AMERICAN UNIVERSITY OF BEIRUT

MEASURING THE IMPACT OF OIL AND GAS PRICE VOLATILITY ON EAST MEDITERRANEAN STOCK MARKETS

by

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AN ABSTRACT OF THE THESIS OF

Christy Anastase Makridis for Master of Arts in Financial Economics
Major: Financial Economics

Title: Measuring the Impact of Oil and Gas Price Volatility on East Mediterranean Stock Markets

This study examines the behavior of stock market returns in East Mediterranean markets due to shocks in energy commodity prices; namely crude oil and natural gas prices. Most of these emerging markets are increasingly consuming more energy and are thus dependent on the supply of energy resources. The main aspect that distinguishes this paper from previous work is the considered region. The discovery of oil and gas in the Eastern Mediterranean increases the policy relevance of this analysis.

Econometric analysis will be used to investigate the relationship between energy commodity prices and stock market returns between 2010 and 2014 and the linkages will be examined through applying different tests and methodologies. Graphical interpretations will be finally displayed.

The findings show that no long-run linkages exist between any of the considered markets and energy prices. However, short-run relationships are present and significant in the regulated and open markets.

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CHAPTER 1

INTRODUCTION

Despite the vigorous search for alternative energy resources, the demand for oil and gas is not falling. Furthermore, developing countries are witnessing a continuous increase in the demand for fuels. Over the past decade, many researchers have examined the relationship between energy prices and stock market behavior. The price movements of natural gas and crude oil are considered a key factor for understanding stock market behavior.

Worldwide demand for natural gas has notably increased over the last two decades, rising significantly from 87,237 billion ft^3 in the year 2000 to around 120,017 billion ft^3 during 2012, which means a total increase of 37.6%; in other words, an average increase of 3.1% every year. Moreover, crude oil consumption has increased at a lower rate during the same period. In 2000, total oil consumption was 76.8 million barrels/day. This figure increased to 90.3 million barrels/day in 2013; a total change of 17.6%. (U.S. Energy Information Administration)

This huge demand for oil and gas sheds light on the important impact that these commodities have on most economies and markets in the world. Thus, it is important to thoroughly comprehend the effect of fluctuations in fuel prices on the world economy in general, and on markets and stock returns specifically.

As the dependence on oil and gas as energy resources increases, and while financial markets continue to develop, researchers are showing growing interest in the relationship between the energy and financial markets sector. The study done by Kling (1985) is one of the earliest papers that examine this relationship in the U.S. economy. Kling investigated the behavior of the U.S. stock markets due to oil shocks between 1973 and 1982. He was able to conclude that increases in crude oil price are associated with stock market declines. Another early paper that also reported negative linkages among U.S. stock returns and oil prices is that of Jones and Kaul (1996). Basher and Sadorsky (2006) study the relationship between oil prices and emerging stock market prices. Through using a multi-factor model, they deduce a positive impact of oil prices on stock returns.

On the other hand, the effect of natural gas price fluctuations on the financial markets has not been deeply investigated. A few studies examine the stock price changes for some companies due to fluctuations in the price of natural gas: Boyer and Filion (2007) and Oberndorfer (2009).

The empirical part of this study examines the relationship between energy prices and stock market indicators. Econometric analysis will be employed through applying unit root tests, cointegration test, causality test, impulse response functions, and variance decompositions, each of which will be explained at a later stage.

The study is divided as follows. Chapter 2 discusses previous literature relating to the energy-stock nexus. Seven energy and financial markets are then introduced in Chapter 3. Next, the methodology and data are established in Chapter 4. Empirical results and findings are then demonstrated in Chapter 5. Finally, Chapter 6 contains some concluding remarks.

CHAPTER 2

LITERATURE REVIEW

The relationship between oil price movements and stock market behavior has been increasingly investigated by studies worldwide. Initially, most studies examined the oil-stock price nexus for developed countries. The papers by Hamilton (1983) and Kling (1985) were two of the earliest studies to examine this topic. In his paper, Kling (1985) investigated the effects of oil shocks on the US stock markets for the period 1973-1982. Kling reported that oil price increases are linked to stock market declines. Jones and Kaul (1996) also concluded that crude oil prices and aggregate stock returns in the United States, Canada, United Kingdom and Japan are negatively related. On the other hand, Huang et al. (1996) could not establish a negative relationship between changes in oil prices and stock returns in the US market. Furthermore, Chen et al. (1986) suggested that asset pricing is not affected by price changes in energy commodities; namely oil. Both Kaul and Seyhun (1990) and Sadorsky (1999) found a negative impact of oil price volatility on stock returns. Kaul and Sehyun (1990) used the low frequency yearly data for stock and oil prices to test the relationship. Alternatively, Sadorsky (1990) used higher frequency monthly figures. By using the monthly data, Sadorsky (1990) suggested that positive shocks to oil prices lead to the depreciation of U.S stock returns.

Park and Ratti (2008) tested the relationship between oil and stock market price movements for 13 European countries over the period 1986–2005. They were able to report a negative relationship between oil prices and real stock returns for all European countries except Norway.

In their paper, Chiou and Lee (2009) confirmed the existence of a negative effect on stock returns due to changes in oil prices. Moreover, they were able to conclude that oil price volatility shocks have an asymmetric effect on stock returns in the U.S markets.

Guntner (2013) used monthly frequency data for a long period between 1974 and 2011. He came to the conclusion that the stock markets of heavy oil-importing countries are mostly affected by oil shocks, though none of the world markets is affected by unexpected shocks to oil supply. However, Guntner (2013) pointed out that most oil demand shocks have a positive impact on stock returns in oil-exporting countries, and tend to have a negative effect on the markets of importing countries. In line with this, Cunado and d Gracia (2014) inferred that a change in the price of crude oil has a negative and significant impact on stock returns in most European markets. However, the paper stresses that the effect on stock markets depends on the underlying cause of the change in oil prices; whether it is a shock in supply or demand.

Using an SVAR model, Abhyankar et al. (2013) examined the dynamic linkages between oil prices and stock returns in Japan. They also found out that the response of the stock market depends on the cause of oil price changes: When the price of oil alters due to aggregate demand shocks, the relationship is positive. However, unexpected oil-market specific demand shocks caused by concerns about future oil supply shortage leads to lower stock returns in Japan.

The markets of developing countries are less affected by oil price shocks. This has led to different approaches on detecting the type of oil-stock relationship. According to Choi and Hammoudeh (2006), there exists no long-run relationship between crude oil prices and stock returns in five stock markets of the Gulf Cooperation Council (GCC). On the contrary, Maghyereh and Al-Kandari (2007) confirmed using nonlinear co-integration analysis that oil prices directly impact the stock price indices in the GCC countries, but in a nonlinear fashion.

Malik and Hammoudeh (2007) tested the volatility and shock transmission mechanism and found that equity markets in the Gulf region receive volatility spillovers from the oil market. The only exception was that of Saudi Arabia, for which the data indicated a significant opposing volatility spillover from the stock market to the oil market. Hammoudeh and Alesia (2004) and Zarour (2006) tested the oil-stock relationship for the same region (GCC) but using a different period. Hammoudeh and Alesia (2004) reported that most of these stock markets react to changes in oil prices, for the period 1994-2001. Moreover, Zarour (2006) deduced that the sensitivity of GCC markets to shocks in crude oil prices has increased over the period 2001-2005.

Narayan and Narayan (2010) studied the interaction between stock and oil prices in Vietnam between 2000 and 2008. The paper used Johansen’s cointegration test and Granger’s causality test to examine the long-run and short-run relationship respectively.

Narayan and Narayan (2010) were able to conclude that a positive and statistically significant relationship between stock prices and oil prices exists in the long-run.

Hamma et al. (2014) investigated the shock and volatility spillover between the price of crude oil and Tunisian stock returns. The results confirm the transmission of oil shocks into the Tunisian stock market.

While the amount of studies on oil-stock relationship is copious, the interaction between natural gas prices and stock markets has not been exhaustively examined. Some of the studies worth mentioning are those of Boyer and Filion (2007), Oberndorfer (2009), and Acaravci et al. (2012). In their findings, Acaravci et al. (2012) suggested that there exist long-term linkages between natural gas prices and stock prices in five EU countries Austria, Denmark, Finland, Germany and Luxembourg. On the other hand, the same results imply that there is no relationship between gas prices and other EU stock markets.

