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## Article

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International Journal of Energy Economics and Policy

## Provided in Cooperation with:

International Journal of Energy Economics and Policy (IJEEP)

*Reference:* Karacaer-Ulusoy, Merve/Kapusuzoglu, Ayhan (2017). The dynamics of financial and macroeconomic determinants in natural gas and crude oil markets : evidence from organization for economic cooperation and development/gulf cooperation council/ organization of the petroleum exporting countries countries. In: International Journal of Energy Economics and Policy 7 (3), S. 167 - 187.

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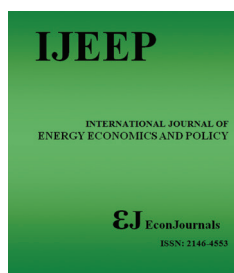
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# **The Dynamics of Financial and Macroeconomic Determinants in Natural Gas and Crude Oil Markets: Evidence from Organization for Economic Cooperation and Development/Gulf Cooperation Council/Organization of the Petroleum Exporting Countries Countries**

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## **ABSTRACT**

This study analyzes the countries in the Organization for Economic Cooperation and Development, Gulf Cooperation Council and Organization of the Petroleum Exporting Countries to test the casual relationship between world energy prices (Brent Oil, West Texas Intermediate, Dubai, Henry Hub (HH), Japan and Russia) and the liquidity level, stock market and industrial production. Augmented Dickey Fuller, Phillips-Perron and Kwiatkowski-Phillips-Schmidt-Shin unit root tests, Johansen cointegration and Granger causality analyses are implemented during the study. The empirical findings indicate that there are multidirectional relationships between the above-mentioned variables. These relationships can be explained by the factors that each country group owns within the framework of their energy sources, financial markets, economic conditions and geographical positions. The data accrued and analyzed in this study is presented as a contribution to guide policymakers, global investors and researchers in constituting an extensive country specific energy, macroeconomic and financial policies.

**Keywords:** Oil and Natural Gas Prices, Financial and Economic Developments, Cointegration, Causality

**JEL Classifications:** C32, Q43

## **1. INTRODUCTION**

The volatility of oil prices has drawn attention to the importance of the effects of energy prices on macroeconomic activities. These effects have been considered using two different approaches. Many researchers have researched the effects of the oil prices shocks of the 1970s and 1980s on macroeconomic variables such as gross domestic product (GDP), inflation, interest rates, industrial production, productivity or liquidity. Numerous other researchers have investigated channels through which energy prices can affect macroeconomic variables (Burbidge and Harrison, 1984; De Pratto et al., 2009; Ferderer, 1997; Hamilton, 2008; Kilian, 2008).

Theoretically, the increase in oil prices can have various effects four of which are given below. First, there is the supply-side

effect in which in the case of increased energy prices, the input cost of the company increases while productivity and accordingly profitability decrease this in turn might force organizations to reduce new capital investments or use energy-efficient capital. Second is the demand-side effect. This refers to the income transfer from the oil importing countries to the oil exporting countries, which damages the aggregate demand in oil importing countries since the decrease in purchasing power of oil importing countries is higher than the increase in purchasing power of oil exporting countries. Third, the real-balance effect which is namely that increased energy prices have both direct and indirect effects on inflation. Initially, the increased energy prices will slowdown economic activities and cause inflation. Then, due to the higher prices of oil products (such as gasoline and heating-oil) the price of alternative energy sources will also increase. Thus, an indirect

effect occurs due to the behavioral responses of companies and their workers, this is also called a second round effect. In this case firms can reflect the increased input costs in the prices of non-energy products. Furthermore, with the increased cost of living, workers can demand higher wages. A corruption in price-wage loop can damage the wealth of households, by reducing consumption and output. The fourth way that higher energy prices affect the economy is through the monetary policy channel. Increased energy prices decrease consumption, investment and stock prices, increase unemployment and construct new production methods which are less dependent on oil inputs (Cologni and Manera, 2008; Kumar, 2005).

It has been observed that the increases in oil prices cause recession especially in industrialized countries, slowdown the productivity and growth, besides cause inflation (Barsky and Kilian, 2004; Hamilton, 1983; Mork and Hall, 1979). On the other hand, the effects of oil price changes differ depending on countries level of development, stage of economy and its organizational structure. For example; in oil-importing countries the increase in oil prices raises inflation and input costs, which effect manufacturing and transportation industries, besides leads to a decrease in demand of non-oil products; reflecting the lower purchasing power. Furthermore, a slowdown in economic growth leads to a reduction in labor demand; in other words employment level. On the fiscal side, government expenditures rise on the one hand and tax revenues drop on the other, leading to an increase in the budget deficit and interest rates (Yıldız and Ulusoy, 2015).

These macroeconomic issues and their important impact on the financial system have also been discussed in the literature over many years (Lucas, 1998; Patrick, 1966; Robinson, 1952; Schumpeter, 1911). In particular, after 1980; the outcomes of financial liberalization regarding the financial system began to achieve prominence. The financial system plays a crucial role in encouraging the development of economic activities since the system includes financial markets, insurance companies, security markets, banks, other financial intermediaries and the supervision of these intermediaries. Knowledge acquisition, the costs of the execution of contracts and transactions have led need for financial contracts, markets and intermediaries. The differential costs due to administrative, legal and tax differences have led to the creation of district financial contracts, markets and intermediaries between countries (Levine, 2004). There are several views about the direction of the causal relationship between financial development and economic growth. A common view is that financial liberalization increases the shared risk; which in turn lowers the cost of equity while raising the borrowed money, capital accumulation, investments besides the demand for energy, and ultimately improves economic growth (Greenwood and Jovanovic, 1989; Sadorsky, 2010). On the other hand, others believe that financial liberalization may have negative effects on the countries that do not have strong legal institutions. According to those supporting this view, the high level of liberalized financial markets causes the total real credits of domestic firms to decrease, which in turn results in a slowdown of investments and economic growth (Samargandi et al., 2014).

The importance of the energy sources and their effects on the financial and macroeconomic factors are the motivation for this research. This study is the one of the first that focuses on energy prices (oil and natural gas), economic performance (economic growth, industrial production and liquidity) and financial development (stock market). For that purpose, it investigates the relationship between energy prices, the stock market index and the economic performance in the Organization for Economic Cooperation and Development (OECD), Gulf Cooperation Council (GCC) and Organization of the Petroleum Exporting Countries (OPEC).

The remaining sections of this study are organized as follows: Section 2 discusses the empirical literature concerning energy prices and liquidity, energy markets and financial/economic variables, and financial development and economic growth; Section 3 introduces the data set, and econometric models; while Section 4 provides the empirical results and finally Section 5 discusses conclusions.

## 2. A BRIEF LITERATURE REVIEW

There is extensive literature concerning the relation between energy prices and the financial/economic variables, liquidity, and between financial development and economic growth. Different studies have been undertaken in various countries, over a range of time periods, and using selected proxy variables using a variety of econometric methodologies. The summary of these selected studies are presented in Tables 1-3.

## 3. DATA AND METHODOLOGY

This section introduces the countries and the variables used in the analysis of the relationship among energy prices, the stock market index and the economic performance of 34 OECD (Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom (UK) and the United States (US), 6 GCC (Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and United ab Emirates (UAE)) and 12 OPEC (Algeria, Angola, Ecuador, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, UAE and Venezuela) countries.

The monthly data for oil prices (Brent Oil, West Texas Intermediate [WTI] and Dubai) (US\$ per barrel) and natural gas prices (Henry Hub, Japan and Russia) (US\$ per million metric British thermal unit) were obtained from the International Monetary Fund (IMF) (<http://imf.org>). The monthly M2 data; used as a measure of liquidity, and daily stock market prices were obtained from Trading Economics database (<http://tradingeconomics.com>) for 34 OECD countries, 6 GCC countries and 13 OPEC countries. Daily stock market prices were converted into monthly data by taking the average price. For all countries, the common period used for M2 was 2000-2014, except for: Slovakia (2006-2014), Slovenia (2005-2014), Turkey (2006-2014), Qatar, (2007-2014),

**Table 1: Summary of empirical studies on the relationship between energy markets and financial/economic variables**

| Authors                      | Period    | Country                            | Methodology            | Result                                                                                                                                                                                                                                                                     |
|------------------------------|-----------|------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Acaravci et al. (2012)       | 1990-2008 | 15 European countries              | Granger causality      | There are long-term relationships between natural gas prices, industrial production and stock prices for Austria, Denmark, Finland, Germany and Luxembourg; while there is no relationship in the other ten of the EU-15 countries                                         |
| Ahmed et al. (2012)          | 1980-2010 | USA                                | CGARCH, VAR            | A one standard deviation shock to oil prices causes an increase in consumer prices index and commodity prices, while there is no evidence of any significant effect on industrial production                                                                               |
| Arshad and Bashir (2015)     | 2009-2013 | Pakistan                           | Multi-factor model     | Oil and natural gas prices, exchange rates and interest rates have negative impact on stock returns                                                                                                                                                                        |
| Basher and Sadorsky (2006)   | 1992-2005 | 21 emerging countries              | Multi-factor model     | Oil price shocks significantly affect stock market returns                                                                                                                                                                                                                 |
| Burbidge and Harrison (1984) | 1961-1982 | Canada, Germany, Japan, UK and USA | VAR                    | There is a uni-directional causality from oil price shocks to macroeconomic variables (CPI, industrial production, interest rates, current account and hourly earnings in manufacturing sector)                                                                            |
| Cuñado and Gracia (2003)     | 1960-1999 | European countries                 | Cointegration, Granger | There is a uni-directional causality running from oil price changes to industrial production growth rates. Moreover, the increases in oil prices affect industrial production growth rates negatively; while the opposite result is not valid for the decreased oil prices |
| Ewing and Thompson (2007)    | 1982-2005 | USA                                | Band pass filter       | While oil prices have a strong contemporaneously correlation with consumer price index, they have a negative correlation with unemployment cycles                                                                                                                          |
| Guesmi and Fattoum (2014)    | 1990-2012 | 10 OECD                            | DCC                    | The author indicates that aggregate demand side oil price shocks such as global financial crisis or Chinese economic growth have greater impact on stock markets compared to supply-side shocks such as OPEC's oil embargo                                                 |
| Ferderer (1997)              | 1970-1990 | USA                                | VAR                    | The deterioration in oil markets leads to sectorial shocks and uncertainty in the USA economy                                                                                                                                                                              |
| Iscan (2010)                 | 2001-2009 | Turkey                             | VAR                    | There is no causality between oil prices and stock market returns                                                                                                                                                                                                          |
| Kumar (2005)                 | 1975-2004 | India                              | VAR                    | Oil prices shocks affect industrial production negatively                                                                                                                                                                                                                  |
| Masih et al. (2011)          | 1985-2005 | South Korea                        | VECM                   | Oil price movements significantly affect stock markets                                                                                                                                                                                                                     |
| Miller and Ratti (2009)      | 1971-2008 | 6 OECD countries                   | VECM                   | There is a negative correlation between oil prices and stock market returns in the long-term                                                                                                                                                                               |
| Ng (2012)                    | 1983-2009 | Singapore                          | VECM                   | While a 1% increase in oil prices causes GDP to decrease by 0.45% in the long-term, in the short term it affects investments, aggregate output and inflation negatively                                                                                                    |
| Papapetrou (2001)            | 1989-1999 | Greece                             | VAR                    | Shocks in oil prices have an important impact on economic activity and employment furthermore; oil prices are the significant factors in the explanation of stock price movements                                                                                          |
| Park and Ratti (2008)        | 1986-2005 | USA, 13 European countries         | VAR                    | Oil price movements significantly affect stock markets                                                                                                                                                                                                                     |
| Sadorsky (1999)              | 1947-1996 | USA                                | Multi-factor model     | Volatility of oil prices significantly affects stock market returns                                                                                                                                                                                                        |
| Tang et al. (2010)           | 1998-2008 | China                              | SVAR                   | While the rise in oil prices affects output and investments negatively, it has a positive effect on inflation and interest rate                                                                                                                                            |

(Contd...)

