Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Department of Economics

Do Global Oil Prices Drive Domestic Food Prices?
- evidence from the Middle East countries

Madina Alieva

Do Global Oil Prices Drive Domestic Food Prices? -evidence from the Middle East countries

Madina Alieva

Abstract

This study investigates the dynamic relationship between global oil prices and domestic food prices across 11 countries of the Middle East. Using monthly data covering the period from January 2010 to October 2018, the study employs long-run cointegration tests, vector error correction model (VECM) and vector autoregression (VAR) model to examine the effect of global oil prices on domestic food prices in a sample of Middle East countries.

The results of panel cointegration tests revealed that there is a long-run relationship between global oil and domestic food prices. Panel VECM along with Granger causality tests showed that in the short-run there is no significant causality running from oil to food prices, while in the long-run global oil prices positively affect domestic food prices.

At the country level, the empirical findings provide inconclusive evidence on the impact of global oil prices on domestic food prices in the region. While Johansen cointegration tests showed long-run relationship between oil and food prices for Bahrain, Egypt and Kuwait, VECM indicated long-run positive and significant oil price transmission only for Bahrain and Egypt. The short-run parameters obtained through VAR and Granger causality tests revealed positive and significant oil price causality on domestic food prices for Bahrain and Saudi Arabia with lesser impact in Lebanon, Qatar and Turkey.

The findings provide some policy implications, such as reconsideration of current food subsidies and price controls, tackling domestic issues related to logistics and infrastructure by improving transportation system and supply chains, as well as maintaining trade diversification within and outside the Middle East region.

The paper contributes to the literature on dynamics of commodity prices and global-to-local price transmission in the as understanding of the relationship and the ability to make a prognosis is of a significant importance for policymakers when formulating future fuel and food policies, and for researchers and economic agents when analysing price forecasts and strategies.

Table of Contents

List of figures

List of tables

Abbreviations

ADF	Augmented Dickey-Fuller test
ARDL	Autoregressive Distributed Lag model
ARMA	Autoregressive Moving-Average model
CPI	Consumer Price Index
ECT	Error Correction Term
FAO	United Nations Food and Agriculture Organization
FAOSTAT	Food and Agriculture Organization Statistical Database
FCPI	Consumer Price Index corresponding to food
GCC	Gulf Cooperation Council
IFPRI	International Food Policy Research Institute
IFS	International Financial Statistics from International Monetary Fund database
LLC	Levin, Lin, and Chu panel unit root test
PP	Phillips-Perron unit root test
UAE	United Arab Emirates
VAR	Vector Autoregression
VECM	Vector Error Correction Model
WDI	World Development Indicators

1 Introduction

Do global oil prices cause higher food prices? And if so, does the impact differ across countries? The present thesis attempts to answer these questions by investigating the impact of oil price movements on domestic food prices in the Middle East countries.

Over the past two decades, agricultural commodity prices have become increasingly volatile in developing countries (Gilbert, 2010; Ortiz, Chai & Cummins, 2011; Bakucs & Fertő, 2013). A number of studies have showed that such volatile food prices have coincided with fluctuations in international oil prices (Dillon *et al.*, 2014; Tadesse *et al.*, 2014; Wang, Wu & Yang, 2014). As shown in Figure 1, food and crude oil price indices have been moving hand-in-hand during the period 2000-2018. Starting from 2003 oil prices experienced sharp rises that continued until the middle of 2008. This has been attributed to a number of reasons which include the increased demand for oil in the United States and emerging countries such as China and India, the weakening of the US dollar, and the decreased oil production due to the occupation of Iraq (Chen, Kuo & Chen, 2010; Belke & Dreger, 2015).

Figure 1. The relationship between global food prices and oil prices.
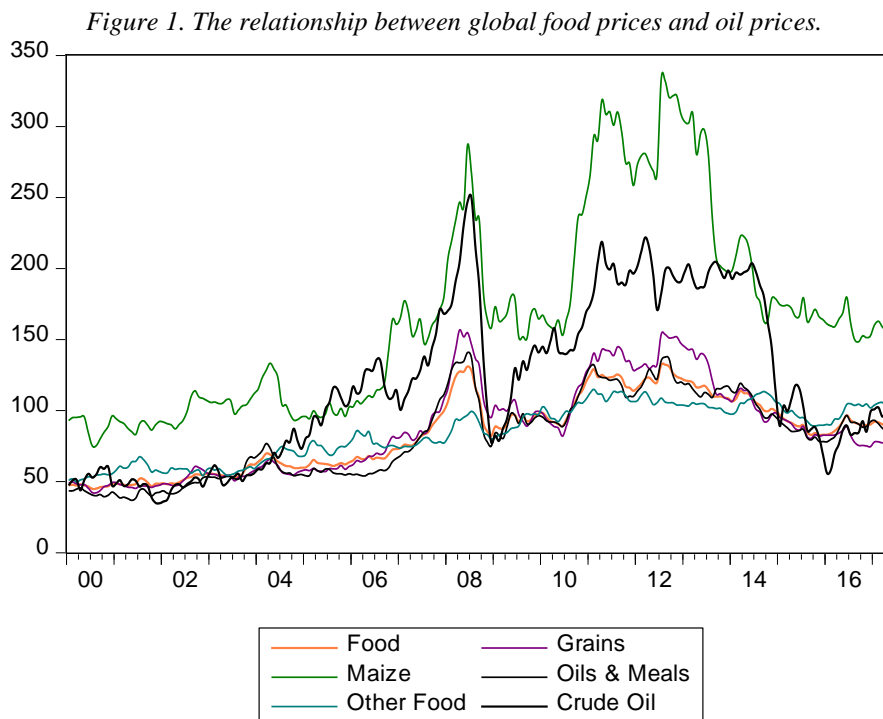
Source: Own calculations based on data from The World Bank Commodity Price Data, 2018.