Boyer and Filion (2007) studied the factors that influence energy companies in Canada, and thus have an indirect effect on the stock market. They found that natural gas and crude oil prices influence stock returns in the Canadian market. Oberndorfer (2009) focused on the linkage between energy prices and energy stock prices in the Eurozone. The study concluded that oil price volatility affects energy stock returns. On the contrary, the gas market does not seem to have an impact on Eurozone energy stocks.

In his paper, Papapetrou (2001) concluded that a shock in oil prices tends to depress Greek stock returns. The paper by Al Nahleh and Al Zaubia (2011) was one of a few studies that examined the influence of oil prices on financial markets in the MENA region. The countries analyzed were Turkey, Jordan, Egypt, Morocco, and Tunisia. These countries were divided into oil-exporting and oil-importing countries. The results suggested that crude oil prices and stock returns tend to be positively related, only when shocks originate from demand. Berk and Aydogan (2012) investigated the impacts of variation in crude oil price on the Turkish stock market. The results showed that Turkish stock returns were only affected by oil price fluctuations after the 2008 crisis.

Using a VAR approach, Dagher and El Hariri (2013) concluded that the level of impact of an oil price shock on Lebanese stock returns is positive but marginal. This was confirmed by applying the impulse response function.

Although the methodologies and empirical tests applied in all these studies vary, most of them come to a similar conclusion that energy resources are an important factor for determining stock market behavior.

CHAPTER 3

COUNTRY PROFILES

The East Mediterranean countries displayed in this study are: Greece, Cyprus, Turkey, Lebanon, Jordan, Israel, and Egypt. Some of these countries have similar characteristics in terms of economic and financial structure. Although it does not share a shoreline on the Mediterranean, Jordan is considered in this analysis due to its role as a net importer of energy fuels and its key emerging financial market. On the other hand, Syria is not counted, despite its major role as an oil producing country, because of its underdeveloped financial sector and due to vagueness surrounding energy information as a result of the ongoing warfare. In this section, we investigate the energy and financial profiles of the considered countries.

3.1. Energy Sector

According to the U.S Geological Survey, the amount of the total recoverable energy fuels in the Eastern Mediterranean is projected at around 5.66 trillion cubic meters of natural gas and 3.7 billion barrels (bbl) of crude oil.

Turkey has limited reserves of domestic crude oil and natural gas. Thus, the country's imports make up a significant portion of its energy consumption. Turkey's role in energy markets is growing, as it has become a major consumer and a regional energy transit hub at the same time. The country's consumption of liquid fuels was 734,800 barrels per day (bbl/day) in 2013 according to the International Energy Agency (IEA), which also expects energy consumption to double over the next decade (IEA, Energy Supply Security, Part 2, 2014). Turkey not only is a major energy consumer, it also has an increasingly important role as an energy transit hub. Oil and gas supplies from Russia, the Middle East and the Caspian region move through pipelines in Turkey to Europe. (EIA, Report on Turkey, April 2014)

Proved oil reserves were estimated by the Oil and Gas Journal in 2014 at 295 million barrels, most of which are located in southeast Turkey. However, unconfirmed offshore reserves in the Black Sea and the Aegean Sea could develop into a potential resource that may supply Turkey's energy needs. (Oil & Gas Journal, 2014)

On the other hand, Egypt is rich in crude oil and natural gas reserves. The country currently possesses around 2.18 trillion cubic meters of proved natural gas reserves, according to the Oil and Gas Journal. It is the largest oil producer outside of the Organization of the Petroleum Exporting Countries (OPEC) and the second largest dry natural gas producer in Africa. Egypt plays a fundamental role in energy markets through operating the SUMED Pipeline and the Suez Canal. Due to rising energy demand in Egypt, the country accounts for more than 40% of dry natural gas consumption and more than 20% of oil consumption in Africa (BP Statistical Review of World Energy, June 2014), making it the largest oil and natural gas consumer on the continent. Total oil consumption averaged 770,000 barrel per day in 2013, based on the U.S Energy Information Administration. (EIA, Report on Egypt, August 2014)

Greece has very little domestic crude oil and natural gas production. The country produced an average of 1,600 barrel of crude oil per day and 5.0 million cubic meters of natural gas in 2012, according to the International Energy Agency (IEA). Most of the country's limited proved reserves of crude oil and natural gas are located in the northern Aegean Sea. Greece heavily relies on imported fossil fuels in order to maintain its energy security. Russia is the principal source of imported crude oil and natural gas, but the dependence on Russian natural gas is gradually decreasing while imports from Turkey and Algeria are growing. However, Greece is a net exporter of refined petroleum products.

On the contrary, Cyprus has substantial offshore reserves, especially in the Levant Basin. The U.S. Geological Survey estimated recoverable resources of 3.45 trillion cubic meters of natural gas and 1.7 billion barrels of oil. In 2012, the country consumed 60,000 barrels per day (bbl/day) on average. In the past, Cyprus used to produce refined petroleum products through its sole oil refinery. The refinery closed in 2004, which ended the island's ability to produce refined oil products. Cyprus now imports all of its oil products, and most of those imports come from neighboring European Union countries. (EIA, Analysis Note on Cyprus, March 2014)

Lebanon depends heavily on imported oil and natural gas to meet domestic energy demand. In 2010, the country imported 120,000 barrels per day (bbl/d) of refined oil products, which accounted for over 90% of total primary energy demand in the country (U.S. Energy Information Administration). Lebanon does not have significant proved reserves of crude oil according to the Oil and Gas Journal. But the recent natural gas discoveries in the Levant Basin have particularly changed the energy situation in the Eastern Mediterranean. The Lebanese government estimates that there are 708 billion cubic meters (bcm) or more of natural gas reserves located in its offshore territory. Lebanon's ability to proceed with its offshore development plans could be affected by the ongoing dispute with Israel over their shared maritime boundary. The disputed region may contain a significant amount of natural gas reserves due to its location around the center of the Levant Basin. (EIA, Analysis Note on Lebanon, March 2014)

Israel has historically been an importer of crude oil and natural gas. In 2013, the country imported 237 thousand barrels per day (bbl/day) of crude oil compared to 202.4 barrels per day in 2009. On the other hand, natural gas imports have been decreasing since the exploration of significant gas reserves. The EIA estimate was 510 million cubic meters of imported dry natural gas in 2013. Energy exploration over the past several years revealed significant natural gas resources in Israel's offshore territories. Specifically, the discoveries of the Leviathan and Tamar fields (among a few others) will allow the country to become a significant exporter of natural gas in the next decade. The production of natural gas has already started at the Tamar field in 2013. The other major discovery was the Leviathan field, which is located in deep waters approximately 130 km off the coast. Initial assessments of the field estimate that it could contain up to 538 billion cubic meters of recoverable natural gas and that production could begin after 2016. (EIA, Analysis Note on Israel, March 2014)

In 2014, the Oil and Gas Journal estimated Israel's proved reserves of oil at 11.5 million barrels. Moreover, natural gas reserves were estimated at 286 billion cubic meters by the same source. These volumes form a huge leap compared to proved reserves several years ago. In early 2014, Israel signed an agreement with Jordan to supply the neighboring country with natural gas from the Tamar field. The period of the agreement is 15 years starting 2016, with a total volume of 1.87 billion cubic meters. (Oil and Gas Journal, http://www.ogj.com/oil-exploration-and-development.html)

Unlike its bordering neighbors, Jordan does not possess remarkable energy resources. The country's proved natural gas reserves are estimated at around 5.66 billion cubic meters by the Oil & Gas Journal, while its oil reserves are estimated at just 1 billion barrels. Jordan relies heavily on imports of natural gas, crude oil and other petroleum products. Jordanian governmental sources indicate that 40% of the country's overall budget comes from those energy imports. In addition to the agreement with Israel, the country is pursuing several pipeline deals with Iraq, to help maintain its energy needs. Currently, Jordan relies on imported natural gas from Egypt through the Arab Gas Pipeline (AGP). This dependence has recently declined due to unrest in Egypt; particularly the Sinai Peninsula. Concerning crude oil supply, the country primarily depends on imports from Saudi Arabia and Iraq. (EIA, Analysis Note on Jordan, March 2014)

On the whole, these seven countries produce around 0.9 % of world oil and 1.9 % of world natural gas. At the same time, they account for 4.3 % of world oil imports & 2 % of world oil exports. Regarding natural gas imports, the studied countries make up around 4.9 % of world gas imports and 0.8 % of world exports. (U.S Energy Information Administration)

3.2. Stock Markets

Borsa Istanbul (BIST) is the only exchange authority in Turkey. It was established in 2013 by combining the Istanbul Stock Exchange (ISE) with the gold and derivatives exchanges. The ISE was initially founded in 1986. Since then, the exchange has attained a remarkable pace of growth in terms of market capitalization, trading volume and foreign investment. Currently, the Turkish government holds around 50% of Borsa Istanbul.