**Table 1: (Continued)**

| Authors                  | Period    | Country                                   | Methodology     | Result                                                                                                                                                                                                                                                        |
|--------------------------|-----------|-------------------------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Wang et al. (2013)       | 1999-2011 | Oil-importing and oil-exporting countries | SVAR            | The uncertainty in oil supply negatively affects the stock market returns of both oil-importing and oil-exporting countries however, the effect of demand uncertainty is much greater on oil-exporting countries when compared to the oil-importing countries |
| Yıldız and Ulusoy (2015) | 2003-2013 | Turkey                                    | VAR             | There is a significant relationship between oil prices and both the gross fixed capital formation and the interest rate                                                                                                                                       |
| Yilmaz et al. (2013)     | 1995-2009 | Turkey                                    | ARDL, causality | There is a uni-directional causality running from stock prices to real GDP, from stock prices to natural gas prices and from GDP to real exchange rates                                                                                                       |

ARDL: Autoregressive distributed lag, CGARCH: Component generalized autoregressive conditional heteroscedasticity, DCC: Dynamic conditional correlations, SVAR: Structural vector autoregressive model, VAR: Vector autoregressive model, VECM: Vector error correction model

**Table 2: Summary of empirical studies on the relationship between energy markets and liquidity**

| Authors                      | Period    | Country                                                                                                | Methodology | Result                                                                                                                                                                                                                 |
|------------------------------|-----------|--------------------------------------------------------------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Belke et al. (2010)          | 1984-2006 | USA, the euro area, Japan, UK, Canada, South Korea, Australia, Switzerland, Sweden, Norway and Denmark | VAR         | Global excess liquidity is an important determinant of asset and goods prices                                                                                                                                          |
| Kang et al. (2016)           | 1996-2014 | China, USA                                                                                             | SVAR        | The increase of China's liquidity increases the global oil and commodity prices and the USA inflation                                                                                                                  |
| Ratti and Vespignani (2013a) | 1997-2011 | BRIC, G3                                                                                               | SVAR        | The increase in oil prices raises the liquidity of Brazil and Russia while reducing the liquidity of China and India due to the different positions between countries such as commodity importers or exporters         |
| Ratti and Vespignani (2013b) | 1996-2011 | China, G3                                                                                              | SVAR        | The cumulative impact of China's M2 variable on crude oil prices is statistically significant and higher when compared to G3 countries                                                                                 |
| Ratti and Vespignani (2015)  | 1999-2012 | BRIC, G3                                                                                               | SFAVEC      | Positive shocks to BRIC M2 lead to increases in global industrial production                                                                                                                                           |
| Wu and Ni (2011)             | 1995-2005 | USA                                                                                                    | VAR         | There is a bi-directional causality between oil price changes and consumer price changes, between M2 changes and interest rate changes and a uni-directional causality running from inflation to interest rate changes |

SFAVEC: Structural factor-augmented error correction, SVAR: Structural vector autoregressive model

UAE (2002-2013), Angola (2010-2014), Ecuador (2007-2014) and Iraq (2004-2014). Australia, Algeria, Iran, and Libya were not selected due to the lack of available data. For all countries the common period used for stock index was also 2000-2014, except for: New Zealand (2001-2014), Slovenia (2004-2014), Bahrain (2003-2014), Kuwait (2011-2014), Qatar (2011-2014), UAE (2002-2013), Ecuador (2005-2014) and Nigeria (2010-2014). Sweden, Algeria, Angola, Iran, Iraq and Libya were not selected due to the lack of available data.

The monthly Industrial Production (IP) data (measured at constant 2005 USA\$, seasonally adjusted) are sourced from WDI (2015) for 34 OECD countries, 6 GCC countries and 13 OPEC countries. For all countries, the period used was 1998-2014, except for: Iceland (1998-2012), Turkey (2005-2014) and Venezuela (1998-2012).

Bahrain, Angola and Nigeria were not selected due to the lack of available data. EViews version 7.0 econometric software was employed for the data analysis.

In the first step, all the data set were transformed into natural logarithms. Next, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root tests were carried out to examine stationary. Although there are different unit root tests that investigate the stability of the series, the one which is most frequently used is the ADF test. The ADF test indicates that the first difference of the variable is regressed onto its own delayed value and onto the delayed values of its first differences in order to test whether the coefficient of ADF is zero (Dickey and Fuller, 1979). Another unit root test made for the determination of stability is PP test. The PP model introduces



**Table 3: Summary of empirical studies on the relationship between financial development and economic growth**

| Authors                          | Period      | Country                                      | Methodology             | Result                                                                                                                                                                           | Supported hypothesis                                           |
|----------------------------------|-------------|----------------------------------------------|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Abu-Bader and Abu-Qarn (2006)    | 1960-2004   | 5 MENA countries                             | Granger                 | FD $\nrightarrow$ GDP                                                                                                                                                            | Neutrality                                                     |
| Al-Malkawi et al. (2012)         | 1974-2008   | UAE                                          | ARDL method             | FD $\leftrightarrow$ GDP                                                                                                                                                         | Feedback                                                       |
| Al-Yousif (2002)                 | 1970-1999   | 30 developing countries                      | Granger                 | FD $\leftrightarrow$ GDP                                                                                                                                                         | Feedback                                                       |
| Ang and McKibbin (2007)          | 1960-2001   | Malaysia                                     | Granger                 | GDP $\rightarrow$ FD                                                                                                                                                             | Demand-following                                               |
| Bangake and Eggoh (2011)         | 1960-2004   | 71 developed and developing countries        | Granger                 | FD $\leftrightarrow$ GDP in long-term<br>FD $\nrightarrow$ GDP for low and middle income countries in short-term<br>GDP $\rightarrow$ FD for high income countries in short-term | Feedback in long-term<br>Neutrality and Feedback in short-term |
| Calderón and Liu (2003)          | 1960-1994   | 109 developing and industrialized countries  | Granger                 | FD $\leftrightarrow$ GDP                                                                                                                                                         | Feedback                                                       |
| Caporale et al. (2005)           | 1979-1998   | Chile, Malaysia, Korea and the Philippines   | VAR, TY                 | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Choe and Moosa (1999)            | 1970-1992   | Korea                                        | Granger                 | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Christopoulos and Tsionas (2004) | 1970-2000   | 10 developing countries                      | Panel                   | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Demetriades and Hussein (1996)   | 1960-1990   | 16 countries                                 | Granger                 | GDP $\rightarrow$ FD                                                                                                                                                             | Demand-following                                               |
| Hayo (1999)                      | 1960-1990   | 14 European countries, Canada, USA and Japan | Granger                 | FD $\nrightarrow$ GDP                                                                                                                                                            | Neutrality                                                     |
| Hsueh et al. (2013)              | 1980-2007   | 10 Asian countries                           | Panel                   | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Jung (1986)                      | 1950-1981   | 37 developing and 19 developed countries     | Granger                 | GDP $\rightarrow$ FD in developed countries<br>FD $\rightarrow$ GDP in developing countries                                                                                      | Demand-following<br>Supply-leading                             |
| King and Levine (1993)           | 1960-1989   | 80 countries                                 | Least squares technique | FD $\leftrightarrow$ GDP, PCA, ECD                                                                                                                                               | Feedback                                                       |
| Luintel and Khan (1999)          | 36-41 years | 10 developing countries                      | Granger                 | FD $\leftrightarrow$ GDP                                                                                                                                                         | Feedback                                                       |
| Menyah et al. (2014)             | 1965-2008   | 21 African countries                         | Granger                 | FD $\nrightarrow$ GDP                                                                                                                                                            | Neutrality                                                     |
| Pradhan et al. (2015)            | 1988-2012   | 34 ECD countries                             | Granger                 | FD $\rightarrow$ GDP in long-term<br>FD $\leftrightarrow$ GDP in short-term                                                                                                      | Supply-leading in long-term<br>Feedback in short-term          |
| Sinha and Macri (2001)           | 1950-1997   | 8 Asian countries                            | Granger                 | GDP $\rightarrow$ FD in Pakistan and the Philippines<br>FD $\rightarrow$ GDP in Japan, Thailand and Korea<br>FD $\leftrightarrow$ GDP in India, Malaysia                         | Demand-following<br>Supply-leading<br>Feedback                 |
| Thangavelu and Jiunn (2004)      | 1960-1999   | Australia                                    | VAR, Granger            | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Uddin et al. (2003)              | 1971-2011   | Kenya                                        | ARDL                    | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Xu (2000)                        | 1960-1993   | 41 countries                                 | VAR                     | FD $\rightarrow$ GDP                                                                                                                                                             | Supply-leading                                                 |
| Zhang et al. (2012)              | 2001-2006   | China                                        | GMM                     | FD $\leftrightarrow$ GDP                                                                                                                                                         | Feedback                                                       |

FD $\rightarrow$ GDP refers to the uni-directional causality running from financial development to economic growth. GDP $\rightarrow$ FD refers to the uni-directional causality running from economic growth to financial development. FD $\leftrightarrow$ GDP refers to the bidirectional causality between financial development and economic growth. FD $\nrightarrow$ GDP refers no causality between financial development and economic growth. FD: Financial development, GDP: Economic growth, ARDL: Autoregressive distributed lag, GMM: Generalized method of moments, TY: Toda-Yamamoto, VAR: Vector autoregressive model

many weakly dependent and heterogeneously distributed time series and ignores any serial correlation. One of the important advantages of using the PP unit root test is that it is more robust to heteroscedasticity in the error term and non-parametric compared to ADF. The excess sensitivity of the results obtained from the ADF

and PP tests to determined lag length has been criticized from time to time. In this context, it is observed that KPSS (1992) stationarity test, which is not sensitive to lag length, has been preferred in recent studies. The KPSS test differs from the other unit root tests since it assumes that series is stationary under the null hypothesis

Table 4: OECD Granger causality test results

| Country   | BR→M2    | M2→BR    | WTI→M2   | M2→WTI   | DUB→M2   | M2→DUB  | HH→M2    | M2→HH   | LNG→M2 |
|-----------|----------|----------|----------|----------|----------|---------|----------|---------|--------|
| Australia |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | -        | -        | -        | -        | -        | -       | -        | -       | -      |
| P-value   | -        | -        | -        | -        | -        | -       | -        | -       | -      |
| Austria   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 16.440   | 4.911    | 17.100   | 5.938    | 17.128   | 4.956   | 0.744    | 0.265   | 7.588  |
| P-value   | 0.002*** | 0.296    | 0.001*** | 0.203    | 0.001*** | 0.291   | 0.388    | 0.606   | 0.107  |
| Belgium   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 0.332    | 7.274    | 1.843    | 3.009    | 0.053    | 8.474   | 0.520    | 1.100   | 1.306  |
| P-value   | 0.846    | 0.026**  | 0.605    | 0.390    | 0.973    | 0.014** | 0.470    | 0.294   | 0.727  |
| Canada    |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 11.705   | 2.153    | 11.746   | 1.892    | 12.444   | 2.138   | 4.078    | 1.114   | 2.008  |
| P-value   | 0.008*** | 0.541    | 0.008*** | 0.594    | 0.006*** | 0.544   | 0.130    | 0.572   | 0.570  |
| Chile     |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 2.782    | 0.593    | 1.834    | 0.661    | 1.719    | 1.434   | 3.822    | 0.651   | 1.201  |
| P-value   | 0.248    | 0.473    | 0.399    | 0.718    | 0.423    | 0.488   | 0.147    | 0.721   | 0.548  |
| Czech     |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 12.181   | 3.557    | 14.166   | 5.219    | 11.501   | 3.142   | 16.043   | 3.106   | 8.859  |
| P-value   | 0.016**  | 0.469    | 0.006*** | 0.265    | 0.021**  | 0.534   | 0.003*** | 0.540   | 0.064* |
| Denmark   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 24.826   | 14.633   | 19.310   | 13.661   | 26.091   | 11.252  | 48.766   | 40.188  | 22.631 |
| P-value   | 0.036**  | 0.403    | 0.153    | 0.475    | 0.025**  | 0.666   | 0.061*   | 0.251   | 0.066* |
| Estonia   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 2.055    | 16.967   | 2.392    | 18.780   | 0.175    | 1.916   | 0.237    | 0.204   | 0.955  |
| P-value   | 0.725    | 0.002*** | 0.663    | 0.000*** | 0.915    | 0.383   | 0.626    | 0.651   | 0.812  |
| Finland   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 6.305    | 4.371    | 6.753    | 4.945    | 6.325    | 3.677   | 5.781    | 5.761   | 2.939  |
| P-value   | 0.042**  | 0.112    | 0.080*   | 0.073*   | 0.042**  | 0.159   | 0.216    | 0.217   | 0.401  |
| France    |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 6.941    | 10.488   | 3.298    | 10.772   | 4.903    | 8.533   | 2.628    | 3.003   | 5.839  |
| P-value   | 0.139    | 0.033**  | 0.509    | 0.029**  | 0.179    | 0.036** | 0.452    | 0.391   | 0.119  |
| Germany   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 2.785    | 2.507    | 3.857    | 3.084    | 2.423    | 2.305   | 0.100    | 0.000   | 1.174  |
| P-value   | 0.248    | 0.285    | 0.425    | 0.543    | 0.297    | 0.315   | 0.751    | 0.981   | 0.882  |
| Greece    |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 4.921    | 8.648    | 6.250    | 9.723    | 3.678    | 10.935  | 13.345   | 15.776  | 3.326  |
| P-value   | 0.669    | 0.278    | 0.510    | 0.204    | 0.815    | 0.141   | 0.064*   | 0.027** | 0.853  |
| Hungary   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 4.973    | 1.349    | 5.122    | 0.399    | 3.662    | 1.675   | 4.883    | 1.054   | 0.358  |
| P-value   | 0.083*   | 0.509    | 0.163    | 0.940    | 0.1601   | 0.432   | 0.087*   | 0.590   | 0.835  |
| Iceland   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 8.601    | 3.347    | 6.917    | 1.963    | 7.737    | 2.556   | 6.133    | 4.914   | 1.219  |
| P-value   | 0.013**  | 0.187    | 0.074*   | 0.580    | 0.020**  | 0.278   | 0.105    | 0.178   | 0.748  |
| Ireland   |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 3.756    | 1.323    | 5.251    | 1.776    | 4.257    | 4.720   | 1.415    | 7.232   | 4.608  |
| P-value   | 0.152    | 0.515    | 0.262    | 0.7476   | 0.372    | 0.317   | 0.492    | 0.026** | 0.329  |
| Israel    |          |          |          |          |          |         |          |         |        |
| $\chi^2$  | 8.464    | 1.954    | 9.392    | 2.452    | 8.623*   | 1.909   | 3.730    | 3.221   | 4.549  |
| P-value   | 0.076*   | 0.744    | 0.052*   | 0.653    | 0.071*   | 0.752   | 0.443    | 0.521   | 0.336  |

