., Stock market index):** Shows the total percentage of shocks or influence received by each market from other markets. For example, wheat (29.37) and corn (29.62) receive the most shocks from other markets.
- **Net:** Indicates the net effect of a market as a transmitter or receiver. A positive net value (e.g., Brent crude oil: 1.81) means the market is a net transmitter of shocks, while a negative value (e.g., coffee: -1.8) indicates it is a net receiver.
- **NPDC:** Refers to the Net Pairwise Directional Connectedness, which shows the net spillover effect between pairs of markets. Higher values indicate greater net influence of one market over another.

Short-Term Section

- **Diagonal Elements:** These represent the proportion of variance in each market explained by its own shocks over the short term. For example, 72.93% of the variance in the stock market index is due to its own shocks in the short term.

- **Off-Diagonal Elements:** Indicates the short-term spillover effect from one market to another. For example, 2.8% of the variance in the stock market index is due to shocks from the Brent crude oil market in the short term.
- **TO and FROM:** Similar to the general section but focuses on short-term influences. Wheat (22.51) and corn (21.89) have the highest TO values, indicating they are the strongest transmitters of shocks in the short term.
- **Net and NPDC:** Show the net short-term connectedness between the markets. Brent crude oil (Net: 1.9) is a net transmitter of shocks, while coffee (Net: -1.66) is a net receiver.

Long-Term Section

- **Diagonal Elements:** These represent the proportion of variance in each market explained by its own shocks over the long term. For instance, 21.94% of the variance in the stock market index is due to its own shocks in the long term.
- **Off-Diagonal Elements:** Indicates the long-term spillover effect from one market to another. For example, 0.53% of the variance in the stock market index is due to shocks from Brent crude oil over the long term.
- **TO and FROM:** Measure the long-term influence of markets on each other. In the long term, TO values are much lower than in the short term, indicating less transmission of shocks over a longer horizon. For example, wheat (7.64) and corn (7.25) still have the highest TO values.
- **Net and NPDC:** Indicate net long-term connectedness. Positive Net values (e.g., Stock market index: 0.34) suggest a net transmitter, while negative values (e.g., corn: -0.18) indicate a net receiver of shocks.

Table 3: Relation of variables in Egypt

General						
Variable	Stock market index	Brent crude oil	coffee	wheat	corn	FROM
Stock market index	93.52	3.39	1.31	1.01	0.77	6.48
Brent crude oil	2.66	94.64	1.16	1	0.53	5.36
coffee	1.15	1.66	88.66	3.92	4.61	11.34
wheat	0.66	1.23	2.99	70.08	25.05	29.92
corn	0.54	0.83	3.5	24.77	70.36	29.64
TO	5.01	7.1	8.95	30.71	30.97	82.74
Inc. Own	98.54	101.74	97.61	100.79	101.32	cTCI/TCI
Net	-1.46	1.74	-2.39	0.79	1.32	20.68/16.55
NPDC	0	4	1	2	3	
Short term						
Stock market index	68.36	2	0.84	0.67	0.55	4.06
Brent crude oil	1.94	72.2	0.85	0.71	0.37	3.88
coffee	0.83	1.24	70.82	2.94	3.65	8.66
wheat	0.46	0.94	2.27	54.18	19.23	22.9
corn	0.35	0.6	2.77	18.76	53.75	22.48
TO	3.58	4.77	6.73	23.09	23.8	61.98
Inc. Own	71.94	76.97	77.55	77.27	77.56	cTCI/TCI
Net	-0.48	0.89	-1.92	0.19	1.33	15.49/12.40
NPDC	0	4	1	2	3	

Long term						
Stock market index	25.16	1.39	0.46	0.35	0.22	2.41
Brent crude oil	0.72	22.44	0.31	0.29	0.16	1.48
coffee	0.32	0.42	17.84	0.98	0.96	2.69
wheat	0.2	0.28	0.71	15.9	5.83	7.02
corn	0.2	0.23	0.73	6	16.61	7.16
TO	1.43	2.33	2.22	7.62	7.16	20.76
Inc. Own	26.6	24.77	20.06	23.51	23.77	cTCI/TCI
Net	-0.98	0.85	-0.46	0.6	0	5.19/4.15
NPDC	0	3	1	4	2	