The Greek stock market – Athens Stock Exchange – was founded back in 1876. Then in 1918, the exchange was converted to a public entity. It is mainly composed of financial institutions and other large firms. The total number of listings is 312. During the 1980s the market witnessed reasonable growth and derivative products were first traded in 1999. Today, banks make up about 50 percent of the weighing of the Athens Stock Exchange, a higher percentage compared to other exchanges in Europe. During the Eurozone crisis, the exchange was highly affected, as was the Greek economy. Equity market capitalization dropped from 137.845 billion USD in late-2009 to 25.77 billion

USD by mid-2012. Currently it stands at 77.164 billion USD. (Athens Exchange Group, www.helex.gr)

The neighboring Cyprus Stock Exchange (CSE) commenced its operations on the 29th of March 1996. In 2006, it launched a common platform with the Athens Stock Exchange. This integration was considered a huge step towards modernization and entry into the world market. Cyprus was also affected by the Eurozone crisis. The CSE market capitalization fell from 12.228 billion USD in 2009 to 1.62 billion USD in mid-2013. It currently has 94 listed companies on equity.

The Beirut Stock Exchange (BSE) is the center of Lebanese financial operations, where Lebanese stocks are traded. It was primarily established in 1920 under the French mandate, making it the second oldest market in the Middle East and North Africa (MENA) region after the Egyptian stock exchanges of Alexandria and Cairo. The BSE witnessed a significant increase in trading activity during the 1950s and 1960s, but this later came to a halt with the start of the Lebanese civil war. The BSE remained closed between 1983 and 1996. Stocks traded on the BSE are currently categorized into four major sectors: Banking, Development and Reconstruction, Trading and Industrial. In 2014, the market capitalization amounted to 11.26 billion USD. (Beirut Stock Exchange, www.bse.com)

Jordan's major financial market is currently known as the Amman Stock Exchange. The market started business in 1978 as the Amman Financial Market (AFM) for trading securities, before being restructured in 1999 with the establishment of the

Amman Stock Exchange. The market is a private sector, non-profit institution with full financial sovereignty. It is classified as one of the top emerging stock markets and ranked among the leading equity markets in the MENA region.

The Amman Stock Exchange operates markets for both stocks and bonds, where the greater focus is on equity. It is currently divided into three main sectors: Financials, Industries and Services market. The number of listed companies stands at 243.

Tel Aviv Stock Exchange (TASE) is the only public market for trading securities in Israel. It was established in 1953 and since that time plays a major role in the Israeli economy. It is hosting an increasing variety of products for investors, including stocks, corporate bonds, treasury bills, derivatives and index-tracking products. TASE is considered a highly regulated market. In recent years, TASE has signed agreements with NASDAQ, New York Stock Exchange (NYSE), London Stock Exchange (LSE), Shanghai Stock Exchange (SSE) and other global markets which enhanced its international presence.

It currently lists some 473 companies, with many companies also listed on stock exchanges in other countries.

One of oldest stock markets in Africa and the Middle East is the Egyptian market: the Alexandria and Cairo Stock Exchanges began trading in 1883 and 1903 respectively. Trading operations in the two stock exchanges used to happen separately, but trading has been unified since 1996. The Egyptian Stock Exchange (EGX) was halted for a period of 2 months during the 2011 Egyptian Revolution. Stocks are distributed into several sectors including the oil and gas, construction, telecommunications, oil and gas, and banking sectors. The most active stocks on the EGX are those belonging to the construction and banking sectors.

Table 1 represents a summary of major financial indicators for the stock markets of the seven studied countries.

Table 1

	Greece	*Cyprus*	*Turkey*	*Lebanon*	*Israel*	*Jordan*	*Egypt*
Date of Establishment	1876	1996	1986	1920	1953	1978	1883
Number of Listed Firms	248	94	225	15	473	237	240
Market Capitalization (billion USD)	77.164	2.195	195.691	11.260	211.162	25.606	73.759
Market Cap. / GDP	0.319	0.100	0.239	0.254	0.725	0.760	0.271

CHAPTER 4

DATA AND METHODOLOGY

4.1. Data

The data employed in this study includes daily closing stock index prices for stock exchanges in our sample of chosen countries. Our sample covers seven East-Mediterranean countries including Greece, Cyprus, Turkey, Lebanon, Israel, Jordan, and Egypt. We use the Athens Stock Exchange General, Cyprus Main Market, Borsa Istanbul 100, BLOM BSI (Beirut Stock Index), Tel Aviv 25, Amman Stock Exchange General, and EGX 30 stock indices as proxies for each of the seven considered stock markets. The index prices are quoted from the stock exchange authority in each country included in the analyses and were compiled using R (3.1).

The sample period of our analysis ranges from January 1, 2010 until November 30, 2014. Due to this relatively long period, our research can be analyzed in terms of daily data with a sufficient number of observations – a total of 1281 observations.

This paper uses the daily closing price of the Europe Brent Spot Price (measured in USD per barrel) which is considered the main benchmark for markets in Europe and the Middle East for the crude oil pricing, in addition to the Henry Hub Natural Gas Spot Price, which is a worldwide standard for natural gas pricing. We separately compute oil and gas returns using the returns of their respective prices.

We have intentionally avoided including the period between 2008 and 2010 in our analysis. The reason behind this was to avoid serious instability in the oil, gas and some stock market prices, potentially caused by the global financial and economic crisis.

The high frequency daily data was chosen in order to avoid observation limitations with lower frequency data. All data are expressed in local currency.

A wide range of methodologies for testing the relationship between stock markets and energy prices have been used. One method is to estimate multifactor market models used by Basher and Sadorsky (2006), Aloui and Nguyen (2012), and Mohanty et al. (2010) in their papers. Some other studies such as the ones investigated by Akoum et al. (2012) and Jammazi (2012) performed wavelet analysis in their oil-stock nexus analysis, which is effective for time series data. There are many other approaches presented by different studies including the Markov switching framework, univariate and multivariate GARCH-type models, Error Correction Models (ECM), etc.

This paper employs the most commonly used framework which is the VAR model (vector autoregression). In the case of cointegrated variables, the VECM (vector error correction model) is implemented instead. The co-integration testing techniques of Engle and Granger (1987) and Johansen (1991) were used by several studies on the relationship between macroeconomic variables and stock prices. To carry on cointegration testing, working with stationary variables of equal order of integration is essential.

The relationship between the oil-gas prices and stock prices will be investigated in several major steps using Eviews (8.0). First, we will examine the order of integration in series by using the unit root test and then we will perform the cointegration test introduced by Johansen and Juselius (1990) to test the long-run relationship between the variables. If cointegration is found, then the remaining analysis can be performed using a VECM (Vector error correction model). Otherwise, the I(1) variables are differenced and a simple unrestricted VAR (Vector auto-regression) is used.

If the examined variables do not exhibit a long-run relationship – in other words aren't cointegrated – the next step involves estimation of an unrestricted VAR model. Otherwise, a VECM model can be used in the case of cointegration. To determine the appropriate number of lag length of the VAR model, we will employ the maximum likelihood statistic which is chi-square distributed. Next, we will run the Granger causality test to check the short-run relationships. Finally, we investigate the short-run dynamics through applying the generalized impulse response function (IRF) and the variance decomposition (VD). The purpose of this process is to find how each country's stock index responds to shocks in crude oil and natural gas prices.

4.2. Unit Root Test

Typically, most time series variables exhibit a unit root property. So the first step would be to examine the order of integration of each of our used variables. This step is considered crucial as skipping unit root testing could cause spurious regression problems, and thus unreliable results.