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Table 4: (Continued)

| Country     | BR→M2    | M2→BR   | WTI→M2   | M2→WTI   | DUB→M2   | M2→DUB   | HH→M2  | M2→HH   | LNG→M2   |
|-------------|----------|---------|----------|----------|----------|----------|--------|---------|----------|
| Italy       |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 7.319    | 9.053   | 5.516    | 10.072   | 5.150    | 9.514    | 11.685 | 3.768   | 4.951    |
| P-value     | 0.396    | 0.248   | 0.640    | 0.184    | 0.161    | 0.023**  | 0.111  | 0.806   | 0.175    |
| Japan       |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 3.607    | 4.640   | 4.153    | 4.563    | 3.121    | 4.736    | 3.062  | 8.862   | 9.573    |
| P-value     | 0.307    | 0.200   | 0.245    | 0.206    | 0.373    | 0.192    | 0.690  | 0.114   | 0.088*   |
| Korea       |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 4.874    | 2.425   | 5.900    | 5.119    | 5.278    | 2.855    | 1.962  | 1.954   | 2.761    |
| P-value     | 0.087*   | 0.297   | 0.116    | 0.163    | 0.071*   | 0.239    | 0.161  | 0.162   | 0.429    |
| Luxembourg  |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 11.188   | 0.465   | 0.838    | 0.675    | 10.918   | 0.339    | 0.699  | 5.495   | 6.518    |
| P-value     | 0.003*** | 0.792   | 0.657    | 0.713    | 0.004*** | 0.843    | 0.704  | 0.064*  | 0.038**  |
| Mexico      |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 44.283   | 4.198   | 35.821   | 7.091    | 43.987   | 3.081    | 0.097  | 1.897   | 21.383   |
| P-value     | 0.000*** | 0.240   | 0.000*** | 0.131    | 0.000*** | 0.379    | 0.755  | 0.168   | 0.000*** |
| Netherlands |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 2.177    | 1.397   | 2.250    | 5.609    | 2.153    | 1.145    | 3.195  | 0.755   | 2.043    |
| P-value     | 0.336    | 0.497   | 0.522    | 0.132    | 0.340    | 0.564    | 0.073* | 0.384   | 0.360    |
| NewZealand  |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 16.889   | 8.591   | 13.026   | 8.232    | 13.971   | 8.221    | 10.282 | 15.256  | 12.669   |
| P-value     | 0.002*** | 0.072*  | 0.011**  | 0.083*   | 0.007*** | 0.083*   | 0.113  | 0.018** | 0.005*** |
| Norway      |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 6.711    | 13.519  | 5.001    | 9.665    | 7.865    | 14.889   | 8.594  | 9.089   | 6.189    |
| P-value     | 0.568    | 0.095*  | 0.757    | 0.289    | 0.446    | 0.061*   | 0.377  | 0.334   | 0.626    |
| Poland      |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 15.166   | 4.341   | 19.052   | 5.568    | 16.607   | 3.231    | 8.920  | 0.011** | 2.658    |
| P-value     | 0.004*** | 0.361   | 0.000*** | 0.233    | 0.002*** | 0.519    | 2.306  | 0.315   | 0.447    |
| Portugal    |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 3.238    | 2.626   | 3.497    | 3.433    | 6.493    | 1.906    | 0.147  | 0.117   | 1.206    |
| P-value     | 0.198    | 0.268   | 0.174    | 0.179    | 0.0358** | 0.385    | 0.700  | 0.732   | 0.751    |
| Slovakia    |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 26.811   | 5.238   | 21.008   | 3.155    | 28.918   | 5.974    | 0.004  | 1.652   | 30.750   |
| P-value     | 0.000*** | 0.263   | 0.000*** | 0.368    | 0.000*** | 0.201    | 0.945  | 0.198   | 0.000*** |
| Slovenia    |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 2.235    | 2.195   | 1.348    | 3.661    | 3.490    | 2.628    | 1.547  | 0.840   | 2.868    |
| P-value     | 0.327    | 0.333   | 0.717    | 0.300    | 0.174    | 0.268    | 0.416  | 0.656   | 0.238    |
| Spain       |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 9.773    | 4.057   | 14.075   | 4.793    | 10.325   | 2.802    | 9.377  | 17.533  | 2.754    |
| P-value     | 0.201    | 0.773   | 0.049**  | 0.685    | 0.170    | 0.902    | 0.226  | 0.014** | 0.906    |
| Sweden      |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 20.100   | 15.278  | 19.131   | 11.266   | 22.489   | 16.955   | 0.204  | 0.093   | 12.906   |
| P-value     | 0.002*** | 0.018** | 0.003*** | 0.080*   | 0.001*** | 0.009*** | 0.902  | 0.954   | 0.011**  |
| Switzerland |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 33.714   | 10.002  | 15.751   | 13.599   | 45.934   | 8.634    | 1.331  | 1.725   | 1.311    |
| P-value     | 0.000*** | 0.188   | 0.003*** | 0.008*** | 0.000*** | 0.280    | 0.513  | 0.422   | 0.519    |
| Turkey      |          |         |          |          |          |          |        |         |          |
| $\chi^2$    | 1.048    | 0.690   | 3.802    | 1.004    | 4.186    | 7.073    | 0.729  | 1.890   | 1.214    |
| P-value     | 0.592    | 0.708   | 0.283    | 0.800    | 0.242    | 0.069    | 0.393  | 0.169   | 0.749    |

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Table 4: (Continued)

| Country   | BR→M2    | M2→BR    | WTI→M2   | M2→WTI  | DUB→M2   | M2→DUB   | HH→M2    | M2→HH    | LNG→M2   |
|-----------|----------|----------|----------|---------|----------|----------|----------|----------|----------|
| UK        |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 2.565    | 21.599   | 0.627    | 22.682  | 1.873    | 21.299   | 0.945    | 15.094   | 3.990    |
| P-value   | 0.633    | 0.000*** | 0.730    | 0.000   | 0.759    | 0.000*** | 0.917    | 0.004*** | 0.407    |
| US        |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 23.620   | 2.582    | 20.009   | 7.707   | 26.091   | 2.887    | 1.883    | 12.666   | 15.908   |
| P-value   | 0.000*** | 0.764    | 0.002*** | 0.260   | 0.000*** | 0.717    | 0.930    | 0.048**  | 0.000*** |
| Country   | M2→LNG   | RUS→M2   | M2→RUS   | BR→SI   | SI→BR    | WTI→SI   | SI→WTI   | DUB→SI   | SI→DUB   |
| Australia |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | -        | -        | -        | 0.144   | 5.897    | 0.673    | 5.349    | 0.098    | 6.069    |
| P-value   | -        | -        | -        | 0.930   | 0.052*   | 0.714    | 0.068*   | 0.981    | 0.048**  |
| Austria   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 8.986    | 4.784    | 9.960    | 1.521   | 24.803   | 1.694    | 17.964   | 1.518    | 19.977   |
| P-value   | 0.061*   | 0.686    | 0.190    | 0.822   | 0.000*** | 0.428    | 0.000*** | 0.468    | 0.000    |
| Belgium   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 9.016    | 2.200    | 1.032    | 0.293   | 16.458   | 7.950    | 18.578   | 0.357    | 13.650   |
| P-value   | 0.029**  | 0.698    | 0.904    | 0.863   | 0.000*** | 0.337    | 0.009*** | 0.836    | 0.001*** |
| Canada    |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 6.462    | 1.669    | 3.293    | 10.815  | 47.340   | 9.716    | 38.323   | 12.971   | 59.603   |
| P-value   | 0.091*   | 0.796    | 0.510    | 0.146   | 0.000*** | 0.205    | 0.000*** | 0.112    | 0.000*** |
| Chile     |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 1.707    | 15.511   | 17.187   | 1.125   | 0.261    | 0.764    | 0.144    | 1.358    | 0.212    |
| P-value   | 0.425    | 0.030**  | 0.016**  | 0.569   | 0.877    | 0.682    | 0.930    | 0.506    | 0.899    |
| Czech     |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 5.8301   | 0.788    | 4.707    | 0.880   | 11.556   | 11.659   | 12.437   | 5.247    | 15.492   |
| P-value   | 0.212    | 0.940    | 0.318    | 0.643   | 0.003*** | 0.112    | 0.087*   | 0.262    | 0.003*** |
| Denmark   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 5.404    | 3.134    | 6.662    | 0.326   | 10.687   | 11.517   | 17.843   | 12.059   | 17.600   |
| P-value   | 0.979    | 0.679    | 0.247    | 0.849   | 0.004*** | 0.117    | 0.012**  | 0.098*   | 0.013**  |
| Estonia   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 2.087    | 4.1801   | 4.653    | 0.825   | 9.524    | 3.694    | 13.604   | 0.771    | 8.547    |
| P-value   | 0.554    | 0.382    | 0.324    | 0.661   | 0.008*** | 0.449    | 0.008    | 0.680    | 0.013**  |
| Finland   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 10.869   | 2.924    | 1.981    | 14.098  | 16.807   | 14.848   | 16.764   | 18.816   | 20.303   |
| P-value   | 0.012**  | 0.570    | 0.739    | 0.049** | 0.018**  | 0.0385** | 0.019**  | 0.008*** | 0.004*** |
| France    |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 4.461    | 5.506    | 10.527   | 8.771   | 18.340   | 12.583   | 15.137   | 9.043    | 16.825   |
| P-value   | 0.215    | 0.239    | 0.032**  | 0.186   | 0.005*** | 0.050*   | 0.019**  | 0.249    | 0.018**  |
| Germany   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 1.075    | 12.922   | 1.056    | 4.444   | 9.533    | 14.942   | 14.763   | 4.573    | 9.258    |
| P-value   | 0.898    | 0.011**  | 0.901    | 0.108   | 0.008*** | 0.036**  | 0.039**  | 0.101    | 0.009*** |
| Greece    |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 8.765    | 2.335    | 11.021   | 2.551   | 9.797    | 2.058    | 5.031    | 2.586    | 10.473   |
| P-value   | 0.269    | 0.938    | 0.137    | 0.279   | 0.007*** | 0.357    | 0.080    | 0.274    | 0.005*** |
| Hungary   |          |          |          |         |          |          |          |          |          |
| $\chi^2$  | 3.842    | 5.873    | 5.465    | 3.886   | 5.750    | 14.125   | 6.503    | 4.862    | 16.865   |
| P-value   | 0.146    | 0.208    | 0.242    | 0.273   | 0.124    | 0.014**  | 0.260    | 0.301    | 0.002*** |