Skyrocketing prices of agricultural commodities, almost as oil price increases starting from 2004 resumed the urgency of addressing food security issues due to raised fears among policy makers about global food shortage and inflationary pressures (Olayungbo & Hassan, 2016). According to the World Bank, the global agricultural commodity prices increased by more than

80% over the period of 2005 to 2008 (Holt-Giménez & Peabody, 2008). This spike in food prices put significant pressure on developing food-importing countries that had to manage the surge of food and oil prices in a fragile macroeconomic environment.

The explanations given to the food price increases vary and researches find it hard to agree on a single factor. There are various interdependent structural and supply- and demand-side factor that caused the price spikes (Tadesse *et al.*, 2014). The supply-side factors include, but no limited to, global cereal productivity decrease, insufficient global grain reserves, trade restrictions or bans on export of key agricultural commodities, diversion of agricultural land for bioenergy production (Obadi & Korček, 2014). The rapidly increasing global population, shifts in food consumption patterns and urbanization in developing and emerging countries present pressures on the demand side.

While the global economic and financial crises caused a decline of international demand for commodities, negatively affecting oil and food prices, they recovered and surged again in 2010-2011 before going down from 2012. At present, the aggregate food price index is higher than the levels observed in mid-2000s and prices of certain agricultural commodities remain to be high (World Bank, 2014). Indeed, extreme price fluctuations of agricultural commodities not only affect the food security of the poor segments of population in developing countries, but they also affect the economic growth and social stability (Dillon *et al.*, 2015; Olayungbo & Hassan, 2016; Ceballos *et al.*, 2017).

Given that worldwide surge in food prices followed increases in crude oil prices, researchers raised a concern that oil and food prices are more closely linked (Baumeister & Kilian, 2014). In this context, the academic literature points out that oil price spikes among other factors, affect food prices in the developing countries due to a number of reasons. Ahmadi *et al.* (2015) point out three main linkage channels between oil and agricultural commodity prices. First, due to the increase in oil prices caused by the improved international economic activity, the demand for food also increases, as higher level of income in emerging economies affects the consumption pattern of food. Hochman *et al.* (2012) and Baumeister and Peersman (2013) emphasize the importance of such link through which oil prices influence food prices. Second, the increase in a crude oil price pushes crop production costs up and consequently the supply curve of food commodities to the left, and as a result price of food commodities rises (Wang, Wu & Yang, 2014; Ahmadi, Bashiri Behmiri & Manera, 2016; Chiu *et al.*, 2016). Therefore, it is argued that rising oil prices result in increase of agricultural commodity prices through cost-push effects by increasing production costs as farm inputs, such as inorganic fertilizers and fuel

for equipment and machinery, are commonly made of oil. Baffes (2007) finds that the price of fertilizers, fuel and transportation costs are influenced directly by the crude oil prices and subsequently the production of agricultural commodities is affected. Third, an increase in price of oil may cause the demand switch to biofuels produced from agricultural commodities, such as maize or wheat. As a result, the demand for biofuels increases which in turn results in higher agricultural commodity prices on the global market, which then transmitted to domestic markets through trade linkages (Larson *et al.*, 2014; Dillon *et al.*, 2015). For instance, the increased ethanol production starting from 2006 triggered the rise in maize demand used in ethanol production and since maize competes with other agricultural products for fertilizer, water and land resources, the price of other agricultural commodities is affected (Baumeister & Peersman, 2013). Furthermore, oil prices drive up international transportation costs and thus affect the prices of traded food commodities, negatively influencing developing food importing countries (Dillon *et al.*, 2015; Ahmadi, Bashiri Behmiri & Manera, 2016; Olayungbo & Hassan, 2016).

1.1 Problem statement

Depending on the degree of transmission of oil price to the domestic food price level, the volatile global prices can significantly affect the real side of the economies. Belke and Dreger (2015) point out that price spikes may negatively influence private households and lead to production losses due to firms' decision to choose labor and capital inputs to match the moves in relative prices. They emphasize that the effects would be especially noticeable in developing net food importing countries. As the proportion of food consumption of private households is relatively large in developing countries, accelerating food commodity prices can lead to increasing poverty, unemployment, social injustice and political instability (Lagi, Bertrand & Bar-Yam, 2011). In the wake of the socio-political unrest in the Middle East region in 2011, the so-called Arab Spring, which led to instability throughout many political systems in the region, several studies pointed out that volatile global food prices contributed to these movements (Arezki & Brückner, 2011; Ianchovichina, Loening & Wood, 2014; Hatab, 2016). This is potentially important given that many countries in this region are dependent on food imports. Moreover, due to high food share in consumption basket of the economies in the region the level of food prices play important role as a determinant of consumers' purchasing power (Ianchovichina, Loening & Wood, 2014; Hatab, 2016). Furthermore, food prices impact wage levels and employment within and outside the food sector, and therefore, affect wage income of rural and urban poor (Headey & Fan, 2010).

Such correlation between high international oil and domestic food prices in the countries of the Middle East in recent years that was followed by a mass revolutionary movement in 2011 have stimulated research and policy debate regarding the transmission of international oil prices into domestic food prices and their subsequent effects on food security and sociopolitical stability in developing countries (Baumeister & Peersman, 2013; Belke & Dreger, 2015; Olayungbo & Hassan, 2016).