The null hypothesis (H_0) is that if a particular financial variable series shows existence of a unit root which cannot be rejected, then the series is said to be non-stationary. In this part, we discuss the two methods of unit root testing used in this study: The augmented Dickey-Fuller (ADF) test and the Ng-Perron test.

4.2.1. Augmented Dickey-Fuller (ADF) test

The three possible forms of ADF test are given by the following equations (Asteriou and Hall (2011)):

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + u_t$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + u_t$$

$$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + u_t$$

The difference between those three equations is the presence of the two deterministic elements: α_0, the intercept and $\alpha_1 t$, the time trend. Equation (3) could be used as a general equation for the ADF test. The null hypothesis (H_0) is: $\gamma = 0$, which would imply the presence of a unit root in variable y; i.e. y is non-stationary. The alternative hypothesis (H_1) is: $\gamma \neq 0$, meaning that y is stationary.

4.2.2. Ng-Perron Test

The Ng-Perron test is constructed using four test statistics: MZ_α^d, MZ_t^d, MSB^d, and MP_T^d. These statistics are based on modifications of the Z_α and Z_t statistics from

Phillips and Perron (1988) and other forms. Ng and Perron (2001) construct the four statistics as follows:

$MZ_{\alpha}^{d} = \frac{(T^{-1}(y_T^d)^2 - f_0)}{2k}$, where $k = \sum_{t=2}^{T} \frac{(y_{t-1}^d)^2}{T^2}$

$MZ_{t}^{d} = MZ_{\alpha}^{d} \times MSB^{d}$

$MSB^{d} = (\frac{k}{f_0})^{1/2}$

$$MP_T^d = \begin{cases} (\bar{c}^2 k - \bar{c}T^{-1}(y_T^d)^2)/f_0 & if \quad x_t = \{1\} \\ (\bar{c}^2 k + (1-\bar{c})T^{-1}(y_T^d)^2)/f_0 & \quad\;\; x_t = \{1,t\} \end{cases}$$

where $\bar{c} = \begin{cases} -7 \\ -13.5 \end{cases}, \quad if \begin{matrix} x_t = \{1\} \\ x_t = \{1,t\} \end{matrix}$ and x_t are exogenous regressors.

As in the case of the ADF unit root test, each of the four test statistics can be compared with the critical value, using an intercept or an intercept and a trend. In our testing, we use the modified Akaike info criteria (MAIC) for the lag length, as suggested by Ng and Perron (2001).

4.3. VAR Framework

The VAR (Vector autoregression) model is frequently used in analyzing the disturbance effect between a set of variables and in examining the relationship between interrelated time series. In the VAR approach, every endogenous variable is modeled as a function of lagged values of itself and other endogenous variables. The general form of a VAR model is represented by equation **(1)**:

$$y_t = A + B_1 y_{t-1} + B_2 y_{t-2} + \cdots + B_i y_{t-i} + \varepsilon_t$$

where $B_1, B_2, \dots, B_i$ are coefficient matrices, y_t is a vector of endogenous variables, and ε_t is a vector of white noise errors. The order of the generalized VAR model is denoted by the number of lags i. This described model is specifically known as the unrestricted VAR. It is commonly used for carrying further analysis. This study will focus on the core procedures of a VAR: The Granger causality test, the impulse response function, and the variance decomposition.

4.4. Cointegration Test

In order to start with examining the long run relationship between the oil-gas prices and the stock indices, we apply the Johansen cointegration test, which is based on the methodology of Johansen (1988) and Johansen (1991). Variables that are cointegrated, do not drift apart from each other, hence they possess a long–run equilibrium relationship. Examining and testing the cointegration relationship among financial time series and economic variables has been commonly used in the empirical literature to study the interrelationships. By definition, a non-stationary variable, which has a unit root property, tends to fluctuate with time. While a pair of non-stationary variables could have a similar motion and a particular linear combination which prevents them from drifting apart, even after disturbances. Under this scenario, the two variables have a long-run relationship and are thus are said to be cointegrated.

The studies of Cheung and Lai (1993) and Gonzalo (1994), among others, examine the Johansen methodology and present ample evidence for the superiority of the Johansen approach over alternative tests.

The starting point in Johansen's methodology is taken in the VAR given by equation (1). We rewrite the VAR as shown in equation (2):

$$\Delta y_t = A + \Lambda y_{t-1} + \sum_{j=1}^{i-1} \Pi_j \Delta y_{t-j} + \varepsilon_t$$

Where

$$\Lambda = \sum_{j=1}^{i} B_j - I \text{ and } \Pi_j = - \sum_{k=j+1}^{i} B_k$$

If Λ, the coefficient matrix, has reduced rank r < n, then there exist two matrices M and N, each with rank r and dimension n x r, such that $\Lambda = MN'$ and $N' y_t$ is stationary. The number of cointegrating relationships is represented by r and the columns of N are the cointegrating vectors.

Johansen (1988) suggested using two likelihood ratio test statistics computed from the residuals of the VAR in order to test the significance of cointegrating relationships. The trace test where the null hypothesis (H_0) is that the number of cointegrating vectors r, is less than or equal to r_0 where r_0 is less than p, the number of variables. While the alternative hypothesis (H_1) is that the impact matrix is full rank. The other test is the maximum eigenvalue test. The null hypothesis (H_0) for this test is that the number of cointegrating vectors is r_0, whereas the alternative hypothesis (H_1) is that the number is r_0+1. The trace and maximum eigenvalue tests are shown in equations (3) and (4):

$$T_{trace} = -N \sum_{j=r+1}^{r_0} \ln(1-\theta)$$

$$T_{max\ eigenvalue} = -N \ln(1-\theta)$$

Where N is the number of observations and θ is the largest canonical correlation.

Neither of these test statistics follows a chi square distribution in general; asymptotic critical values can be found in Johansen and Juselius (1990).

4.5. Causality Test

The Granger causality test is a technique based on multiple regression analysis, which investigates whether one time series can correctly forecast another series (Granger, 1969). While the presence of a cointegration relationship implies the existence of Granger causality, it does not indicate the direction of the causality relationship between both considered variables. Under a standard Granger causality test, an unrestricted VAR

(Vector Autoregression) should be implemented. However, if the two variables in our model are cointegrated, Granger (1988) emphasizes that a VECM (Vector error correction model) shall be applied instead.

To carry out the Granger causality test, we have to first construct an unrestricted VAR framework. Consider the bivariate VAR(i) model represented by equations **(2)** and **(3)**:

$$x_t = A_1 + [B_{11}x_{t-1} + \cdots + B_{1i}x_{t-i}] + [C_{11}y_{t-1} + \cdots + C_{1i}y_{t-i}] + \varepsilon_{1t}$$

$$y_t = A_2 + [C_{21}y_{t-1} + \cdots + C_{2i}y_{t-i}] + [B_{21}x_{t-1} + \cdots + B_{2i}x_{t-i}] + \varepsilon_{2t}$$

where $B_{11},\ B_{12}, \ldots,\ B_{1i}$ and $C_{11},\ C_{12}, \ldots,\ C_{1i}$ are coefficient matrices, x and y are the studied time series variables.

As stated previously, the Granger causality test indicates the direction of short-run relationship. In order to apply the causality test, we should test whether the coefficients of each endogenous variable are equal to zero. If in equation (2), $C_{11} = C_{12} = \ldots = C_{1i} = 0$, then it is implied that y does not Granger cause x. The same applies for equation (3).

The causality between each stock market index and both commodity prices will be examined separately, which is a similar econometric approach to the one applied by Cetin Ciner (2001) and Roger D. Huang, Ronald W. Masulis, Hans R. Stoll (1995)

In their studies, Hamilton (1983) and Uri (1996) applied the Granger causality test to examine the linkages between oil prices and other macroeconomic or financial variables.

4.6. Impulse Response Function

The causality test may not explain the complete story about the relationship between the considered variables. In applied work, it is often of interest to know the response of one series to an impulse or shock in other variables in a system.

The impulse response function (IRF) provides an estimate of the short-run response of a variable in the case of disturbances or shocks in another variable. This procedure traces the effect of a shock to one series on the current and future values of the dependent variable. In order to explore this response between time series, an impulse response plot is commonly used. The impulse response function is obtained using the Cholesky factorization and is sensitive to the ordering of the variables.

4.7. Variance Decomposition

The variance decomposition is another method that enables us to characterize dynamics of the VAR model. It decomposes the variation in an endogenous variable into component shocks to the endogenous variables in the model.