Table 4: Relation of variables in Kuwait

General						
Variable	Stock market index	Brent crude oil	coffee	wheat	corn	FROM
Stock market index	91.9	4.41	1.72	1	0.97	8.1
Brent crude oil	4.07	93.59	0.76	1.14	0.44	6.41
coffee	1.26	0.58	89.84	4.61	3.71	10.16
wheat	0.68	1.56	3.93	79.96	13.86	20.04
corn	0.99	1.04	3.77	13.71	80.49	19.51
TO	7.01	7.58	10.18	20.47	18.99	64.22
Inc. Own	98.9	101.17	100.01	100.43	99.48	cTCI/TCI
Net	-1.1	1.17	0.01	0.43	-0.52	16.06/12.84
NPDC	1	3	3	2	1	
Short term						
Stock market index	69.82	2.64	1.03	0.65	0.69	5.01
Brent crude oil	2.61	69.78	0.48	0.75	0.29	4.13
coffee	0.97	0.48	69.95	3.33	2.92	7.69
wheat	0.52	0.94	2.84	60.93	10.2	14.5
corn	0.65	0.74	3.01	9.96	60.53	14.36
TO	4.75	4.8	7.36	14.69	14.1	45.69
Inc. Own	74.56	74.58	77.31	75.62	74.63	cTCI/TCI
Net	-0.27	0.67	-0.34	0.19	-0.26	11.42/9.14
NPDC	0	3	3	2	2	
Long term						
Stock market index	22.08	1.77	0.69	0.35	0.28	3.09
Brent crude oil	1.46	23.8	0.28	0.39	0.15	2.28
coffee	0.29	0.1	19.88	1.29	0.79	2.47
wheat	0.16	0.62	1.09	19.04	3.66	5.54
corn	0.35	0.3	0.75	3.75	19.96	5.15
TO	2.26	2.79	2.82	5.77	4.89	18.53
Inc. Own	24.34	26.59	22.7	24.81	24.85	cTCI/TCI
Net	-0.83	0.5	0.35	0.24	-0.26	4.63/3.71
NPDC	1	3	2	3	1	