However, a critical look at the literature shows that, despite the large body of research analyzing the relationship between oil and food prices in developing countries in general and in the Middle East countries in particular, there is still no consensus on the relative importance of oil price changes to food price moves. That is, there is no consensus among researches on the volume and magnitude of the effects. While there have been empirical results showing no correlation between oil and food prices (e.g. Reboredo, 2012; Baumeister & Kilian, 2014; Burakov, 2016), some research works confirm the causality running from oil prices to food prices (e.g. Rezitis, 2015; Ahmadi, Bashiri Behmiri & Manera, 2016; Cabrera & Schulz, 2016).

Such inconclusive evidence in the literature might be explained by the fact that oil price changes transmit partially and/or to various degrees across economies and change over different periods (Campiche *et al.*, 2007; Nazlioglu, 2011). Moreover, the extent to which international oil prices cause domestic food price fluctuations can be affected by a number of country specific factors, which include countries' policy responces such as food commodity subsidies and price controls, trade and production policies, domestic supply chain issues, exchange rates and infrastructure (Ianchovichina, Loening & Wood, 2012; Belke & Awad, 2015; Belke & Dreger, 2015).

The Middle East region is one of the most rapidly transforming region in political, economic, demographical and environmental aspects. Despite many shared features across the Middle East countries, the region is heterogeneous in terms of political coordination on demographic as well as economic policies and there is comparatively little regional integration as compared to other regions (Belke & Awad, 2015). The Middle East has seen significant economic development due to exploiting large hydrocarbons reserves, which at the same time led to a rentier state economic model in large parts of the region. In such model, countries rely mostly on external rents such as oil and gas revenues rather than on the domestic production sector and economies are not sufficiently diversified. As a result, governments play a major role in distributing the rents that are used to subsidize food, energy and medical services, which in turn negatively affects the development of the private sector (Mckee *et al.*, 2017). The main rentier states are GCC countries, as they possess the largest energy reserves. However, other countries with

4

fewer resources, such as Syria, Egypt and Lebanon are influenced by the rentier states due to remittances.

In terms of GDP, the countries of the Middle East are diverse. Qatar shows the highest GDP per capita in the world. Other high income countries in terms of GDP per capita basis are represented by Bahrain, United Arab Emirates (UAE), Oman, Saudi Arabia, Kuwait, and Israel. The upper middle-income countries are Turkey, Lebanon, Iran and Iraq. The lower middle-income countries include Syria, Egypt, Jordan and Yemen represents the poorest lower middle-income country (Mckee *et al.*, 2017).

As for the demographics, starting from the 1960s the total population size of the Middle East countries has increased fourfold, from 103,4 million in 1960 to 423,9 million in 2017 (WDI, 2017). According to UNDESA (2017), despite decreasing fertility rates, population is expected to double by 2100. The largest contribution to the population increase will come from countries that are already experiencing demographic transitions, such as Egypt and Iraq and this effect is largely due to the population momentum or high proportion of women of childbearing age. The urban population significantly surpasses rural population across Middle East. As projected by UNDESA (2017), almost 90% of population increase will be accounted from the urban regions by 2050. The GCC already experience high urbanization levels. For instance, more than 80% of people in Kuwait and almost 100% of people in Qatar live in urban areas. This urbanization trends increase agricultural import dependency and introduce food sovereignty and food security issues for regional governments in the future.

Despite the presence of the hydrocarbons and mineral reserves in certain countries of the Middle East, due to arid climate, the region is water-scarce and has limited arable land. Renewable freshwater resources in the region are among the lowest in the world, while over 95% of soils on the Arabian Peninsula is subject to some form of desertification (Bailey & Willoughby, 2013). As forecasted by the UNDESA (2017), more than 60% of the Middle East population will depend upon Nile, Euphrates, Jordan, and Tigris rivers by 2100 compared to 48% of today's dependence. This reliance on international river basins have significant implications for the sustainability of maintaining the future increase in agricultural, industrial and municipal water demands which in turn can raise concerns of the transboundary governance, rural livelihood and food security of the region. Accordingly, countries of the Middle East depend heavily on imports of food and are exposed to supply and price volatility risks of food commodities. The Middle East countries import close to 60% of their food needs

and according to the United Nations Food and Agriculture Organization (FAO) are the largest grain importers worldwide (Katkhuda, 2017).

In relation to food policies, the Middle East region stands out among other developing countries for its extensive use of food commodity subsidies and controls (Ortiz, Chai & Cummins, 2011; Ianchovichina, Loening & Wood, 2014). The governments of the region employ policies targeted to regulate and manage food consumption, production and trade through various production subsidies, import protection cuts and food reserves. Yet, the Middle East countries are highly vulnerable to volatile international commodity markets, which introduce a major concern in the region and even contributed to the recent Arab Spring (Breisinger, Ecker & Al-Riffai, 2011). In 2006-2011, food prices increased on average by 10% per year in Egypt, Iran, and Yemen and by 5% per year in Kuwait, Lebanon, Oman, Qatar, Saudi Arabia and UAE (Larson *et al.*, 2014). The impact of soaring prices during world financial crisis was devastating and caused civil uprisings and political unrest due to the substantial food import dependence of the region (Belke & Awad, 2015). Moreover, in 2011, as global agricultural commodity prices skyrocketed once again, approximately 44 million people were pushed into poverty. This had disastrous effects for the Middle East, as almost quarter of the population is poor and three quarters of those poor live in rural areas with limited access to food (Larson *et al.*, 2014). Given the expected rapid population growth, urbanization and climate change, the region's food import dependence will continue to rise, resulting in high vulnerability to food inflation.