Both the impulse response function and the variance decomposition are tools that can provide evidence on the patterns of interaction between two or more variables, as well as contribute to enhancing our insights upon how markets react to system-wide shocks over time.

CHAPTER 5

EMPIRICAL RESULTS

The econometric part starts with displaying some summary statistics on each time series. Then both unit root tests will be discussed and stationarity will be established among the variables. Next, the Johansen cointegration test will be employed and based on the rank and maximum eigenvalue statistics, a VAR model will be constructed. Pairwise Granger causality will be tested in both directions and finally the outcome of the impulse response functions and variance decompositions will be analyzed.

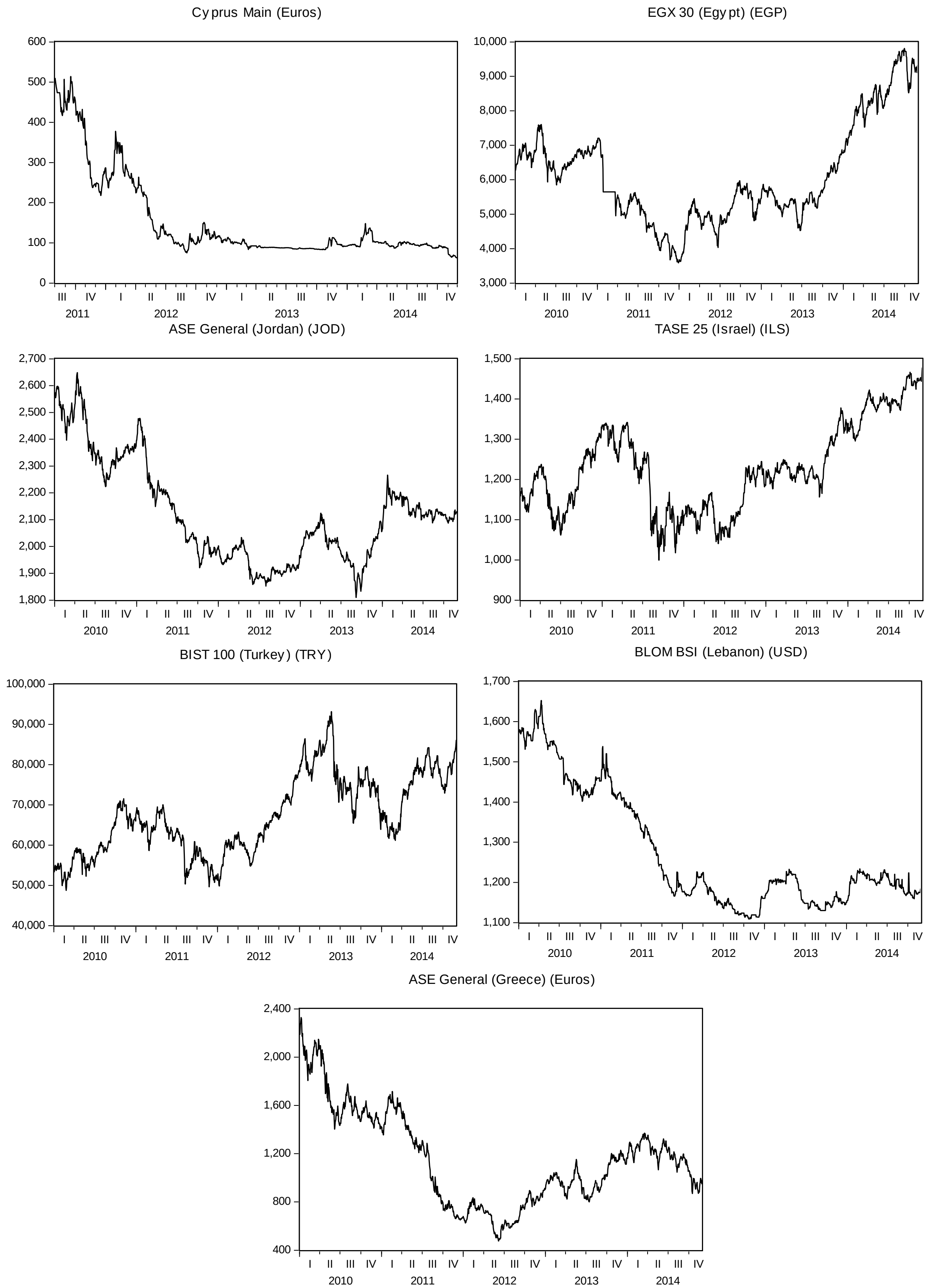
Table 2 shows some descriptive statistics for each of the considered variables.

Table 2
Summary statistics

Index	*Mean*	*SD*	*Skewness*	*Kurtosis*	*JB-stat*	*Prob.*
Greece	0.000	0.022	0.362	6.430	444.890	0.000
Cyprus	-0.002	0.035	0.431	8.421	1090.773	0.000
Turkey	0.000	0.015	-0.566	7.658	832.002	0.000
Lebanon	0.000	0.005	1.319	24.153	16453.810	0.000
Jordan	0.000	0.005	-0.046	6.228	377.486	0.000
Israel	0.000	0.010	-0.546	9.217	1442.514	0.000
Egypt	0.001	0.015	-0.186	7.674	795.926	0.000
Crude Oil (Brent)	0.000	0.013	-0.326	5.129	179.421	0.000
Natural Gas (Henry Hub)	0.001	0.040	3.537	50.441	83303.990	0.000

Figure 1 below displays the prices of the 7 stock indices in local currencies.

Figure 1


Cyprus Main (Euros)
EGX 30 (Egypt) (EGP)
ASE General (Jordan) (JOD)
TASE 25 (Israel) (ILS)
BIST 100 (Turkey) (TRY)
BLOM BSI (Lebanon) (USD)
ASE General (Greece) (Euros)

In order to test the stationarity properties of the data, we run the two previously discussed unit root tests: ADF test and Ng-Perron test. Table 3 displays the results of the ADF unit root test. The null hypothesis is unit root while the alternative hypothesis is level stationary. We use two different specifications: one that uses a time trend and constant, and one that only uses a constant. Based on the ADF test outcome, all the variables are unit root at the 5% level, except for Natural Gas, which is unit root at the 1% level.

Table 3
ADF unit root test

Indicator	*ADF test statistic*	*Prob*
Greece*	-2.651782	0.0829
Cyprus*	-2.540567	0.1061
Turkey	-2.503289	0.3265
Lebanon*	-2.088291	0.2496
Jordan*	-2.358095	0.1541
Israel*	-1.190404	0.6806
Egypt	-1.020261	0.9394
Crude Oil (Brent)*	-1.534783	0.5158
Natural Gas (Henry Hub)*	-3.050205	0.0307

* The series has no time trend

To further examine the unit root component of these 9 variables, the Ng-Perron test is employed. The findings of the test, which are displayed in Table 4, confirm our previous results that all the examined variables are non-stationary at the level, but are stationary at the first differences. Thus we can proceed with applying the Johansen cointegration methodology in order to determine the long-run relationship between each of the indices and energy prices.

Table 4
Ng–Perron unit root test

Indicator	*Lag Length*	MZ_a	MZ_t	*MSB*	*MPT*
Greece*	1	0.1863	0.2018	1.0833	67.558
Cyprus*	0	0.5292	0.8343	1.5766	147.18
Turkey	0	-12.783	-2.5025	0.1958	7.2772
Lebanon*	2	0.4409	0.6304	1.4298	119.78
Jordan*	1	-0.1047	-0.1047	1.0005	54.581
Israel*	0	-1.8964	-0.6054	0.3192	9.2846
Egypt	1	-2.0374	-0.8027	0.3940	33.614
Crude Oil (Brent)*	0	-1.7572	-0.9258	0.5268	13.772
Natural Gas (Henry Hub)*	15	-1.2616	-0.7203	0.5709	17.213
		MZ_a	MZ_t	*MSB*	*MPT*
Critical value: Ng–Perron (2001)	1%	-13.80	-2.58	0.174	1.78
Test equation includes the intercept only	5%	-8.10	-1.98	0.233	3.17
	10%	-5.70	-1.62	0.275	4.45
	1%	-23.80	-3.42	0.143	4.03
Test equation includes both intercept and trend	5%	-17.30	-2.91	0.168	5.48
	10%	-14.20	-2.62	0.185	6.67

* The series has no trend

Having established the presence of a unit root component in the first-difference of all the stock indices series, the next objective is to check whether the series studied are cointegrated. The results of the Johansen cointegration test between each stock market and energy prices are displayed in Tables 5 and 6.