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Table 4: (Continued)

| Country     | M2→LNG   | RUS→M2   | M2→RUS   | BR→SI    | SI→BR    | WTI→SI  | SI→WTI   | DUB→SI   | SI→DUB   |
|-------------|----------|----------|----------|----------|----------|---------|----------|----------|----------|
| Iceland     |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 13.260   | 1.087    | 3.305    | 9.793    | 14.192   | 12.413  | 16.383   | 12.004   | 11.275   |
| P-value     | 0.004*** | 0.896    | 0.508    | 0.044**  | 0.006*** | 0.087*  | 0.021**  | 0.017**  | 0.023**  |
| Ireland     |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 5.157    | 3.356    | 3.417    | 11.301   | 19.510   | 14.435  | 16.273   | 12.649   | 15.804   |
| P-value     | 0.271    | 0.500    | 0.490    | 0.126    | 0.006*** | 0.044** | 0.022**  | 0.081*   | 0.027**  |
| Israel      |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 6.899    | 10.033   | 1.320    | 0.145    | 13.089   | 17.218  | 19.204   | 19.774   | 20.005   |
| P-value     | 0.141    | 0.039**  | 0.857    | 0.929    | 0.001*** | 0.016** | 0.007*** | 0.006*** | 0.005*** |
| Italy       |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 6.175    | 8.907    | 9.662    | 2.093    | 7.978    | 8.762   | 13.445   | 5.593    | 10.507   |
| P-value     | 0.103    | 0.259    | 0.208    | 0.351    | 0.018**  | 0.270   | 0.062**  | 0.231    | 0.032**  |
| Japan       |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 14.185   | 6.033    | 18.358   | 0.645    | 5.954    | 0.571   | 2.706    | 19.774   | 20.005   |
| P-value     | 0.014**  | 0.535    | 0.010*   | 0.724    | 0.050    | 0.751   | 0.258    | 0.006*** | 0.005*** |
| Korea       |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 9.185    | 9.012    | 20.815   | 3.315    | 4.285    | 3.154   | 0.888    | 5.593    | 10.507   |
| P-value     | 0.026**  | 0.251    | 0.004*** | 0.345    | 0.232    | 0.368   | 0.828    | 0.231    | 0.032**  |
| Luxembourg  |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 2.296    | 5.644    | 5.079    | 9.998    | 34.389   | 8.859   | 29.970   | 11.081   | 37.284   |
| P-value     | 0.317    | 0.342    | 0.406    | 0.124    | 0.000*** | 0.181   | 0.000*** | 0.085*   | 0.000*** |
| Mexico      |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 1.756    | 7.038    | 23.343   | 0.252    | 1.059    | 0.247   | 0.628    | 0.134    | 1.508    |
| p-value     | 0.624    | 0.217    | 0.000*** | 0.881    | 0.588    | 0.883   | 0.730    | 0.935    | 0.470    |
| Netherlands |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 0.673    | 3.660    | 1.330    | 8.931    | 27.867   | 8.061   | 22.100   | 7.086    | 23.821   |
| P-value     | 0.714    | 0.453    | 0.856    | 0.177    | 0.000*** | 0.327   | 0.002*** | 0.419    | 0.001*** |
| New Zealand |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 8.103    | 6.239    | 6.571    | 0.927    | 4.575    | 2.185   | 3.410    | 0.737    | 3.967    |
| P-value     | 0.043**  | 0.182    | 0.160    | 0.628    | 0.101    | 0.534   | 0.332    | 0.691    | 0.137    |
| Norway      |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 12.065   | 3.601    | 21.387   | 10.476   | 33.112   | 11.038  | 31.146   | 11.195   | 28.533   |
| P-value     | 0.148    | 0.891    | 0.006*** | 0.106    | 0.000*** | 0.087*  | 0.000*** | 0.082*   | 0.000*** |
| Poland      |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 2.766    | 6.846    | 2.175    | 0.108    | 9.480    | 1.127   | 0.222    | 0.013    | 9.401    |
| P-value     | 0.429    | 0.144    | 0.703    | 0.947    | 0.008*** | 0.569   | 0.894    | 0.993    | 0.009*** |
| Portugal    |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 5.700    | 4.585    | 8.772    | 0.936    | 8.351    | 9.084   | 20.752   | 1.091    | 9.596    |
| P-value     | 0.127    | 0.468    | 0.118    | 0.626    | 0.015**  | 0.246   | 0.004*** | 0.579    | 0.008*** |
| Slovakia    |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 2.172    | 19.961   | 29.725   | 3.719    | 1.680    | 6.688   | 2.128    | 4.036    | 1.958    |
| P-value     | 0.537    | 0.005*** | 0.000*** | 0.155    | 0.431    | 0.035** | 0.345    | 0.132    | 0.375    |
| Slovenia    |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 2.102    | 5.710    | 4.154    | 31.264   | 4.052    | 4.243   | 3.312    | 12.455   | 1.138    |
| P-value     | 0.349    | 0.221    | 0.385    | 0.000*** | 0.852    | 0.374   | 0.507    | 0.014**  | 0.888    |
| Spain       |          |          |          |          |          |         |          |          |          |
| $\chi^2$    | 0.906    | 6.772    | 4.009    | 0.435    | 9.348    | 0.901   | 5.270    | 0.514    | 11.779   |
| P-value     | 0.044**  | 0.453    | 0.778    | 0.804    | 0.009*** | 0.637   | 0.071*   | 0.773    | 0.002*** |

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Table 4: (Continued)

| Country     | BR→M2    | M2→BR | WTI→M2   | M2→WTI | DUB→M2   | M2→DUB | HH→M2    | M2→HH | LNG→M2   |
|-------------|----------|-------|----------|--------|----------|--------|----------|-------|----------|
| Sweden      |          |       |          |        |          |        |          |       |          |
| $\chi^2$    | 12.162   | 2.448 | 1.776    | -      | -        | -      | -        | -     | -        |
| P-value     | 0.016**  | 0.653 | 0.776    | -      | -        | -      | -        | -     | -        |
| Switzerland |          |       |          |        |          |        |          |       |          |
| $\chi^2$    | 18.622   | 3.877 | 32.686   | 1.017  | 7.164    | 0.895  | 4.818    | 0.923 | 7.369    |
| P-value     | 0.000    | 0.567 | 0.000*** | 0.601  | 0.027**  | 0.639  | 0.089    | 0.630 | 0.025**  |
| Turkey      |          |       |          |        |          |        |          |       |          |
| $\chi^2$    | 11.013   | 2.580 | 6.022    | 3.479  | 3.917    | 4.562  | 0.676    | 3.418 | 4.294    |
| P-value     | 0.011**  | 0.630 | 0.197    | 0.323  | 0.270    | 0.206  | 0.878    | 0.331 | 0.231    |
| UK          |          |       |          |        |          |        |          |       |          |
| $\chi^2$    | 15.528   | 5.438 | 26.658   | 2.351  | 12.218   | 7.842  | 13.464   | 2.355 | 12.925   |
| P-value     | 0.003*** | 0.606 | 0.000*** | 0.502  | 0.006*** | 0.165  | 0.019**  | 0.501 | 0.004*** |
| US          |          |       |          |        |          |        |          |       |          |
| $\chi^2$    | 2.943    | 5.842 | 17.351   | 0.870  | 13.222   | 3.881  | 16.018   | 9.107 | 22.897   |
| P-value     | 0.229    | 0.321 | 0.003*** | 0.647  | 0.001*** | 0.422  | 0.003*** | 0.104 | 0.000*** |

“→” denotes unidirectional causality, BR: Brent oil price, WTI: West Texas Intermediate price, DUB: Dubai oil price, HH: Henry Hub price, LNG: Liquefied natural gas price, M2: Liquidity, SI: Stock index, IP: Industrial production, \*\*\*, \*\* and \* denote statistical significance at 1%, 5% and 10% level of significance respectively

(Başar and Temurlenk, 2007). Thus, hypothesis to be built for KPSS test means that null hypothesis time series is stationary and on the other hand alternative hypothesis means that time series is not stationary (Sevüktekin and Nargeleşkenler, 2005).

After determining whether the variables were suitable for the analysis, Johansen cointegration tests were performed to examine the long-term relationship between world oil and natural gas prices and stock markets, liquidity and industrial production respectively and between financial development and economic growth. In the presence of a long-term relationship (cointegration vector) between the relevant variables the vector error correction model was conducted; while in the case of absence of a long-term relationship, in order to investigate the short-term Granger causality the vector autoregressive model (VAR) was applied.

## 4. EMPIRICAL FINDINGS

The Granger causality tests results of OECD, GCC and OPEC countries are illustrated in at Tables 4-9. The relationship between energy prices (Brent, WTI, Dubai, HH, LNG and Russia) and liquidity was the subject of the first investigation. For most OECD, GCC and OPEC countries; there were long-term relationships between the energy prices and liquidity. The general findings of the Granger causality test results showed that in most of the OECD countries there was a uni-directional causality running from oil prices (Brent, WTI and Dubai) to liquidity, which is in line with the results of Ratti and Vespignani (2013a). It is not possible to generalize the results from the analysis of the GCC countries since the results are country specific however, there were no causal relationships between oil prices and liquidity in most of the OPEC countries. Furthermore, when the relationship between natural gas prices (HH, LNG and Russia) and liquidity was investigated an absence of causality between natural gas prices and liquidity was detected in most of the OECD, GCC and OPEC countries. This finding was not in line with those of Belke et al. (2010), Ratti and Vespignani (2013b) and Kang et al. (2016). Concerning the liquidity theory, the increase in liquidity would increase aggregate demand, while lowering interest rates; which may in turn raise commodity and oil prices. On the other hand, the increase in oil prices may cause recessions by lowering consumption, investments, stock prices, economic growth and aggregate demand. The findings of the current study indicate that a rise in oil prices may damage liquidity level, and consequently, have a negative effect on economic growth in the long-term for OECD countries; while this will not have an effect in OPEC countries. Furthermore, while the increase in natural gas prices will not have any negative effect on the liquidity level of the OECD, GCC and OPEC countries, a monetary expansion policy would promote economic growth without affecting oil prices in the OECD and OPEC countries, or natural gas prices in OECD, GCC and OPEC countries.

The second relationship to be examined was between energy prices and stock index. For most OECD, GCC and OPEC countries; there were no long-term relationships between energy prices and the stock index. The general findings of the Granger causality test results showed that; in most of the OECD countries there