According to International Food Policy Research Institute (IFPRI) report, food price volatility and demand for food are expected to continue to rise in upcoming future (Headey & Fan, 2010). In order to meet the demands of growing populations the food import reliance is likely to increase and further worsen trade imbalances and vulnerability associated with world price volatility and restrictions of food exports. Such vulnerability will be particularly prominent in countries with trade deficit and limited agricultural productivity.

The current political instability and insecurity in the Middle East make research about food security urgent as the region is particularly susceptible to fluctuations in both price and availability of global food stocks. These markets are ideal for analyzing the correlation between global oil and local food prices in developing economies. Due to the special sociodemographic and economic characteristics presented in the above paragraphs, further volatilities and instabilities in food prices may trigger political unrest. The evaluation of the impacts of global oil prices on domestic food prices in the region is therefore crucial to develop deeper understanding of the magnitude of these effects that may help policy makers in the Middle East

countries to implement appropriate policies and actions to mitigate the impacts of global oil prices on domestic food prices.

1.2 Objectives and Research questions

Against this background, the aim of this study is twofold to examine impact of global oil price movements on domestic food prices in the Middle East countries, and to assess how such impact differs across countries of the region. Specifically, the study addresses the following two research questions:

1. Do global oil price movements affect domestic food prices in the Middle East countries?
2. Does (and how) the effect of global oil prices on domestic food prices vary across the countries of the region?

1.3 Contribution and Significance of the study

This study contributes to the academic literature in a number of strands. First, effects of changes of international oil prices on a set of domestic food prices of the Middle East countries are studied. The findings add to the literature on food security and vulnerability to shocks for developing food-importing countries. While there is a substantial research on the impact of global oil prices on global food prices, much less is known about the links between the global oil prices and local food prices in the region of the Middle East. Due to the fact that countries of this region are net food importers, the oil price fluctuations represent a more significant threat to welfare. Thus, proper understanding of the relationship between domestic food prices and international oil prices for each country is directly relevant for welfare assessment. This paper connects to prior work on dynamics of commodity prices and global-to-local transmission in the Middle East. The understanding of the commodity price dynamics and the ability to make a prognosis is of a significant importance for policymakers when formulating future fuel and food policies, and for researchers and economic agents when analysing price forecasts and strategies.

1.4 Organization of the study

The rest of the work is organized as follows. The next section presents the discussion on the determinants of the increasing food prices as well as the empirical literature. Section 3 outlines the estimation strategy of the study, model specification and explores methodology of the research in detail and implemented data in Section 4, respectively. Empirical findings and discussion of the results for panel data as well as time-series data are provided in Section 5, while concluding remarks, policy recommendations and study limitations are made in Section 6. Finally, references and appendices are presented by the end of the paper.

2 Literature review

This section reviews the existing literature conducted to assess the effects of global oil prices on food prices across different countries and the gap in the literature is identified.

The energy and agricultural market interlinkages become a common subject of discussion for energy, environmental, and agricultural economists specializing on the topic of food security and sustainable development (Baumeister & Kilian, 2014; Cabrera & Schulz, 2016; Zafeiriou *et al.*, 2018). The global food crisis, which was characterized by the sharp increase in agricultural commodity prices and crude oil prices, has captured very wide academic and policy interest within the last decade and it remains influencing policymakers regarding oil prices and food prices concerns. The summary of the academic literature on oil price and food price relationship is provided in the Appendix. Despite the wide literature on the factors causing the increase in food prices, the relative impact of oil price has been a disputable issue. A large number of studies have been conducted to assess the effects of global oil prices on food prices. However, the results of the research conducted have largely been mixed and quite controversial.

On the one hand, there have been empirical results that show no correlation between oil and food prices supporting the evidence of neutrality hypothesis. For instance, Yu *et al.* (2006) examined the relationship between vegetable oil and crude oil prices using weekly data covering the 1999-2006 period by applying time-series methods and acyclic graphs. The authors discovered no significant effect of crude oil price on edible oil prices. Zhang and Reed (2008) studied the effects of world crude oil price on feed grain and pork prices in China based on monthly prices from January 2000 to October 2007 using Vector autoregressive moving average (ARMA) models, Granger causality test, cointegration analysis as well as impulse response functions and variance decompositions to investigate dynamic relationship. The results showed that crude oil price is not a main driver of increasing pork and feed grain prices in China. Kaltalioglu and Soytas (2009) investigated volatility spillover between oil, food and agricultural raw material price indexes for the period from January 1980 to April 2008 using vector autoregressive (VAR) model and concluded that there is no causality between oil prices and world food and agricultural raw material prices. Mutuc, Pan and Hudson (2011) in their analysis of the response of cotton prices in U.S. to fluctuations in global oil prices found the asymmetry of the response of U.S. cotton prices to oil price shocks depending on whether the increase is driven by demand or supply shocks in the crude oil market. By implementing VECM and monthly data from January 1975 to February 2008, the results showed that the increase of

cotton prices were not affected by oil price shocks as only 3% of the variability of cotton prices are explained by oil price fluctuations. Reboredo (2012) studied the relationship between international oil prices and prices for corn, soybean and wheat using copulas. Empirical results for weekly data spanning from January 1998 to April 2011 showed weak oil causality and no extreme market dependence. Another research by Baumeister and Kilian (2014) applied VAR models and impulse response functions in order to identify the link between oil prices and U.S. retail agricultural and food prices using monthly data from January 1974 to May 2013. They found no evidence of price transmission from oil prices to agricultural commodity prices.