The rank and maximum eigenvalue statistics both indicate that none of the considered 7 markets is cointegrated with oil and gas prices. In other words, there exists no long-run relationship between any of the stock markets and energy prices.

Table 5

Johansen cointegration test with crude oil

Sample: 01/01/2010 - 11/28/2014
Trend assumption: Linear deterministic trend

Market	*r*	*Trace Statistic*	*Prob. ** *	*Max-Eigen Stat.*	*Prob. ** *
Greece	r = 0	14.92816	0.0607	12.29616	0.1002
	r ≤ 1	2.632007	0.1047	2.632007	0.1047
Cyprus	r = 0	11.74988	0.1693	9.831763	0.2232
	r ≤ 1	1.918115	0.1661	1.918115	0.1661
Turkey	r = 0	5.346872	0.7709	4.963669	0.7464
	r ≤ 1	0.383203	0.5359	0.383203	0.5359
Lebanon	r = 0	9.826071	0.2943	7.506681	0.4311
	r ≤ 1	2.319391	0.1278	2.319391	0.1278
Jordan	r = 0	10.73059	0.2286	7.643977	0.416
	r ≤ 1	3.086617	0.0789	3.086617	0.0789
Israel	r = 0	5.064403	0.8019	5.062834	0.7339
	r ≤ 1	0.001569	0.9664	0.001569	0.9664
Egypt	r = 0	8.606147	0.4031	8.594646	0.3214
	r ≤ 1	0.011501	0.9144	0.011501	0.9144

* denotes rejection of the hypothesis at the 0.05 level
** MacKinnon-Haug-Michelis (1999) p-values

Table 6

Johansen cointegration test with natural gas

Sample: 01/01/2010 - 11/28/2014
Trend assumption: Linear deterministic trend

Market	*r*	*Trace Statistic*	*Prob. ** *	*Max-Eigen Stat.*	*Prob. ** *
Greece	r = 0	14.93032	0.0607	12.91988	0.0806
	r ≤ 1	2.010445	0.1562	2.010445	0.1562
Cyprus	r = 0	8.308201	0.2138	7.99758	0.1746
	r ≤ 1	0.31062	0.6391	0.31062	0.6391
Turkey	r = 0	9.413099	0.3285	7.935555	0.3853
	r ≤ 1	1.477544	0.2242	1.477544	0.2242
Lebanon	r = 0	7.717339	0.2594	6.837625	0.2639
	r ≤ 1	0.879714	0.4026	0.879714	0.4026
Jordan	r = 0	15.49774	0.0505	13.74302	0.0603
	r ≤ 1	1.754716	0.1853	1.754716	0.1853
Israel	r = 0	11.29741	0.1938	11.06965	0.1507
	r ≤ 1	0.227756	0.6332	0.227756	0.6332
Egypt	r = 0	9.226186	0.3449	9.221182	0.2682
	r ≤ 1	0.005004	0.9426	0.005004	0.9426

* denotes rejection of the hypothesis at the 0.05 level
** MacKinnon-Haug-Michelis (1999) p-values

Having found no cointegration between the studied series, a VAR (Vector Auto Regression) model is constructed and we start by testing the Granger causal bidirectional relationship. The pairwise Granger causality test between each stock market and crude oil prices is displayed in Table 7. Based on these findings, it could be deduced that the Brent price Granger causes the Egyptian and Jordanian stock markets. This is due to the fact that the probability calculated based on the F-statistic is less than 5%, our confidence interval.

Table 7
Pairwise Granger causality test with crude oil

Sample: 01/01/2010 - 11/28/2014		
Null Hypothesis	F-statistic	Prob.
R_CYPRUS does not Granger Cause R_BRENT	0.47068	0.6247
R_BRENT does not Granger Cause R_CYPRUS	0.96289	0.3822
R_EGYPT does not Granger Cause R_BRENT	1.82075	0.1623
R_BRENT does not Granger Cause R_EGYPT	7.36874	0.0007
R_GREECE does not Granger Cause R_BRENT	0.19532	0.8226
R_BRENT does not Granger Cause R_GREECE	0.45016	0.6376
R_ISRAEL does not Granger Cause R_BRENT	0.93043	0.3947
R_BRENT does not Granger Cause R_ISRAEL	0.61140	0.5427
R_JORDAN does not Granger Cause R_BRENT	1.45027	0.2349
R_BRENT does not Granger Cause R_JORDAN	4.27822	0.0141
R_LEBANON does not Granger Cause R_BRENT	0.36263	0.6959
R_BRENT does not Granger Cause R_LEBANON	0.99558	0.3698
R_TURKEY does not Granger Cause R_BRENT	0.22064	0.8020
R_BRENT does not Granger Cause R_TURKEY	0.60113	0.5483

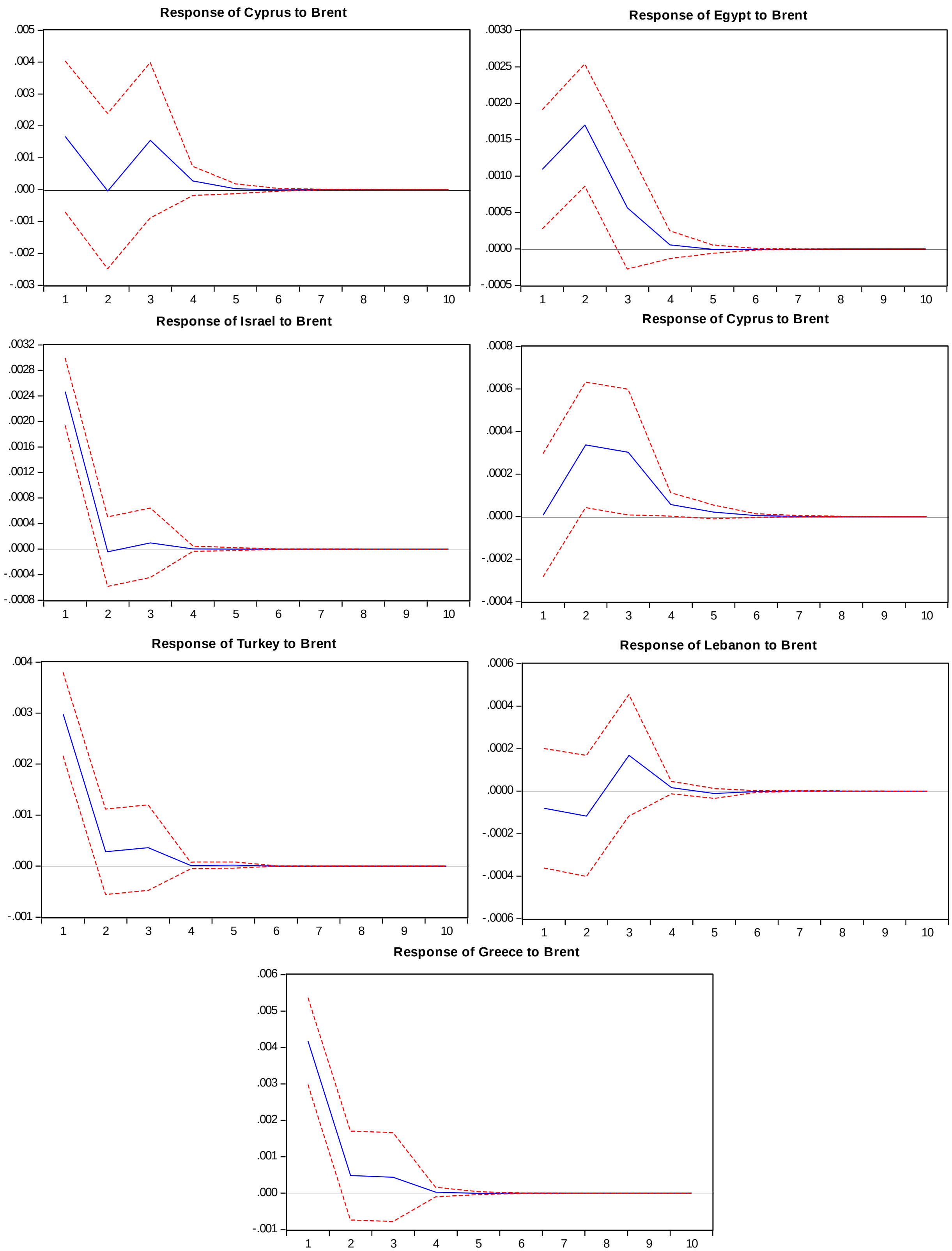
The outcome of the Granger causality test between natural gas prices and stock markets is presented in Table 8. According to these results, natural gas prices tend to Granger-cause the Turkish stock market, while there exists no causality with any of the other markets.