**Table 5: OECD Granger causality test results cont**

| Country    | HH→SI  | SI→HH  | LNG→SI  | SI→LNG   | RUS→SI   | SI→RUS    | BR→IP    | IP→BR  | WTI→IP   | IP→WTI  |
|------------|--------|--------|---------|----------|----------|-----------|----------|--------|----------|---------|
| Australia  |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.717  | 2.066  | 0.742   | 16.306   | 10.822   | 1.767     | 4.358    | 0.866  | 3.363    | 1.426   |
| P-value    | 0.698  | 0.355  | 0.690   | 0.000*** | 0.028**  | 0.778     | 0.225    | 0.833  | 0.338    | 0.699   |
| Austria    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.076  | 2.951  | 4.252   | 41.963   | 5.056    | 27.132    | 15.865   | 8.374  | 17.385   | 8.056   |
| P-value    | 0.962  | 0.228  | 0.373   | 0.000*** | 0.653    | 0.000***  | 0.003*** | 0.078* | 0.001*** | 0.089*  |
| Belgium    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.355  | 5.487  | 11.599  | 20.220   | 5.531    | 16.785    | 3.299    | 3.264  | 5.769    | 1.905   |
| P-value    | 0.837  | 0.064* | 0.071*  | 0.002*** | 0.595    | 0.018**   | 0.192    | 0.195  | 0.123    | 0.592   |
| Canada     |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.603  | 0.204  | 2.219   | 52.268   | 2.979    | 9.832     | 11.701   | 1.702  | 10.065   | 1.678   |
| P-value    | 0.739  | 0.902  | 0.528   | 0.000*** | 0.561    | 0.043**   | 0.019**  | 0.790  | 0.039**  | 0.794   |
| Chile      |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 2.069  | 1.753  | 3.542   | 3.535    | 10.780   | 16.715    | 3.215    | 7.458  | 4.564    | 7.386   |
| P-value    | 0.355  | 0.416  | 0.170   | 0.170    | 0.029**  | 0.002***  | 0.359    | 0.058* | 0.206    | 0.0609* |
| Czech      |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.452  | 1.900  | 5.865   | 23.480   | 12.979   | 27.046*** | 3.609    | 3.087  | 2.148    | 1.168   |
| P-value    | 0.797  | 0.386  | 0.118   | 0.000*** | 0.072*   | 0.000     | 0.164    | 0.213  | 0.341    | 0.557   |
| Denmark    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.397  | 0.161  | 2.395   | 26.272   | 6.325    | 23.805    | 24.725   | 7.930  | 24.932   | 7.618   |
| P-value    | 0.819  | 0.922  | 0.494   | 0.000*** | 0.502    | 0.001***  | 0.000*** | 0.338  | 0.000*** | 0.367   |
| Estonia    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 1.799  | 0.369  | 0.752   | 15.819   | 14.927   | 20.295    | 19.280   | 4.129  | 18.192   | 3.882   |
| P-value    | 0.406  | 0.831  | 0.686   | 0.000*** | 0.036**  | 0.005***  | 0.000*** | 0.388  | 0.001*** | 0.422   |
| Finland    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 2.080  | 1.044  | 1.315   | 5.150    | 2.224    | 13.834    | 24.725   | 7.930  | 24.932   | 7.618   |
| P-value    | 0.353  | 0.593  | 0.725   | 0.161    | 0.694    | 0.007***  | 0.000*** | 0.338  | 0.000*** | 0.367   |
| France     |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.160  | 0.457  | 1.904   | 17.382   | 7.004    | 9.443     | 28.945   | 2.323  | 31.058   | 2.323   |
| P-value    | 0.922  | 0.795  | 0.592   | 0.000*** | 0.428    | 0.222     | 0.000*** | 0.676  | 0.000*** | 0.676   |
| Germany    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.340  | 0.528  | 5.988   | 13.229   | 10.930   | 11.450    | 34.524   | 4.956  | 36.411   | 4.956   |
| P-value    | 0.843  | 0.767  | 0.112   | 0.004*** | 0.141    | 0.120     | 0.000*** | 0.421  | 0.000*** | 0.421   |
| Greece     |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.702  | 0.588  | 4.017   | 16.016   | 16.279   | 8.311     | 6.339    | 0.898  | 6.519    | 0.909   |
| P-value    | 0.704  | 0.745  | 0.259   | 0.001*** | 0.022*** | 0.306     | 0.096*   | 0.825  | 0.088*   | 0.823   |
| Hungary    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.149  | 1.056  | 8.342   | 22.934   | 16.561   | 4.850     | 11.200   | 0.412  | 14.880   | 7.606   |
| P-value    | 0.928  | 0.589  | 0.079*  | 0.001*** | 0.002*** | 0.303     | 0.010*   | 0.937  | 0.001*** | 0.054*  |
| Iceland    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 6.901  | 1.207  | 12.874  | 50.150   | 11.426   | 73.974    | 14.122   | 3.242  | 15.912   | 4.053   |
| P-value    | 0.075* | 0.751  | 0.045** | 0.000*** | 0.178    | 0.000***  | 0.002    | 0.355  | 0.001*** | 0.255   |
| Ireland    |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.855  | 0.001  | 15.088  | 18.045   | 8.390    | 13.227    | 2.542    | 2.287  | 2.165    | 1.186   |
| P-value    | 0.652  | 0.999  | 0.019** | 0.006*** | 0.299    | 0.066*    | 0.467    | 0.514  | 0.538    | 0.756   |
| Israel     |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.232  | 0.088  | 8.633   | 22.904   | 11.620   | 14.516    | 0.050    | 0.465  | 0.056    | 0.012   |
| P-value    | 0.890  | 0.956  | 0.124   | 0.000*** | 0.113    | 0.042**   | 0.975    | 0.792  | 0.972    | 0.993   |
| Italy      |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.021  | 0.306  | 5.972   | 0.113    | 9.453    | 0.221     | 21.468   | 4.073  | 22.419   | 2.910   |
| P-value    | 0.884  | 0.579  | 11.938  | 0.007*** | 13.925   | 0.052*    | 0.000*** | 0.538  | 0.004*** | 0.713   |
| Japan      |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.019  | 1.358  | 1.924   | 19.579   | 3.306    | 5.792     | 24.887   | 1.661  | 31.068   | 1.936   |
| P-value    | 0.990  | 0.507  | 0.588   | 0.000*** | 0.507    | 0.215     | 0.000*** | 0.797  | 0.000*** | 0.747   |
| Korea      |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.091  | 0.349  | 13.013  | 30.526   | 8.150    | 9.447     | 16.450   | 0.501  | 14.659   | 1.226   |
| P-value    | 0.955  | 0.839  | 0.023** | 0.000*** | 0.086*   | 0.050*    | 0.000*** | 0.778  | 0.000*** | 0.541   |
| Luxembourg |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 2.231  | 0.386  | 4.840   | 25.959   | 5.030    | 19.801    | 26.618   | 0.428  | 16.637   | 3.754   |
| P-value    | 0.327  | 0.824  | 0.304   | 0.000*** | 0.656    | 0.006***  | 0.000*** | 0.807  | 0.000*** | 0.289   |
| Mexico     |        |        |         |          |          |           |          |        |          |         |
| $\chi^2$   | 0.150  | 0.680  | 3.885   | 23.275   | 9.994    | 8.170     | 9.240    | 1.265  | 10.345   | 2.531   |
| P-value    | 0.927  | 0.711  | 0.274   | 0.000*** | 0.040**  | 0.085*    | 0.009*** | 0.531  | 0.005*** | 0.282   |

(Contd...)

**Table 5: (Continued)**

| Country     | HH→SI    | SI→HH   | LNG→SI   | SI→LNG   | RUS→SI   | SI→RUS   | BR→IP    | IP→BR    | WTI→IP   | IP→WTI  |
|-------------|----------|---------|----------|----------|----------|----------|----------|----------|----------|---------|
| Netherlands |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 1.481    | 0.815   | 2.273    | 27.623   | 4.538    | 21.906   | 2.181    | 1.732    | 4.873    | 2.466   |
| P-value     | 0.476    | 0.665   | 0.685    | 0.000*** | 0.716    | 0.002*** | 0.335    | 0.420    | 0.181    | 0.481   |
| New Zealand |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.068    | 0.013   | 1.043    | 19.649   | 6.243    | 9.334    | 5.946    | 4.340    | 9.657    | 10.563  |
| P-value     | 0.966    | 0.993   | 0.790    | 0.000*** | 0.181    | 0.053*   | 0.114    | 0.226    | 0.046**  | 0.031** |
| Norway      |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.092    | 1.340   | 2.923    | 55.381   | 4.165    | 9.937    | 3.284    | 8.151    | 2.905    | 6.931   |
| P-value     | 0.954    | 0.511   | 0.403    | 0.000*** | 0.384    | 0.041**  | 0.656    | 0.148    | 0.714    | 0.225   |
| Poland      |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.488    | 0.331   | 0.283    | 19.441   | 9.267    | 2.249    | 4.760    | 17.708   | 7.000    | 5.160   |
| P-value     | 0.783    | 0.847   | 0.867    | 0.000*** | 0.054*   | 0.689    | 0.312    | 0.001*** | 0.135    | 0.271   |
| Portugal    |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.542    | 1.658   | 2.291    | 11.432   | 3.294    | 6.270    | 10.376   | 2.563    | 8.890    | 4.134   |
| P-value     | 0.762    | 0.436   | 0.514    | 0.009*** | 0.509    | 0.179    | 0.034**  | 0.633    | 0.063*   | 0.388   |
| Slovakia    |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 1.673    | 4.786   | 2.447    | 3.864    | 13.500   | 18.331   | 32.111   | 8.000    | 25.632   | 9.039   |
| P-value     | 0.433    | 0.01*   | 0.294    | 0.144    | 0.095*   | 0.018**  | 0.000*** | 0.091*   | 0.000*** | 0.060*  |
| Slovenia    |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 1.955    | 4.752   | 11.612   | 12.198   | 23.300   | 20.729   | 15.836   | 0.280    | 13.935   | 0.383   |
| P-value     | 0.376    | 0.092*  | 0.020**  | 0.015**  | 0.000*** | 0.002*** | 0.000*** | 0.869    | 0.000*** | 0.825   |
| Spain       |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.330    | 0.973   | 0.199    | 11.143   | 8.700    | 9.568    | 20.325   | 0.131    | 21.408   | 1.719   |
| P-value     | 0.847    | 0.614   | 0.977    | 0.011**  | 0.069*   | 0.048**  | 0.000*** | 0.997    | 0.000*** | 0.787   |
| Sweden      |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | -        | -       | -        | -        | -        | -        | 22.556   | 2.225    | 19.360   | 1.557   |
| P-value     | -        | -       | -        | -        | -        | -        | 0.000*** | 0.694    | 0.000*** | 0.816   |
| Switzerland |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.156    | 2.041   | 6.244    | 11.061   | 3.623    | 8.099    | 8.605    | 0.601    | 7.234    | 0.854   |
| P-value     | 0.924    | 0.360   | 0.100    | 0.011**  | 0.459    | 0.088*   | 0.013**  | 0.740    | 0.026**  | 0.652   |
| Turkey      |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.166    | 0.110   | 2.275    | 3.916    | 8.807    | 5.133    | 34.896   | 2.757    | 40.311   | 0.697   |
| P-value     | 0.83     | 0.739   | 0.517    | 0.270    | 0.066*   | 0.273    | 0.000*** | 0.251    | 0.000*** | 0.873   |
| UK          |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 0.334    | 0.109   | 4.866    | 22.4763  | 7.838    | 19.360   | 8.696    | 2.116    | 12.754   | 2.555   |
| P-value     | 0.563    | 0.740   | 0.181    | 0.000*** | 0.347    | 0.007*** | 0.012**  | 0.347    | 0.001*** | 0.278   |
| US          |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 2.097    | 1.408   | 5.660    | 21.563   | 6.047    | 19.536   | 5.409    | 10.775   | 9.635    | 10.887  |
| P-value     | 0.350    | 0.494   | 0.129    | 0.000*** | 0.534    | 0.006*** | 0.492    | 0.095*   | 0.210    | 0.143   |
| Country     | DUB→IP   | IP→DUB  | HH→IP    | IP→HH    | LNG→IP   | IP→LNG   | RUS→IP   | IP→RUS   | SI→IP    | IP→SI   |
| Australia   |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 3.976    | 0.991   | 7.489    | 3.062    | 7.202    | 2.807    | 4.184    | 6.388    | 3.950    | 1.592   |
| P-value     | 0.264    | 0.803   | 0.057*   | 0.382    | 0.065*   | 0.422    | 0.381    | 0.172    | 0.266    | 0.661   |
| Austria     |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 16.121   | 7.713   | 6.486    | 0.162    | 7.122    | 10.371   | 3.541    | 1.491    | 16.566   | 3.314   |
| P-value     | 0.002*** | 0.102   | 0.010**  | 0.686    | 0.129    | 0.034**  | 0.471    | 0.828    | 0.035**  | 0.913   |
| Belgium     |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 2.448    | 4.190   | 8.318    | 1.285    | 15.010   | 4.787    | 1.249    | 2.984    | 31.039   | 7.437   |
| P-value     | 0.294    | 0.123   | 0.039**  | 0.732    | 0.001*** | 0.188    | 0.869    | 0.560    | 0.000*** | 0.282   |
| Canada      |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 15.844   | 0.678   | 19.675   | 3.752    | 6.884    | 7.382    | 3.646    | 17.540   | 31.278   | 5.796   |
| P-value     | 0.007*** | 0.984   | 0.001*** | 0.585    | 0.229    | 0.193    | 0.601    | 0.003*** | 0.000*** | 0.214   |
| Chile       |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 8.513    | 3.529   | 0.415    | 4.587    | 7.044    | 12.548   | 0.620    | 2.616    | 7.519    | 4.363   |
| P-value     | 0.317    | 0.036** | 0.937    | 0.204    | 0.070*   | 0.005*** | 0.960    | 0.623    | 0.057*   | 0.224   |
| Czech       |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 3.569    | 4.148   | 1.181    | 0.088    | 0.747    | 5.869    | 1.004    | 7.828    | 10.431   | 4.640   |
| P-value     | 0.167    | 0.125   | 0.554    | 0.956    | 0.688    | 0.053*   | 0.909    | 0.098*   | 0.015**  | 0.200   |
| Denmark     |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 20.429   | 6.610   | 3.621    | 8.382    | 5.039    | 3.531    | 10.981   | 4.410    | 10.223   | 6.384   |
| P-value     | 0.004*** | 0.470   | 0.605    | 0.136    | 0.411    | 0.618    | 0.051*   | 0.491    | 0.036**  | 0.172   |
| Estonia     |          |         |          |          |          |          |          |          |          |         |
| $\chi^2$    | 9.695    | 2.278   | 4.613    | 0.120    | 12.327   | 14.790   | 3.719    | 28.477   | 22.316   | 4.827   |
| P-value     | 0.007*** | 0.320   | 0.099*   | 0.941    | 0.015**  | 0.005*** | 0.445    | 0.000*** | 0.002*** | 0.681   |

(Contd...)