On the other hand, some researches showed the causality of oil price changes to food price changes. For example, Baffes (2007) examined the effect of crude oil prices on the prices of 35 internationally traded primary commodities for the 1960-2005 period and found 17% pass-through of oil price changes on agricultural commodity prices. Campiche *et al.* (2007) investigated the covariability between crude oil prices and corn, sorghum, sugar, soybeans, soybean oil, and palm oil prices during 2003-2007 using weekly data and applying Johansen cointegration tests. While the results showed no cointegration for the period 2003-2005, corn and soybean prices were cointegrated with crude oil prices during the period 2006-2007. By using a global Computable General Equilibrium (CGE) model Yang *et al.* (2008) showed in their research that the world price rise in maize and soybeans was largely due to higher world oil prices and demand for biofuels. They also identified that an increase in world oil price pushes up prices of food and feed grains from 16,6% to 27,9%. Moreover, results showed world oil prices positively affect soybean and pork prices by 17% and 26,5% respectively. Gilbert (2010) stated that all agricultural markets are affected by oil price changes either by increasing production costs or by using food for bioenergy. Chen, Kuo and Chen (2010) and Nazlioglu and Soytas (2012) also support the causality of oil price changes on food price changes. Chen, Kuo and Chen (2010) investigated the significant influence of crude oil price based on McConnell (1989) cropland allocation model with which the relationship between the crude oil price and the global grain prices for corn, soybean, and wheat was analysed using weekly data spanning from 2005 to 2008. By implying autoregressive distributed lag (ARDL) model, they found that an increase in oil prices will increase price of soybeans by 26,8%, corn price will increase by 29,4% and wheat price by 41,3%. Nazlioglu and Soytas (2012) in their work employed panel cointegration and Granger causality methods for a panel of 24 agricultural products based on monthly prices from January 1980 to February 2010. Their empirical results provided strong evidence on the impact of oil prices on food prices.

Using monthly price indices series from 1995 to 2010, Irz, Niemi and Liu (2013) estimated VECM in cointegration framework and the results showed significant long-run equilibrium relationship between food prices in Finland and world oil prices. The results have been supported by Tadesse *et al.* (2014), Obadi and Korček (2014), Wang, Wu and Yang (2014) and Dillon *et al.* (2015). The more recent works by Rezitis (2015), Cabrera and Schulz (2016), Olayungbo and Hassan (2016), and Zafeiriou *et al.* (2018) also showed long-run cointegration between oil and agricultural commodity prices. Rezitis (2015) implemented panel VECM in order to examine the relationship between monthly crude oil prices, U.S. dollar exchange rates, 30 international agricultural prices and 5 international fertilizer prices for the period June 1983 – June 2013. The results showed positive relationship between oil and agricultural commodity prices. In particular, estimated results indicate that in the long-run agricultural commodity prices respond positively (between 0,32 to 0,41) to oil prices. Using an asymmetric dynamic generalized autoregressive conditional heteroscedasticity (GARCH) model and VECM model, Cabrera and Schulz (2016) found that crude oil, rapeseed oil and biodiesel prices move together in the long run. Olayungbo and Hassan (2016) and Zafeiriou *et al.* (2018) applied ARDL model on annual data sets of 31 developing countries spanning 2001-2013 and monthly futures prices from July 1987 to February 2015 respectively to establish interlinkages between energy and agricultural commodity markets and confirm oil price causality.

For the case of individual Middle East countries, the empirical literature provides little information about the transmission of global oil prices on domestic food prices. Crowley (2010) analysed commodity price inflation in the countries of the Middle East, North Africa, and Central Asia during the period 1996-2009. He concluded that international fuel prices do not explain the co-movement of oil and food prices for these countries. He suggests that subsidies and price controls can explain insignificance of oil price effects on commodity prices in region. Nazlioglu and Soytas (2011) examined short- and long-run interdependence between monthly world oil prices, U.S. dollar exchange rate and five individual agricultural commodity prices in Turkey for the period from January 1994 to March 2010 by applying Toda-Yamamoto approach and generalized impulse response analysis. The result of the research supports the neutrality of agricultural commodity markets in Turkey to direct and indirect effects of oil price fluctuations in both short- and long-run. Belke and Dreger (2015) investigated the effects of global oil and food prices on consumer prices across Algeria, Egypt, Jordan, Morocco and Tunisia using threshold cointegration methods on quarterly data of consumer price indices, world oil prices and exchange rates from January 1990 to last quarter of 2011. Their results indicated long run

relationship between global oil and domestic food prices. Ali and Al-Maadid (2016) analysed how food prices are affected by oil price shocks for the countries of Gulf Cooperation Council (GCC): Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. Using daily data for two energy spot price series (crude oil and ethanol) and eight food commodity prices (cacao, coffee, corn, soybeans, soybean oil, steer, sugar and wheat) for the period January 2003 – June 2015, he implemented VAR-GARCH model with a Baba-Engle-Kraft-Kroner (BEKK) model representation. The results of volatility spillovers confirm strong linkage between food and energy market for the countries analysed.

As evidence is scares for Middle East countries, further analysis is needed for investigating the short- and long-run effects of oil prices on food prices. This paper, therefore, fills the void and contribute to the literature by investigating the dynamic relationship between world oil prices and domestic food prices for Middle East region, and brings new insights on the food-energy nexus, using data accumulated from various sources throughout the region.