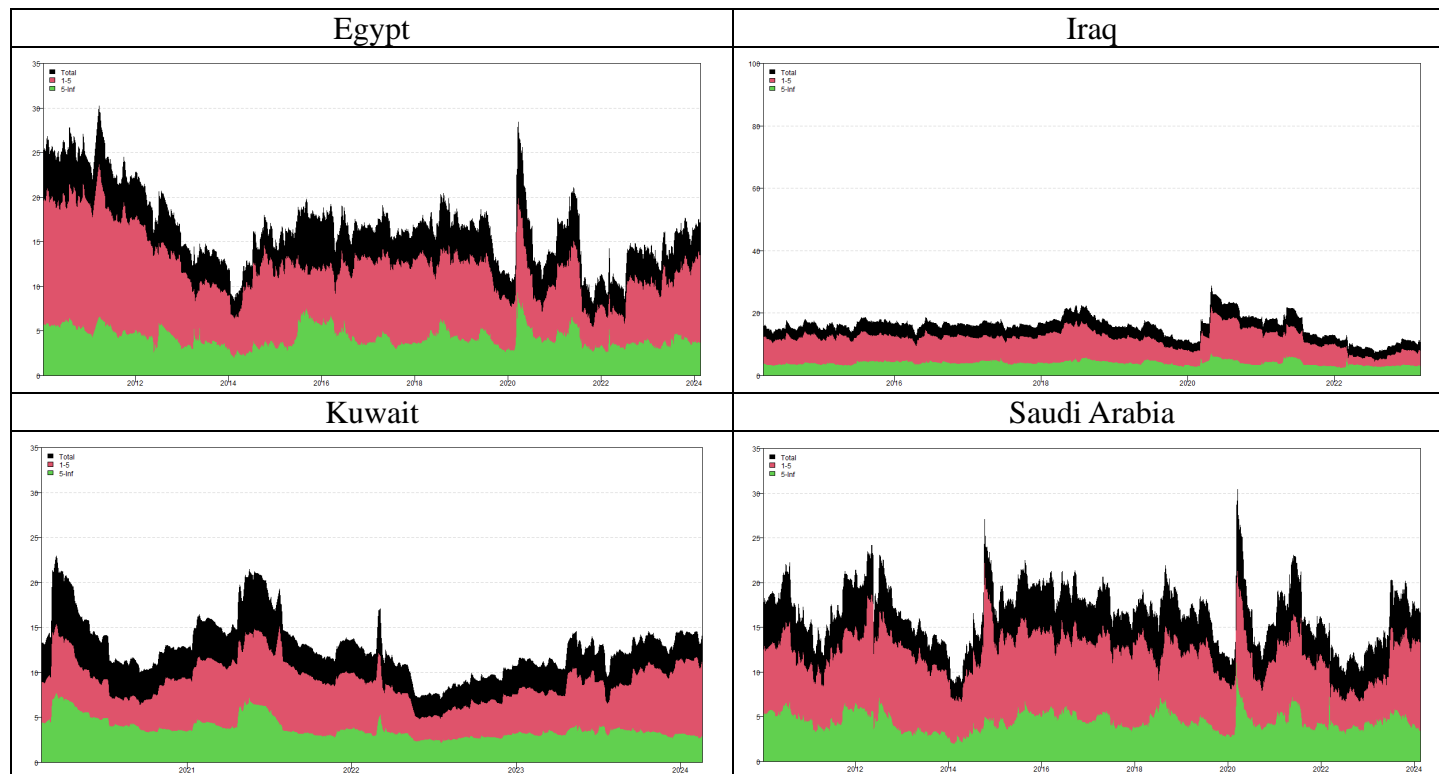
Table 5: Relation of variables in Saudi Arabia

General						
Variable	Stock market index	Brent crude oil	coffee	wheat	corn	FROM
Stock market index	90.87	6.6	0.95	0.96	0.63	9.13
Brent crude oil	4.8	93.27	0.58	0.75	0.6	6.73
coffee	1	1.27	90.42	3.84	3.46	9.58
wheat	0.62	1.07	3.14	71.26	23.91	28.74
corn	0.53	0.86	2.85	23.92	71.83	28.17
TO	6.96	9.8	7.53	29.47	28.6	82.35
Inc. Own	97.83	103.07	97.95	100.72	100.43	cTCI/TCI
Net	-2.17	3.07	-2.05	0.72	0.43	20.59/16.47
NPDC	1	4	0	3	2	
Short term						
Stock market index	68.55	4.04	0.7	0.69	0.48	5.91
Brent crude oil	3.15	69.88	0.35	0.42	0.37	4.29
coffee	0.69	0.89	71.37	2.92	2.56	7.05
wheat	0.43	0.72	2.35	55.32	18.25	21.76
corn	0.39	0.62	2.26	18.15	55.09	21.41
TO	4.66	6.26	5.66	22.17	21.66	60.42
Inc. Own	73.21	76.14	77.02	77.5	76.75	cTCI/TCI
Net	-1.25	1.97	-1.39	0.42	0.25	15.10/12.08
NPDC	0	4	1	2	3	
Long term						
Stock market index	22.32	2.56	0.26	0.26	0.14	3.23
Brent crude oil	1.65	23.39	0.22	0.33	0.23	2.44
coffee	0.31	0.38	19.06	0.92	0.91	2.52
wheat	0.19	0.35	0.79	15.93	5.66	6.99
corn	0.14	0.24	0.6	5.77	16.74	6.76
TO	2.3	3.54	1.87	7.29	6.94	21.93
Inc. Own	24.62	26.93	20.93	23.22	23.68	cTCI/TCI
Net	-0.93	1.1	-0.65	0.3	0.18	5.48/4.39
NPDC	2	4	0	3	1	

6- General Frequency Communication

The following diagrams illustrate the total frequency connectedness among markets, highlighting how the Total Connectedness Index (TCI) evolves over time and across different frequencies.