Table 5: (Continued)

| Country     | DUB→IP   | IP→DUB  | HH→IP   | IP→HH   | LNG→IP   | IP→LNG   | RUS→IP   | IP→RUS   | SI→IP    | IP→SI    |
|-------------|----------|---------|---------|---------|----------|----------|----------|----------|----------|----------|
| Finland     |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 20.429   | 6.610   | 3.621   | 8.382   | 3.954    | 1.782    | 14.769   | 4.760    | 19.059   | 5.312    |
| P-value     | 0.004*** | 0.470   | 0.605   | 0.136   | 0.266    | 0.618    | 0.0369** | 0.689    | 0.000*** | 0.256    |
| France      |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 27.064   | 2.799   | 0.078*  | 0.101   | 30.356   | 5.368    | 10.501   | 27.950   | 18.456   | 4.281    |
| P-value     | 0.000*** | 0.591   |         |         | 0.000*** | 0.146    | 0.062*   | 0.000*** | 0.001*** | 0.369    |
| Germany     |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 34.532   | 5.994   | 2.061   | 8.867   | 24.210   | 25.345   | 7.534    | 39.039   | 35.616   | 7.596    |
| P-value     | 0.000*** | 0.306   |         | 0.064** | 0.000*** | 0.000*** | 0.110    | 0.000*** | 0.000*** | 0.269    |
| Greece      |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 6.844    | 1.097   | 6.935   | 3.715   | 5.583    | 2.863    | 4.090    | 1.760    | 6.854    | 10.111   |
| P-value     | 0.077*   | 0.777   | 0.225   | 0.591   | 0.133    | 0.413    | 0.393    | 0.779    | 0.143    | 0.038**  |
| Hungary     |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 17.689   | 2.593   | 3.627   | 0.550   | 14.0701  | 2.444    | 3.871    | 20.434   | 5.538    | 4.277    |
| P-value     | 0.000*** | 0.458   | 0.163   | 0.759   | 0.002*** | 0.485    | 0.568    | 0.001*** | 0.136    | 0.233    |
| Iceland     |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 3.027    | 2.420   | 2.336   | 0.667   | 14.612   | 4.847    | 7.7412   | 7.444    | 15.463   | 10.133   |
| P-value     | 0.387    | 0.489   | 0.310   | 0.716   | 0.002*** | 0.183    | 0.191    | 0.189    | 0.050*   | 0.255    |
| Ireland     |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 1.703    | 1.717   | 7.390   | 2.316   | 2.801    | 1.750    | 4.350    | 4.520    | 2.584    | 4.747    |
| P-value     | 0.636    | 0.633   | 0.060*  | 0.509   | 0.423    | 0.625    | 0.360    | 0.340    | 0.629    | 0.314    |
| Israel      |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 0.179    | 0.144   | 3.799   | 0.0748  | 9.809    | 1.453    | 2.713    | 2.437    | 0.782    | 0.248    |
| P-value     | 0.914    | 0.930   | 0.149   | 0.961   | 0.020**  | 0.693    | 0.606    | 0.655    | 0.676    | 0.833    |
| Italy       |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 31.401   | 18.956  | 4.019   | 15.563  | 15.544   | 15.052   | 19.063   | 21.528   | 20.415   | 7.213    |
| P-value     | 0.000*** | 0.015** | 0.674   | 0.016** | 0.016**  | 0.019**  | 0.008*** | 0.003*** | 0.000*** | 0.125    |
| Japan       |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 26.458   | 2.664   | 1.005   | 1.614   | 19.451   | 2.758    | 2.090    | 35.237   | 1.100    | 2.205    |
| P-value     | 0.000*** | 0.615   | 0.604   | 0.446   | 0.000    | 0.430    | 0.719    | 0.000*** | 0.576    | 0.332    |
| Korea       |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 19.345   | 0.222   | 1.331   | 0.095   | 7.371    | 5.082    | 7.422    | 23.032   | 13.908   | 0.802    |
| P-value     | 0.000*** | 0.894   | 0.248   | 0.756   | 0.025**  | 0.078*   | 0.115    | 0.000*** | 0.001*** | 0.669    |
| Luxembourg  |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 21.071   | 0.311   | 2.242   | 0.544   | 1.925    | 3.297    | 11.155   | 32.086   | 8.256    | 0.932    |
| P-value     | 0.000*** | 0.855   | 0.326   | 0.761   | 0.381    | 0.192    | 0.132    | 0.000*** | 0.016**  | 0.627    |
| Mexico      |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 8.631    | 1.736   | 6.521   | 7.418   | 20.443   | 9.733    | 6.530    | 0.786    | 22.070   | 5.511    |
| P-value     | 0.013**  | 0.419   | 0.258   | 0.191   | 0.000*** | 0.021**  | 0.088*   | 0.852    | 0.000*** | 0.356    |
| Netherlands |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 2.328    | 2.706   | 0.5601  | 0.961   | 6.001    | 6.205    | 5.437    | 8.509    | -        | -        |
| P-value     | 0.312    | 0.258   | 0.755   | 0.618   | 0.111    | 0.102    | 0.364    | 0.130    | -        | -        |
| New Zealand |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 7.887    | 2.198   | 0.557   | 6.980   | 3.287    | 6.838    | 4.598    | 21.350   | 2.373    | 1.658    |
| P-value     | 0.048**  | 0.532   | 0.906   | 0.072*  | 0.348    | 0.077*   | 0.331    | 0.000*** | 0.498    | 0.646    |
| Norway      |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 4.259    | 1.542   | 2.287   | 1.378   | 8.199    | 20.288   | 4.732    | 5.867    | 1.160    | 3.963    |
| P-value     | 0.234    | 0.672   | 0.808   | 0.926   | 0.223    | 0.002*** | 0.315    | 0.209    | 0.884    | 0.411    |
| Poland      |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 4.645    | 1.534   | 3.576   | 8.502   | 3.874    | 6.371    | 1.801    | 32.010   | 12.304   | 17.552   |
| P-value     | 0.098*   | 0.464   | 0.611   | 0.130   | 0.567    | 0.271    | 0.772    | 0.000*** | 0.030**  | 0.003*** |
| Portugal    |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 10.410   | 2.007   | 13.762  | 11.413  | 10.175   | 3.428    | 11.416   | 9.582    | 9.825    | 2.363    |
| P-value     | 0.034**  | 0.734   | 0.032** | 0.076*  | 0.037**  | 0.488    | 0.043**  | 0.088*   | 0.043**  | 0.669    |
| Slovakia    |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 31.512   | 9.212   | 0.5772  | 2.597   | 32.294   | 12.489   | 5.051    | 17.983   | 1.443    | 3.449    |
| P-value     | 0.000*** | 0.056*  | 0.966   | 0.627   | 0.000*** | 0.051*   | 0.409    | 0.003*** | 0.836    | 0.485    |
| Slovenia    |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 17.938   | 1.680   | 7.118   | 10.946  | 12.501   | 5.570    | 5.491    | 59.002   | 14.696   | 7.884    |
| P-value     | 0.000*** | 0.431   | 0.212   | 0.052*  | 0.014**  | 0.233    | 0.704    | 0.000*** | 0.005*** | 0.095*   |
| Spain       |          |         |         |         |          |          |          |          |          |          |
| $\chi^2$    | 24.403   | 0.211   | 8.286   | 8.255   | 31.113   | 16.916   | 20.426   | 30.484   | 12.055   | 6.302    |
| P-value     | 0.000*** | 0.994   | 0.081*  | 0.082*  | 0.000*** | 0.031**  | 0.004*** | 0.000*** | 0.016**  | 0.177    |

(Contd...)

**Table 5: (Continued)**

| Country     | DUB→IP   | IP→DUB | HH→IP | IP→HH  | LNG→IP   | IP→LNG   | RUS→IP  | IP→RUS   | SI→IP    | IP→SI    |
|-------------|----------|--------|-------|--------|----------|----------|---------|----------|----------|----------|
| Sweden      |          |        |       |        |          |          |         |          |          |          |
| $\chi^2$    | 24.505   | 1.241  | 1.039 | 2.482  | 18.568   | 4.134    | 5.150   | 25.793   | -        | -        |
| P-value     | 0.000*** | 0.871  | 0.594 | 0.2859 | 0.001*** | 0.388    | 0.397   | 0.000*** | -        | -        |
| Switzerland |          |        |       |        |          |          |         |          |          |          |
| $\chi^2$    | 13.473   | 2.313  | 5.519 | 6.020  | 6.826    | 12.751   | 14.191  | 6.562    | 18.737   | 7.712    |
| P-value     | 0.009*** | 0.678  | 0.355 | 0.304  | 0.145    | 0.012**  | 0.014** | 0.255    | 0.000*** | 0.102    |
| Turkey      |          |        |       |        |          |          |         |          |          |          |
| $\chi^2$    | 33.961   | 1.168  | 6.030 | 4.085  | 6.944    | 15.657   | 15.911  | 3.089    | 5.244    | 5.372    |
| P-value     | 0.000*** | 0.557  | 0.110 | 0.252  | 0.073*   | 0.001*** | 0.025** | 0.876    | 0.072*   | 0.068*   |
| UK          |          |        |       |        |          |          |         |          |          |          |
| $\chi^2$    | 8.738    | 2.056  | 1.471 | 1.606  | 15.453   | 10.292   | 3.524   | 13.513   | 2.068    | 9.526    |
| P-value     | 0.012**  | 0.357  | 0.479 | 0.447  | 0.001*** | 0.016**  | 0.474   | 0.009**  | 0.355    | 0.008*** |
| US          |          |        |       |        |          |          |         |          |          |          |
| $\chi^2$    | 8.636    | 13.356 | 7.653 | 3.398  | 10.395   | 10.652   | 15.982  | 26.652   | 31.927   | 26.785   |
| P-value     | 0.279    | 0.063* | 0.176 | 0.638  | 0.108    | 0.099*   | 0.067*  | 0.001*** | 0.000*** | 0.000*** |

“→” denotes unidirectional causality, BR: Brent oil price, WTI: West Texas Intermediate price, DUB: Dubai oil price, HH: Henry Hub price, LNG: Liquefied natural gas price, RUS: Russia natural gas price, M2: Liquidity; SI: Stock index, IP: Industrial production, \*\*\*, \*\* and \* denote statistical significance at 1%, 5% and 10% level of significance respectively

was a uni-directional causality running from stock index to oil prices; on the other hand, in most of the GCC countries there was a uni-directional causality running from oil prices to stock index, which is in line with the findings of Basher and Sadorsky (2006), Masih et al. (2011), Park and Ratti (2008) and Sadorsky (1999). Furthermore, in most of the OPEC countries there were no causal relationships between oil prices and the stock index, in line with the results of Iscan's study (2010). An oil demand shortage or oil supply surplus can cause oil prices to decrease leading to smaller revenues and reduced stock market returns in GCC countries. As a result, investors in GCC countries can buy futures contracts or use financial derivatives in order to hedge the demand uncertainty. Furthermore, to achieve an effective diversified portfolio, investors can invest in OECD and OPEC countries when there was a high volatility in energy prices as oil and natural gas price changes do not have a significant effect on stock market returns of OECD and OPEC countries. For most of the OECD countries, there was a uni-directional causality running from stock index to natural gas prices which is in line with the results from research undertaken by Yilmaz et al. (2013); however, there were no causal relationships between natural gas prices and the stock index of both GCC and OPEC countries, which is in agreement with the results obtained by Acaravci et al. (2012). Finally, policies to avoid natural gas price uncertainty may not have any impact on stock index of OECD, GCC and OPEC countries.

The relationship between energy prices and industrial production accounts for the third relationship. For most of the OECD, GCC and OPEC countries; there were no long-term relationships between the energy prices and industrial production. The general findings of the Granger causality tests showed that in most of the OECD, GCC and OPEC countries there was a uni-directional causality running from oil prices to industrial production and the results are in line with the studies of Burbidge and Harrison (1984) and Cuñado and Gracia (2003). These results indicate that three of the country groups could choose energy policies that stabilize the uncertainties in oil prices, since oil price volatility is the reason for the volatility in industrial production as well as in economic growth. In an environment of volatile oil prices, OECD countries may delay their oil sensitive investments in the

short-term. However, a long-delay may cause aggregate industrial output level to decrease and dampen economic activities. For GCC and OPEC countries, an increase in oil prices would increase the export earnings, and consequently, the industrial output level. The danger will occur when the oil prices are too high and remain at that level for a long-time. In that case, energy demand would start to decrease, which may cause oil surplus and lead to a reduction in oil prices which would damage the budget of oil-exporting countries. As a result, the governments of OECD, GCC and OPEC countries may implement policies that reduce the oil price volatility in order to have steady industrial production in the short-term. The economies of GCC and OPEC countries are heavily dependent on oil exports. An uncertainty in oil prices can easily affect their income levels. These countries may diversify their income sources or reduce the impact of oil price shocks on economic growth (Ftiti et al., 2014). On the other hand; there were no causal relationships between natural gas prices and industrial production in most of the OECD, GCC and OPEC countries. This means that energy policies to stabilize the uncertainty in natural gas prices would not have a significant effect on industrial production as well as economic growth in OECD, GCC and OPEC countries.