3 Method

This section is structured into three parts. The first part describes the model specification implied for the analysis of the link between commodity prices of interest. Then, estimation strategy and empirical modelling framework is presented, followed by the methods used in order to investigate the cointegration between oil and food prices. The last part provides information about data sources and description of variables included in the empirical study.

3.1 Model specification

Based on the aforementioned discussions, in an attempt to investigate the link between global oil and domestic food prices in the sample of 11 Middle East countries, the food prices are expressed as a function of oil price as follows:

$$fpl = f(oil) \tag{1}$$

Where *fpl* represents food prices in the Middle East region, while *oil* denotes the average crude oil spot price of Brent, Dubai and West Texas Intermediate. Some previous studies such as Belke and Dreger (2015), Rezitis (2015), Olayungbo and Hassan (2016). have also considered domestic food price to depend on variables such as U.S. dollar effective exchange rate and international food prices. Therefore, taking into consideration these variables, equation (1) becomes:

$$fpl = f(oil, exr, fpg) \tag{2}$$

Considering the panel data, the empirical model in the log-log form is specified as followed:

$$log\_fpl_{it} = \alpha_i + \delta_i t + \beta_{1i} log\_oil_t + \beta_{2i} log\_exr_t + \beta_{3i} log\_fpg_t + \varepsilon_{it} \tag{3}$$

where fpl_{it} denotes food prices in the sampled country *i* (*i=1,..., 11*) in the panel at time *t* (*t=2010:01 – 2018:10*), oil_t is the international crude oil price, exr_t denotes US dollar exchange rate, fpg_t is the global food price, while ε_{it} is the error term. The parameter α_i is a fixed effect parameter, while β_{1t}, β_{2t}, β_{3t} are the slope parameters, and $\delta_i t$ indicates deterministic time trends, which are specific to individual countries in the dataset.

3.2 Estimation strategy

The current paper utilized panel unit root test in order to provide the stationarity properties of the variables considered, cointegration tests are performed to ascertain the presence of cointegration and then causality analyses in order to examine the interrelationship between the series. Panel data methods combine information from both time and cross-section dimensions, and as a result these methods increase the power of unit root and cointegration tests.

Figure 2. The empirical modelling framework.
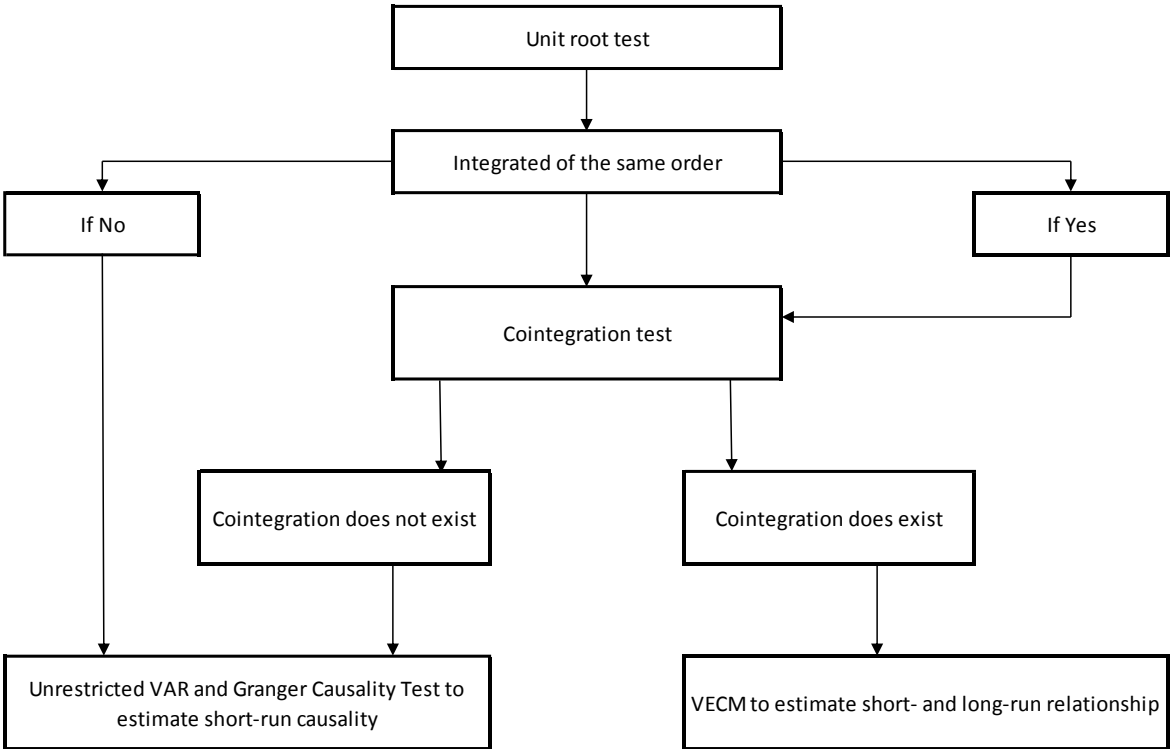
Source: own figure, (Obadi and Korček, 2014)

The empirical modelling framework is outlined in Figure 2. The first step focuses on the stochastic stationarity properties of the variables by testing the presence of the unit roots and classifying the order of integration using panel unit root tests. This allows identifying stationary and non-stationary time series, which in turn allows for the model specification and avoidance of the spurious regression. In order to avoid statistical insignificance of coefficients and multicollinearity, the optimal lag length is then determined with application of Akaike information criterion (AIC) and Schwarz information criterion (SIC). Second, an unrestricted VAR is estimated involving potentially non-stationary variables. Then, the cointegration test is applied by implementing Johansen test to ascertain the presence of cointegration and the long-run cointegration parameters are estimated. If the cointegration exists among variables, causal

relationships are analysed based on the panel VECM model. If cointegration does not exist, unrestricted VAR model is estimated and followed by the Granger Causality test.