Table 8

Pairwise Granger causality test with natural gas

Sample: 01/01/2010 - 11/28/2014		
Null Hypothesis	F-statistic	Prob.
R_CYPRUS does not Granger Cause R_HENRYHUB	0.80414	0.4478
R_HENRYHUB does not Granger Cause R_CYPRUS	0.95259	0.3861
R_EGYPT does not Granger Cause R_HENRYHUB	2.34395	0.0964
R_HENRYHUB does not Granger Cause R_EGYPT	0.72097	0.4865
R_GREECE does not Granger Cause R_HENRYHUB	0.88609	0.4125
R_HENRYHUB does not Granger Cause R_GREECE	0.53043	0.5885
R_ISRAEL does not Granger Cause R_HENRYHUB	0.42569	0.6534
R_HENRYHUB does not Granger Cause R_ISRAEL	0.07006	0.9323
R_JORDAN does not Granger Cause R_HENRYHUB	1.96971	0.1399
R_HENRYHUB does not Granger Cause R_JORDAN	1.59297	0.2037
R_LEBANON does not Granger Cause R_HENRYHUB	0.96029	0.3831
R_HENRYHUB does not Granger Cause R_LEBANON	0.01239	0.9877
R_TURKEY does not Granger Cause R_HENRYHUB	0.46307	0.6295
R_HENRYHUB does not Granger Cause R_TURKEY	3.60543	0.0275

Figure 2


Response of Cyprus to Brent
.005
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-.002
-.003
1 2 3 4 5 6 7 8 9 10
Response of Egypt to Brent
.0030
.0025
.0020
.0015
.0010
.0005
.0000
-.0005
1 2 3 4 5 6 7 8 9 10
Response of Israel to Brent
.0032
.0028
.0024
.0020
.0016
.0012
.0008
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1 2 3 4 5 6 7 8 9 10
Response of Cyprus to Brent
.0008
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.0000
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1 2 3 4 5 6 7 8 9 10
Response of Turkey to Brent
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1 2 3 4 5 6 7 8 9 10
Response of Lebanon to Brent
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Response of Greece to Brent
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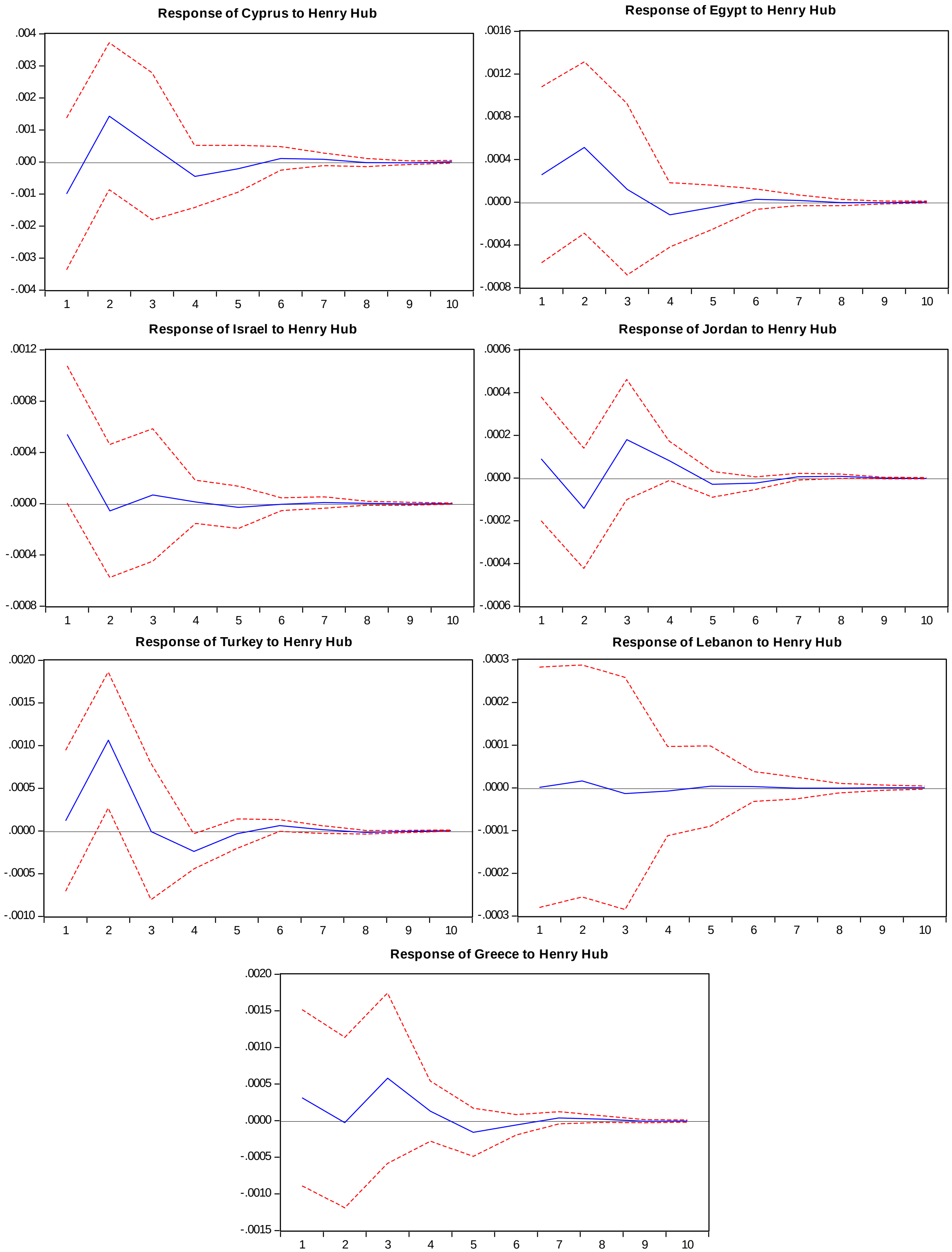
Figure 3


Response of Cyprus to Henry Hub
.004
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Response of Egypt to Henry Hub
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Response of Israel to Henry Hub
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Response of Jordan to Henry Hub
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Response of Turkey to Henry Hub
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Response of Lebanon to Henry Hub
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Response of Greece to Henry Hub
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Figure 4