The last relationship is between the stock index and industrial production. In this study, stock index is considered as a proxy for financial development and industrial production is considered as a proxy for economic growth. The findings show that there were no long-term relationships between financial development and economic growth for most of the OECD, GCC and OPEC countries. On the other hand, the findings of the Granger causality test showed that while there was uni-directional causality running from the stock index to industrial production in most of the OECD countries, the absence of causality between the stock index and industrial production was supported in most of the GCC and OPEC countries. The findings from OECD countries support the view of Schumpeter (1934), which advocates the supply-leading hypothesis, and the findings of GCC and OPEC countries support the view of Lucas (1998) and Stern (1989), endorsing the neutrality hypothesis. This means that for OECD countries, the services provided by financial intermediaries promote innovation and economic growth; while financial stress affects savings and

Table 6: GCC Granger causality test results

| Country      | BR→M2    | M2→BR   | WTI→M2   | DUB→M2   | M2→DUB   | HH→M2    | M2→HH    | LNG→M2   |
|--------------|----------|---------|----------|----------|----------|----------|----------|----------|
| Bahrain      |          |         |          |          |          |          |          |          |
| $\chi^2$     | 9.414    | 7.015   | 13.414   | 12.255   | 8.668    | 17.654   | 9.318    | 11.739   |
| P-value      | 0.009*** | 0.030** | 0.006*** | 0.006*** | 0.034**  | 0.013**  | 0.230    | 0.109    |
| Kuwait       |          |         |          |          |          |          |          |          |
| $\chi^2$     | 21.092   | 17.280  | 21.573   | 20.562   | 17.014   | 0.052    | 1.927    | 8.058    |
| P-value      | 0.003*** | 0.015** | 0.003*** | 0.004*** | 0.017**  | 0.818    | 0.165    | 0.044**  |
| Oman         |          |         |          |          |          |          |          |          |
| $\chi^2$     | 8.885    | 1.977   | 7.483    | 6.706    | 3.599    | 0.762    | 5.661    | 0.548    |
| P-value      | 0.011**  | 0.372   | 0.023**  | 0.035**  | 0.165    | 0.683    | 0.059*   | 0.908    |
| Qatar        |          |         |          |          |          |          |          |          |
| $\chi^2$     | 10.227   | 7.403   | 16.152   | 7.780    | 7.139    | 19.956   | 8.836    | 6.972    |
| P-value      | 0.069*   | 0.192   | 0.023**  | 0.099*   | 0.128    | 0.002*** | 0.183    | 0.072*   |
| Saudi Arabia |          |         |          |          |          |          |          |          |
| $\chi^2$     | 1.151    | 10.715  | 1.245    | 4.760    | 13.194   | 3.358    | 0.355    | 0.510    |
| P-value      | 0.764    | 0.013** | 0.742    | 0.190    | 0.004*** | 0.066*   | 0.551    | 0.916    |
| UAE          |          |         |          |          |          |          |          |          |
| $\chi^2$     | 5.282    | 12.817  | 7.964    | 4.925    | 12.198   | 1.554    | 0.001    | 2.599    |
| P-value      | 0.259    | 0.012** | 0.002*** | 0.295    | 0.015**  | 0.212    | 0.972    | 0.626    |
| Country      | M2→LNG   | RUS→M2  | M2→RUS   | BR→SI    | WTI→SI   | SI→WTI   | DUB→SI   | SI→DUB   |
| Bahrain      |          |         |          |          |          |          |          |          |
| $\chi^2$     | 4.498    | 9.233   | 15.094   | 10.391   | 13.064   | 2.160    | 9.822    | 1.221    |
| P-value      | 0.720    | 0.236   | 0.034**  | 0.005*** | 0.001**  | 0.339    | 0.007*** | 0.543    |
| Kuwait       |          |         |          |          |          |          |          |          |
| $\chi^2$     | 9.596    | 7.571   | 7.190    | 2.616    | 3.326    | 0.259    | -        | -        |
| P-value      | 0.022**  | 0.371   | 0.409    | 0.270    | 0.189    | 0.878    | -        | -        |
| Oman         |          |         |          |          |          |          |          |          |
| $\chi^2$     | 6.611    | 1.782   | 4.212    | 12.644   | 11.618   | 26.047   | 16.288   | 32.652   |
| P-value      | 0.085*   | 0.775   | 0.378    | 0.008*** | 0.008*** | 0.000*** | 0.026**  | 0.000*** |
| Qatar        |          |         |          |          |          |          |          |          |
| $\chi^2$     | 5.770    | 5.520   | 11.578   | 0.823    | 2.754    | 8.926    | 1.402    | 6.012    |
| P-value      | 0.123    | 0.479   | 0.072*   | 0.843    | 0.431    | 0.030**  | 0.705    | 0.111    |
| Saudi Arabia |          |         |          |          |          |          |          |          |
| $\chi^2$     | 5.619    | 10.125  | 1.170    | 3.462    | 6.788    | 4.406    | 3.189    | 5.458    |
| P-value      | 0.131    | 0.038** | 0.882    | 0.177    | 0.033**  | 0.110    | 0.202    | 0.065*   |
| UAE          |          |         |          |          |          |          |          |          |
| $\chi^2$     | 8.040    | 2.302   | 6.357    | 18.660   | 1.633    | 5.030    | 21.371   | 11.191   |
| P-value      | 0.090*   | 0.680   | 0.174    | 0.009*** | 0.442    | 0.080*   | 0.003*** | 0.130    |

“→” denotes unidirectional causality, BR: Brent oil price, WTI: West Texas Intermediate price, DUB: Dubai oil price, HH: Henry Hub price, LNG: Liquefied natural gas price, RUS: Russia natural gas price, M2: Liquidity, SI: Stock index, IP: Industrial production, \*\*\*, \*\* and \* denote statistical significance at 1%, 5% and 10% level of significance respectively

Table 7: GCC Granger causality test results cont

| Country      | HH→SI    | SI→HH    | LNG→SI | SI→LNG   | RUS→SI   | SI→RUS   | BR→IP    | IP→BR    | WTI→IP   | IP→WTI  |
|--------------|----------|----------|--------|----------|----------|----------|----------|----------|----------|---------|
| Bahrain      |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 13.935   | 11.742   | 0.654  | 3.630    | 3.022    | 7.173    | -        | -        | -        | -       |
| P-value      | 0.003*** | 0.008*** | 0.721  | 0.162    | 0.554    | 0.127    | -        | -        | -        | -       |
| Kuwait       |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 1.075    | 2.450    | -      | -        | 0.925    | 3.625    | 4.900    | 0.488    | 5.707    | 0.560   |
| P-value      | 0.584    | 0.293    | -      | -        | 0.629    | 0.163    | 0.086*   | 0.783    | 0.057*   | 0.755   |
| Oman         |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 2.390    | 4.836    | 1.313  | 11.325   | 21.216   | 43.955   | 1.427    | 6.842    | 1.573    | 7.565   |
| P-value      | 0.302    | 0.089*   | 0.518  | 0.003*** | 0.006*** | 0.000*** | 0.489    | 0.032**  | 0.455    | 0.022** |
| Qatar        |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 1.214    | 0.002    | 2.936  | 0.466    | 2.293    | 2.801    | 11.588   | 9.115    | 11.321   | 9.683   |
| P-value      | 0.270    | 0.961    | 0.086* | 0.494    | 0.317    | 0.246    | 0.008*** | 0.027**  | 0.010**  | 0.021** |
| Saudi Arabia |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 0.288    | 0.762    | 2.873  | 11.894   | 10.186   | 18.919   | 15.222   | 2.962    | 16.447   | 3.181   |
| P-value      | 0.865    | 0.683    | 0.237  | 0.002*** | 0.178    | 0.008*** | 0.001*** | 0.397    | 0.000*** | 0.364   |
| UAE          |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 2.179    | 1.493    | 4.213  | 3.933    | 11.542   | 14.264   | 4.265    | 1.083    | 6.393    | 1.775   |
| P-value      | 0.336    | 0.474    | 0.121  | 0.139    | 0.116    | 0.046**  | 0.118    | 0.581    | 0.040**  | 0.411   |
| Country      | DUB→IP   | IP→DUB   | HH→IP  | IP→HH    | LNG→IP   | IP→LNG   | RUS→IP   | IP→RUS   | SI→IP    | IP→SI   |
| Bahrain      |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | --       | -        | -      | -        | -        | -        | -        | -        | -        | -       |
| P-value      | --       | -        | -      | -        | -        | -        | -        | -        | -        | -       |
| Kuwait       |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 3.648    | 0.545    | 2.699  | 0.087    | 7.216    | 4.096    | 5.624    | 17.900   | 0.785    | 0.390   |
| P-value      | 0.161    | 0.761    | 0.259  | 0.957    | 0.27**   | 0.129    | 0.344    | 0.003*** | 0.675    | 0.302   |
| Oman         |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 2.707    | 5.447    | 0.327  | 6.096    | 1.074    | 0.273    | 2.846    | 4.535    | 3.463    | 2.334   |
| P-value      | 0.258    | 0.065*   | 0.848  | 0.047*   | 0.584    | 0.872    | 0.583    | 0.338    | 0.177    | 0.311   |
| Qatar        |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 9.873    | 10.058   | 0.252  | 4.064    | 8.868    | 11.288   | 3.179    | 9.205    | 9.510    | 2.035   |
| P-value      | 0.019**  | 0.018**  | 0.881  | 0.131    | 0.031**  | 0.010**  | 0.528    | 0.056*   | 0.002*** | 0.153   |
| Saudi Arabia |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 8.995    | 2.166    | 1.681  | 0.000    | 10.503   | 6.766    | 7.510    | 10.512   | 12.286   | 1.743   |
| P-value      | 0.011**  | 0.338    | 0.194  | 0.980    | 0.014**  | 0.079*   | 0.111    | 0.032**  | 0.002*** | 0.418   |
| UAE          |          |          |        |          |          |          |          |          |          |         |
| $\chi^2$     | 3.567    | 1.728    | 1.918  | 4.120    | 11.944   | 0.401    | 4.817    | 11.458   | 1.134    | 2.233   |
| P-value      | 0.168    | 0.421    | 0.383  | 0.127    | 0.002*** | 0.818    | 0.306    | 0.021**  | 0.567    | 0.327   |

“→” denotes unidirectional causality, BR: Brent oil price, WTI: West Texas Intermediate price, DUB: Dubai oil price, HH: Henry Hub price, LNG: Liquefied natural gas price, RUS: Russia natural gas price, M2: Liquidity, SI: Stock index, IP: Industrial production. \*\*\*, \*\* and \* denote statistical significance at 1%, 5% and 10% level of significance respectively

Table 8: OPEC Granger causality test results

| Country      | BR→M2    | M2→BR    | WTI→M2   | M2→WTI   | DUB→M2   | M2→DUB   | HH→M2    | M2→HH    | LNG→M2  |
|--------------|----------|----------|----------|----------|----------|----------|----------|----------|---------|
| Algeria      |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| Angola       |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 5.255    | 4.459    | 1.304    | 1.721    | 4.540    | 3.237    | 1.552    | 7.176    | 1.191   |
| P-value      | 0.072*   | 0.107    | 0.520    | 0.422    | 0.103    | 0.198    | 0.670    | 0.066*   | 0.275   |
| Ecuador      |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 0.686    | 0.978    | 0.721    | 3.630    | 12.971   | 1.353    | 13.293   | 12.409   | 6.012   |
| P-value      | 0.876    | 0.806    | 0.868    | 0.304    | 0.011**  | 0.852    | 0.065*   | 0.087*   | 0.111   |
| Iran         |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| Iraq         |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 1.051    | 0.964    | 1.957    | 0.571    | 0.142    | 1.284    | 0.018    | 5.787    | 0.256   |
| P-value      | 0.591    | 0.617    | 0.5281   | 0.902    | 0.986    | 0.732    | 0.891    | 0.016    | 0.879   |
| Kuwait       |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 21.092   | 17.280   | 21.573   | 16.344   | 20.562   | 17.014   | 0.052    | 1.927    | 8.058   |
| P-value      | 0.003*** | 0.015**  | 0.003*** | 0.022**  | 0.004*** | 0.017**  | 0.818    | 0.165    | 0.044** |
| Nigeria      |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 2.632    | 4.834    | 2.211    | 4.110    | 3.443    | 3.434    | 0.222    | 0.120    | 2.549   |
| P-value      | 0.451    | 0.184    | 0.529    | 0.249    | 0.328    | 0.329    | 0.637    | 0.728    | 0.279   |
| Qatar        |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 10.227   | 7.403    | 16.152   | 9.864    | 7.780    | 7.139    | 19.956   | 8.836    | 6.972   |
| P-value      | 0.069*   | 0.192    | 0.023**  | 0.196    | 0.099*   | 0.128    | 0.002*** | 0.183    | 0.072*  |
| Saudi Arabia |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 1.151    | 10.715   | 1.245    | 9.986    | 4.760    | 13.194   | 3.358    | 0.355    | 0.510   |
| P-value      | 0.764    | 0.013**  | 0.742    | 0.018**  | 0.190    | 0.004*** | 0.066*   | 0.551    | 0.916   |
| UAE          |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 5.282    | 12.817   | 7.964    | 18.829   | 4.925    | 12.198   | 1.554    | 0.001    | 2.599   |
| P-value      | 0.259    | 0.012**  | 0.158    | 0.002*** | 0.295    | 0.015**  | 0.212    | 0.972    | 0.626   |
| Venezuela    |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 4.993    | 1.911    | 10.734   | 3.953    | 3.390    | 2.982    | 4.062    | 18.797   | 13.844  |
| P-value      | 0.082*   | 0.384    | 0.056*   | 0.552    | 0.183    | 0.225    | 0.540    | 0.002*** | 0.016** |
| Country      | M2→LNG   | RUS→M2   | M2→RUS   | BR→SI    | SI→BR    | WTI→SI   | SI→WTI   | DUB→SI   | SI→DUB  |
| Algeria      |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| Angola       |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 0.311    | 10.938   | 7.873    | -        | -        | -        | -        | -        | -       |
| P-value      | 0.576    | 0.012**  | 0.048**  | -        | -        | -        | -        | -        | -       |
| Ecuador      |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | 0.355    | 21.651   | 12.004   | 6.036    | 4.609    | 2.174    | 2.644    | 4.997    | 3.847   |
| P-value      | 0.949    | 0.006*** | 0.034**  | 0.109    | 0.202    | 0.537    | 0.449    | 0.172    | 0.278   |
| Iran         |          |          |          |          |          |          |          |          |         |
| $\chi^2$     | -        | -        | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -        | -        | -        | -        | -        | -        | -        | -        | -       |

(Contd...)