3.2.1 Panel unit root analysis

The crucial step in empirical analysis is the determination of the order of integration of the variables, since the conventional OLS estimators with non-stationary variables leads to spurious results (Irz, Niemi & Liu, 2013). Many research studies rely on panel unit root tests for the purpose of increasing the statistical power of the estimators (Nazlioglu & Soytas, 2012; Olayungbo & Hassan, 2016). The panel unit root tests entail estimating the following panel model:

$$\Delta y_{it} = \mu_i + \rho_i y_{it-1} + \sum_{j=1}^{k} \alpha_{ij} \Delta y_{it-j} + \delta_i t + \theta_t + \varepsilon_{it} \tag{4}$$

where Δ is the first difference operator, k is the lag length, μ_i and θ_t are unit-specific fixed and time effects, respectively.

There are two types of panel unit root processes. Fist type is called a common unit root process when the persistence parameters are common across cross-sections. The null hypothesis is $\rho_i=0$ for all i is tested against the alternative hypothesis of $\rho_i<0$ for all i. The null hypothesis implies that all series are non-stationary and have a unit root while the alternative hypothesis implies a panel stationary process. The strong assumption of homogenous ρ_i is difficult to satisfy, as cross-sections may have different speed of adjustment towards the long-run equilibrium (Nazlioglu & Soytas, 2012).

Second type is characterized by the persistence of parameters moving freely across cross-sections and is called an individual unit root process. The null hypothesis of $\rho_i=0$ for all i is tested against the alternative hypothesis of $\rho_i<0$ for at least one i. The null hypothesis accordingly implies that all series are non-stationary and have a unit root while the alternative hypothesis implies that some of the series are stationary. Thus, the rejection of null hypothesis suggests stationarity of some of the series in the panel data (Serra & Zilberman, 2013).

In this respect, three unit root tests were employed in the current work: the unit root test developed by Levin, Lin and James Chu (2002) that assumes common unit root process, and two unit root tests, Augmented Dickey and Fuller (1979) (ADF) and Phillips and Perron (1988) (PP) tests, that assume individual unit root process. The tests are conducted with two alternatives for each type of test: consideration of constant trend and consideration of both

14

constant coefficient and trend. The lag length for each test is automatically selected by SIC criterion.

3.2.2 Panel cointegration analysis

Prior to estimating long-run model, the cointegration relationship between the variables of interest need to be determined. According to Engle and Granger (1987), two series integrated of the same order d, $I(d)$, are co-integrated, if their linear combination generates a stationary series. The series that are non-stationary and co-integrated may move away in the short run but must be linked together in the long run. The cointegration analysis implies testing the existence of a long run relationship between co-integrated variables that never move far apart and are attracted to their long run relationship (Nwoko, Aye & Asogwa, 2016).

There is a variety of methods for testing the cointegration between series and for the purpose of this study the Johansen-Fisher cointegration test was implemented in order to capture the long-run relationship between variables of interest. The Johansen-Fisher cointegration framework allows determining the number of co-integrating vectors among series but its weakness is that it is based on asymptotic properties and requires the variables to be integrated of the same order. The pre-testing is done by the unit root test discussed above and if the series are integrated of the same order, the estimation of long run equilibrium relationship follows. The Johansen-Fisher cointegration test is based on unrestricted VAR. Consider a general $p-$ dimensional, k^{th} order panel unrestricted VAR:

$$y_{it} = \sum_{k=1}^{k_i} \Pi_{ik} y_{i,t-k} + \varepsilon_{it} \tag{5}$$

where i=1, 2,…,N cross-section units and t=1, 2,…, T time periods, and ε_{it} are errors that are assumed to be independent and Gaussian with zero mean and covariance matrix Ω, $\varepsilon_{it} \sim N_P(0, \Omega_i)$.

The error correction form of VAR:

$$\Delta y_{it} = \Pi_i y_{i,t-1} + \sum_{j=1}^{k_i-1} \Gamma_i \Delta y_{i,t-k} + \varepsilon_{it} \tag{6}$$

where Δy_{it} is a p x 1 vector of endogenous variables, p is a number of variables, Γ_1 through $\Gamma_{k-1}(p \times p)$ and Π_i $(p \times p)$ are matrix of parameters to estimate for k order of lags and $r = 1, …, p$.

According to Engle and Granger (1987), if all the variables in y_t are integrated of order d, and there exists a co-integrating vector $\beta_i \neq 0$ such that $\beta'_i y_{it}$ is integrated of order $d - r$, then the process in y_{it} is co-integrated of order CI (d,r). If the $rank(\Pi_i) = 0$, the model represented by equation (6) is reduced to a differenced vector time-series model and no co-integration exists among variables in y_{it}. If $0 < rank(\Pi_i) < p$, there exists two matrices α_i $(p \times r)$ and β_i $(p \times r)$ each with a rank r such that $\Pi_i = \alpha_i \beta'_i$. β'_i consists of r co-integrating vectors and represents the long run relationship between the variables in y_{it}, while α_i represents the speed of adjustment to the long-run equilibrium. By assuming co-integration of order r the equation (6) can be written as:

$$\Delta y_{it} = \alpha_i \beta'_i y_{i,t-1} + \sum_{j=1}^{k_i-1} \Gamma_i \Delta y_{i,t-j} + \varepsilon_{it} \tag{7}$$

The model represented in equation (7) has the property that under suitable conditions on the parameters the process is non-stationary, Δy_{it} is stationary, and $\beta'_i y_{it}$ is stationary.