Figure 1. Stock Markets total frequency connection



Total Connectedness Chart: This chart depicts the proportion of forecast error variance within an economic or financial network that is attributed to the interconnections between different markets. A higher TCI value indicates increased interactions and spillovers between markets.

Black Shaded Areas: These areas represent the overall connectedness over time, reflecting the changes in the TCI index. They show how the degree of connectedness among markets fluctuates throughout different periods.

Red Shaded Areas: These sections illustrate short-term connectedness, indicating the extent to which market variations are due to short-term interactions between markets.

Green Shaded Areas: These sections represent long-term connectedness, showing the extent to which market variations are driven by long-term correlations between markets.

Fluctuations Over Time: The Total Connectedness chart allows observation of how market correlations change over time, distinguishing the contributions of short-term and long-term shocks during different periods.

Changes in TCI: Generally, an increase in the TCI during a specific period suggests heightened interdependence among markets, where fluctuations in one market are rapidly transmitted to others.

This analysis provides insight into the dynamic behavior of market interactions, helping to identify periods of high volatility and strong market linkages.

7- CONCLUSION

The interconnectedness between the stock markets of Arab countries and the prices of oil and agricultural commodities has significant implications for global economic stability and regional financial resilience. The study finds that both short-term and long-term spillovers exist between these markets, influenced by factors such as oil price fluctuations, agricultural commodity prices, geopolitical tensions, and other external shocks.

Key findings reveal that oil-exporting countries like Saudi Arabia, Qatar, and Iraq are directly impacted by oil price volatility, which affects government revenues and overall economic growth, while oil-importing countries like Egypt and Jordan are vulnerable to inflationary pressures caused by rising energy costs. The study also shows that agricultural commodities play a dual role as both transmitters and receivers of risk, with complex interdependencies driven by external shocks and market conditions.

Advanced econometric analysis using the Time-Varying Parameter Vector Autoregressive (TVP-VAR) model highlights the dynamic nature of these relationships, indicating both short-term and long-term interdependencies among stock markets, oil prices, and agricultural commodities. The empirical findings underline that periods of financial crises or geopolitical tensions tend to intensify market connectedness, leading to increased volatility.

Policy Suggestions

Diversification Strategies for Investors: Investors should consider diversification strategies that mitigate risks arising from the interconnectedness of stock markets, oil prices, and agricultural commodities. Given the high level of spillovers, particularly during periods of geopolitical instability or financial crises, diversified portfolios can help cushion the impact of negative shocks.

Adaptive Monetary and Fiscal Policies: Policymakers in Arab countries should adopt adaptive monetary and fiscal policies that account for the volatile nature of oil and agricultural commodity prices. For oil-exporting countries, policies could focus on building foreign exchange reserves during periods of high oil prices to buffer against future price declines. For oil-importing countries, inflation-targeting measures could help manage the inflationary effects of rising energy costs.

Strengthen Regional Economic Cooperation: To reduce vulnerabilities to external shocks, Arab countries could strengthen regional economic cooperation and coordination, particularly in areas like trade policies, energy security, and agricultural production. Collaborative efforts could help mitigate the impact of global disruptions, such as supply chain breakdowns or geopolitical conflicts.

Monitor External Shocks: Given that external shocks like geopolitical conflicts, pandemics, and supply chain disruptions significantly impact these markets, there should be an emphasis on monitoring and preparing for such shocks. Establishing early warning systems and strategic reserves can help mitigate their adverse effects on national economies and financial markets.

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