Table 8: (Continued)

| Country      | M2→LNG  | RUS→M2  | M2→RUS  | BR→SI    | SI→BR  | WTI→SI  | SI→WTI  | DUB→SI   | SI→DUB |
|--------------|---------|---------|---------|----------|--------|---------|---------|----------|--------|
| Iraq         |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 0.757   | 5.324   | 6.520   | -        | -      | -       | -       | -        | -      |
| P-value      | 0.684   | 0.255   | 0.163   | -        | 1.755  | -       | -       | -        | -      |
| Kuwait       |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 9.596   | 7.571   | 7.190   | 2.616    | 0.415  | 3.326   | 0.259   | -        | -      |
| P-value      | 0.022** | 0.371   | 0.409   | 0.270    | 2.640  | 0.189   | 0.878   | -        | -      |
| Nigeria      |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 2.298   | 16.751  | 17.511  | 2.048    | 0.267  | 6.291   | 0.565   | 2.018    | 2.966  |
| P-value      | 0.317   | 0.019** | 0.014** | 0.359    | 6.477  | 0.043** | 0.753   | 0.364    | 0.226  |
| Qatar        |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 5.770   | 5.520   | 11.578  | 0.823    | 0.090* | 2.754   | 8.926   | 1.402    | 6.012  |
| P-value      | 0.123   | 0.479   | 0.072*  | 0.843    | 5.221  | 0.431   | 0.030** | 0.705    | 0.111  |
| Saudi Arabia |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 5.619   | 10.125  | 1.170   | 3.462    | 0.073* | 6.788   | 4.406   | 3.189    | 5.458  |
| P-value      | 0.131   | 0.038** | 0.882   | 0.177    | 9.049  | 0.033** | 0.110   | 0.202    | 0.065* |
| UAE          |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 8.040   | 2.302   | 6.357   | 18.660   | 0.249  | 1.633   | 5.030   | 21.371   | 11.191 |
| P-value      | 0.090*  | 0.680   | 0.174   | 0.009*** | 0.332  | 0.442   | 0.080*  | 0.003*** | 0.130  |
| Venezuela    |         |         |         |          |        |         |         |          |        |
| $\chi^2$     | 14.343  | 4.148   | 0.663   | 0.345    | 0.953  | 0.497   | 0.639   | 0.502    | 0.220  |
| P-value      | 0.013** | 0.528   | 0.984   | 0.951    | -      | 0.919   | 0.887   | 0.918    | 0.974  |

"-" denotes unidirectional causality, BR: Brent oil price, WTI: West Texas Intermediate price, DUB: Dubai oil price, HH: Henry Hub price, LNG: Liquefied natural gas price, RUS: Russia natural gas price, M2: Liquidity, SI: Stock index, IP: Industrial production, \*\*\*, \*\* and \* denote statistical significance at 1%, 5% and 10% level of significance respectively

Table 9: OPEC Granger causality test results cont

| Country  | HH→SI | SI→HH   | LNG→SI | SI→LNG | RUS→SI   | SI→RUS | BR→IP  | IP→BR  | WTI→IP | IP→WTI |
|----------|-------|---------|--------|--------|----------|--------|--------|--------|--------|--------|
| Algeria  |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | -     | -       | -      | -      | -        | -      | -      | -      | -      | -      |
| P-value  | -     | -       | -      | -      | -        | -      | -      | -      | -      | -      |
| Angola   |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | -     | -       | -      | -      | -        | -      | -      | -      | -      | -      |
| P-value  | -     | -       | -      | -      | -        | -      | -      | -      | -      | -      |
| Ecuador  |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | 0.260 | 0.205   | 3.917  | 1.884  | 19.190   | 1.559  | 3.158  | 5.941  | 3.560  | 5.212  |
| P-value  | 0.609 | 0.650   | 0.270  | 0.596  | 0.007*** | 0.816  | 0.206  | 0.051* | 0.168  | 0.073* |
| Iran     |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | -     | -       | -      | -      | -        | -      | 2.140  | 0.898  | 2.260  | 0.815  |
| P-value  | -     | -       | -      | -      | -        | -      | 0.342  | 0.638  | 0.323  | 0.665  |
| Iraq     |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | -     | -       | -      | -      | -        | -      | -      | -      | -      | -      |
| P-value  | -     | -       | -      | -      | -        | -      | -      | -      | -      | -      |
| Kuwait   |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | 1.075 | 2.450   | -      | -      | 0.925    | 3.625  | 4.900  | 0.488  | 5.707  | 0.560  |
| P-value  | 0.584 | 0.293   | -      | -      | 0.629    | 0.163  | 0.086* | 0.783  | 0.057* | 0.755  |
| Nigeria  |       |         |        |        |          |        |        |        |        |        |
| $\chi^2$ | 1.304 | 4.676   | 0.171  | 0.599  | 8.067    | 3.617  | -      | -      | -      | -      |
| P-value  | 0.253 | 0.030** | 0.678  | 0.438  | 0.089*   | 0.460  | -      | -      | -      | -      |

(Contd...)



Table 9: (Continued...)

| Country      | HH→SI   | SI→HH   | LNG→SI | SI→LNG   | RUS→SI   | SI→RUS   | BR→IP    | IP→BR    | WTI→IP   | IP→WTI  |
|--------------|---------|---------|--------|----------|----------|----------|----------|----------|----------|---------|
| Qatar        |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 1.214   | 0.002   | 2.936  | 0.466    | 2.293    | 2.801    | 11.588   | 9.115    | 11.321   | 9.683   |
| P-value      | 0.270   | 0.961   | 0.086* | 0.494    | 0.317    | 0.246    | 0.008*** | 0.027**  | 0.010**  | 0.021** |
| Saudi Arabia |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 0.288   | 0.762   | 2.873  | 11.894   | 10.186   | 18.919   | 15.222   | 2.962    | 16.447   | 3.181   |
| P-value      | 0.865   | 0.683   | 0.237  | 0.002*** | 0.178    | 0.008*** | 0.001*** | 0.397    | 0.000*** | 0.364   |
| UAE          |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 2.179   | 1.493   | 4.213  | 3.933    | 11.542   | 14.264   | 4.265    | 1.083    | 6.393    | 1.775   |
| P-value      | 0.336   | 0.474   | 0.121  | 0.139    | 0.116    | 0.046**  | 0.118    | 0.581    | 0.040**  | 0.411   |
| Venezuela    |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 1.394   | 0.797   | 4.106  | 5.208    | 0.809    | 3.673    | 11.070   | 2.577    | 0.922    | 3.804   |
| P-value      | 0.706   | 0.850   | 0.250  | 0.157    | 0.937    | 0.452    | 0.025**  | 0.630    | 0.820    | 0.283   |
| Country      | DUB→IP  | IP→DUB  | HH→IP  | IP→HH    | LNG→IP   | IP→LNG   | RUS→IP   | IP→RUS   | SI→IP    | IP→SI   |
| Algeria      |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| Angola       |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| Ecuador      |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 2.368   | 5.273   | 2.821  | 0.979    | 1.493    | 2.271    | 1.965    | 4.454    | 2.854    | 0.438   |
| P-value      | 0.305   | 0.071*  | 0.244  | 0.612    | 0.473    | 0.321    | 0.742    | 0.348    | 0.414    | 0.932   |
| Iran         |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 3.018   | 0.533   | 2.654  | 0.239    | 8.847    | 1.197    | 5.453    | 1.877    | -        | -       |
| P-value      | 0.221   | 0.765   | 0.265  | 0.887    | 0.031**  | 0.753    | 0.243    | 0.758    | -        | -       |
| Iraq         |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| Kuwait       |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 3.648   | 0.545   | 2.699  | 0.087    | 7.216    | 4.096    | 5.624    | 17.900   | 0.785    | 0.390   |
| P-value      | 0.161   | 0.761   | 0.259  | 0.957    | 0.27**   | 0.129    | 0.344    | 0.003*** | 0.675    | 0.302   |
| Nigeria      |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| P-value      | -       | -       | -      | -        | -        | -        | -        | -        | -        | -       |
| Qatar        |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 9.873   | 10.058  | 0.252  | 4.064    | 8.868    | 11.288   | 3.179    | 9.205    | 9.510    | 2.035   |
| P-value      | 0.019** | 0.018** | 0.881  | 0.131    | 0.031**  | 0.010**  | 0.528    | 0.056*   | 0.002*** | 0.153   |
| Saudi Arabia |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 8.995   | 2.166   | 1.681  | 0.000    | 10.503   | 6.766    | 7.510    | 10.512   | 12.286   | 1.743   |
| P-value      | 0.011** | 0.338   | 0.194  | 0.980    | 0.014**  | 0.079*   | 0.111    | 0.032**  | 0.002*** | 0.418   |
| UAE          |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 3.567   | 1.728   | 1.918  | 4.120    | 11.944   | 0.401    | 4.817    | 11.458   | 1.134    | 2.233   |
| P-value      | 0.168   | 0.421   | 0.383  | 0.127    | 0.002*** | 0.818    | 0.306    | 0.021**  | 0.567    | 0.327   |
| Venezuela    |         |         |        |          |          |          |          |          |          |         |
| $\chi^2$     | 11.238  | 3.214   | 1.012  | 11.734   | 39.704   | 8.576    | 10.508   | 2.072    | 3.755    | 0.237   |
| P-value      | 0.024** | 0.522   | 0.798  | 0.008*** | 0.000*** | 0.284    | 0.032**  | 0.722    | 0.289    | 0.971   |

“→” denotes unidirectional causality, BR: Brent oil price, WTI: West Texas Intermediate price, DUB: Dubai oil price, HH: Henry Hub price, LNG: Liquefied natural gas price, RUS: Russia natural gas price, M2: Liquidity, SI: Stock index, IP: Industrial production, \*\*\*, \*\* and \* denote statistical significance at 1%, 5% and 10% level of significance respectively

investments negatively. As a result, in order to obtain sustainable economic growth in OECD countries, it is necessary to undertake financial reforms, such as the liberalization of the finance sector. These results are in line with the work of Caporale et al. (2005), Choe and Moosa (1999), Christopoulos and Tsionas (2004), Hsueh et al. (2013), Thangavelu and Jiunn (2004), Uddin et al. (2003) and Xu (2000). On the other hand, policies to promote economic growth or finance sector liberalization would not have any significant effect in GCC and OPEC countries; this is in line with the findings of Abu-Bader and Abu-Qarn (2006), Hayo (1999), and Menyah et al. (2014).

## 5. CONCLUDING REMARKS

The purpose of this study was to analyze the countries in the group of OECD, GCC and OPEC under the selected data periods to test whether there are long-term or short-term relationships between the world energy prices (Brent Oil, WTI, Dubai, HH, Japan and Russia) and the liquidity level, stock market and industrial production of the target countries and to test whether there are long-term or short-term relationship between financial development and the economic growth of the these countries.

The determination of the relationships between the relevant variables varies across countries in regard to their economic policies, proximity to raw material sources, energy production capacities, energy reserves or stock markets. This causes commodity prices, stock prices and even output level to be affected by energy price changes (Arouri et al., 2011). As a result it is difficult to reach a common associative consequence between countries; however, it is possible to propose some generalizations and interpretations.

The empirical findings of the current study indicate that there were multidirectional relationships between the above-mentioned variables. These relationships can be explained by the factors that each country group owns within the framework of their energy sources, financial markets, economic conditions and geographical positions. The data accrued and analyzed in this study is presented as a contribution to guide policymakers, global investors and researchers in constituting an extensive country specific energy, macroeconomic and financial policies.

This study does not cover the period after 2014. There have been very important issues in energy markets since that year and it is essential that there is further research to capture the latest events in the energy markets, understand those developments and consider their likely effects on the countries of the. This future work could be undertaken by applying the models and approaches in the current study to an enlarged data set covering an extended period of time.

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