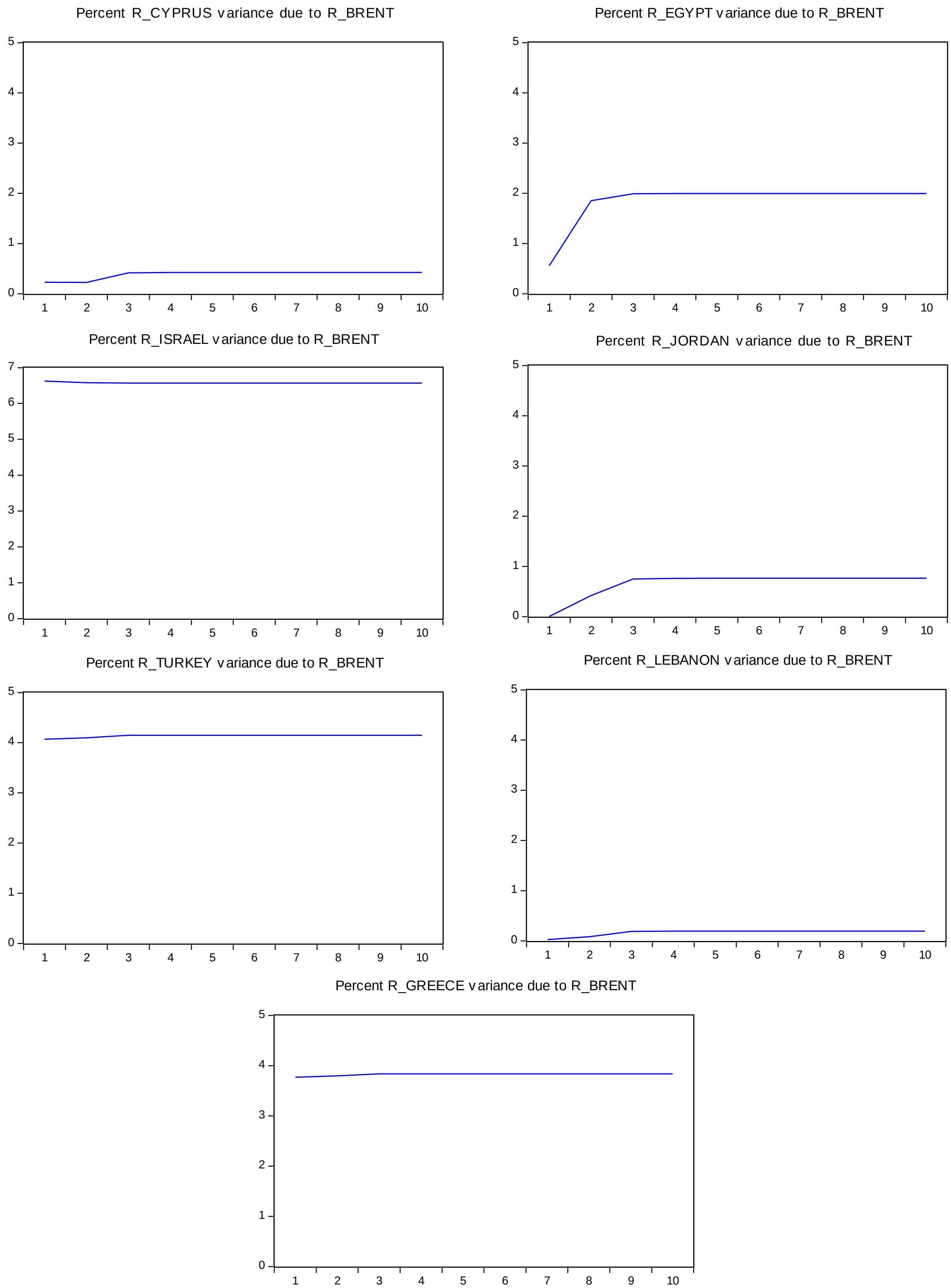
Percent R_CYPRUS variance due to R_BRENT
Percent R_EGYPT variance due to R_BRENT
Percent R_ISRAEL variance due to R_BRENT
Percent R_JORDAN variance due to R_BRENT
Percent R_TURKEY variance due to R_BRENT
Percent R_LEBANON variance due to R_BRENT
Percent R_GREECE variance due to R_BRENT
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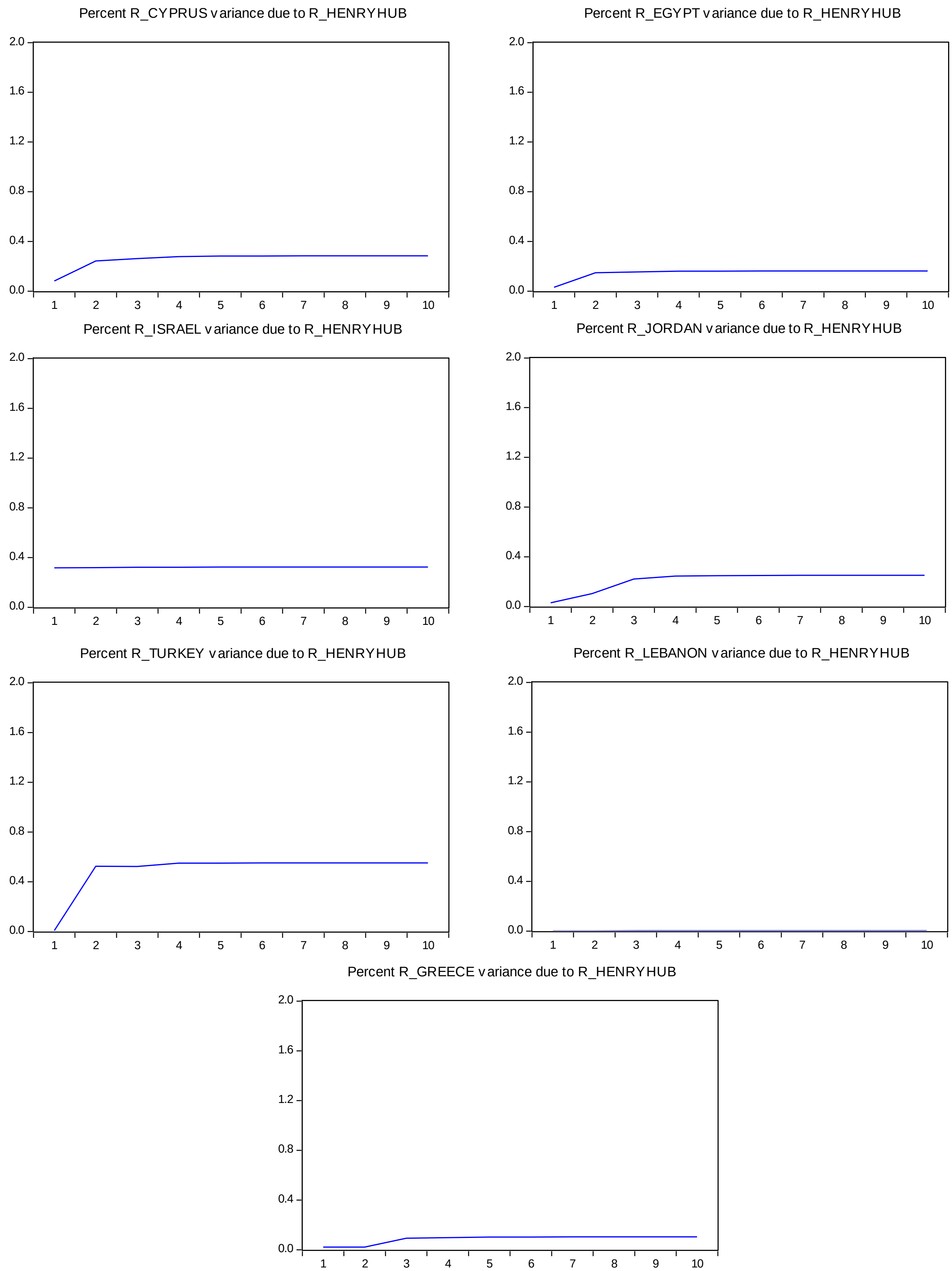
Figure 5


Percent R_CYPRUS variance due to R_HENRYHUB
Percent R_EGYPT variance due to R_HENRYHUB
Percent R_ISRAEL variance due to R_HENRYHUB
Percent R_JORDAN variance due to R_HENRYHUB
Percent R_TURKEY variance due to R_HENRYHUB
Percent R_LEBANON variance due to R_HENRYHUB
Percent R_GREECE variance due to R_HENRYHUB

CHAPTER 6

Conclusion

The objective of this study was to investigate the relationship between 7 stock markets in the East Mediterranean region and energy prices. This is known as the energy-stock nexus. The sample period spans from January 2010 to November 2014. The empirical part starts with establishing stationary variables for the major stock market inidices and energy prices. This is fulfilled through examining the unit root property of each time series. Empirical findings indicate that there exists no general long-run relationship among oil and gas prices and stock markets in the considered region, which leads to the construction of a VAR framework. On the other hand, a uni-directional Granger causal relationship exists between oil prices and both Egyptian and Jordanian stock markets; Egypt being a heavy oil consuming country and Jordan being a heavy importing country. In addition to that, natural gas prices seem to Granger cause the Turkish stock market, where Turkey is a heavy natural gas consuming state.

The impulse response function shows that more open markets such as Greece, Israel and Turkey are highly exposed to oil shocks. The response happens to take place instantaneously in these regulated markets. The financial markets of Israel and Turkey have a higher percentage of variance due to a change in both oil and gas prices. This was deduced from the variance decomposition outcome. According to the impulse response function and variance decomposition, the Lebanese stock market is least affected by shocks and changes in energy prices, and thus the Lebanese market is the least exposed among the 7 countries.

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