In order to ascertain cointegration relationships, first optimal lag length (k) is determined by the use of AIC and SIC and the cointegration rank (r) is determined. For cointegration rank estimation, or the presence of cointegration vectors in non-stationary series, Johansen (1988) proposes two approaches – maximum eigenvalue statistics and likelihood ratio trace statistics. The advantage of the tests is that they do not specify the cointegration vectors, but examine how many stationary combinations can be made within the variables' set.

$$\lambda_{max}(r, r+1) = -T ln(1 - \hat{\lambda}_{r+1}) \tag{8}$$

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} \ln(1 - \hat{\lambda}_i) \tag{9}$$

where T is the sample size, p is the number of variables, r is the rank of cointegration, $\hat{\lambda}_i$ is the ith eigenvalue of the co-integrating matrix.

The maximum eigenvalue statistics shown as equation (8) performs separate tests on each eigenvalue. It tests a null hypothesis of existence of r co-integrating vectors against the alternative of $r + 1$ cointegration vectors. The trace test is a one sided test represented by the equation (9). It tests the null hypothesis of at most r cointegration vector against the alternative hypothesis of full rank $r = p$ cointegration vector.

Using Johansen cointegration test (1988), Maddala and Wu (1999) propose Fisher's suggestion (1926) to combine trace test and maximum eigenvalue statistics in order to test for cointegration in full panel by combining individual cross-section tests for cointegration.

If π_i is the p-value from an individual cointegration test for cross-section i, then under the null hypothesis for the whole panel,

$$-2 \sum_{i=1}^{N} log_e(\pi_i) \tag{10}$$

is distributed as χ^2_{2N}.

Johansen-Fisher panel cointegration test aggregates p-values of individual Johansen maximum likelihood cointegration test statistics. Unlike other panel cointegration tests (Pedroni and Kao) it is not residual based which is taken from Engle Granger two step test, rather it is system based cointegration for the whole panel set (Maddala & Wu, 1999).

3.2.3 Panel causality analysis

Since cointegration analysis does not identify the direction of causality, causal interactions among the variables need to be determined. In case of long-run relationship, panel VECM is implemented while panel VAR is applied in case of no cointegration. The models were then used to conduct Granger causality tests on the relationship between domestic food prices, international oil and food prices, U.S. dollar exchange rate and country inflation.
Panel unrestricted VAR model is estimated as follows:

$$log\_fpl_{it} = \alpha_i + \sum_{j=1}^{k} \beta_{ij} log\_fpl_{it-j} + \sum_{j=1}^{k} \gamma_{ij} log\_oil_{it-j} + \sum_{j=1}^{k} \delta_{ij} log\_exr_{it-j} +$$
$$+ \sum_{j=1}^{k} \varphi_{ij} log\_fpg_{it-j} + \varepsilon_{it} \tag{11}$$

where k is the optimum number of lags, α_i is country fixed effects.

The unrestricted VAR is specified in levels and the dependent variable log_fpl_{it} is a function of its own lagged values and the lagged values of other variables in the model. However, as Engle and Granger (1987) showed, implications of causality based on a VAR model in first differences will be misleading in case the variables are co-integrated. In order to avoid such problem, is to estimate panel VECM by augmenting the VAR with one-lagged error correction term.

The panel VECM is obtained by differenciating VAR and can be presented as follows to get the direction of causality between the variables of interest:

$$\Delta log\_fpl_{it} = \alpha_{1i} + \sum_{j=1}^{k} \beta_{11ij} \Delta log\_fpl_{it-j} + \sum_{j=1}^{k} \gamma_{12ij} \Delta log\_oil_{it-j} +$$
$$\sum_{j=1}^{k} \delta_{13ij} \Delta log\_exr_{it-j} + + \sum_{j=1}^{k} \varphi_{14ij} \Delta log\_fpg_{it-j} + \lambda_{1i} ECT_{it-1} + \varepsilon_{1it} \tag{12}$$

where Δ is first difference, k is the optimum number of lags, $\beta, \gamma, \delta, \varphi$ are short-run dynamic coefficients of the model's adjustment long-run equilibrium, ECT_{it-1} is an error correction term and λ_{1i} is a speed of adjustment parameter for each cross-section.

The VECM specification allows to investigate both short- and long-run causality. The causality can be identified by the significance of coefficients on the lagged variables in equation (12). The short-run Granger weak causality, for example, from oil prices to domestic food prices, is tested by imposing $\gamma_{12ij} = 0$ for all i. The long-run causality or weak exogeneity is determined by the statistical significance of the error correction term (ECT) which stands for the lagged values of residuals obtained from co-integrating regression of the dependent variable on the regressors and represents short-run adjustment to long-run equilibrium trends. The coefficient of ECT λ_{1i} represents how fast deviations from long-run equilibrium are adjusted following changes in variable. If, for example, λ_{1i} is non-zero and significant, then log_fpl_{it} is Granger caused in the long-run by the oil prices, exchange rates, global food prices, and inflation; in other words, log_fpl_{it} responds to a deviation from the long-run equilibrium in the previous period.

The present work also checked whether the causation sources are jointly significant by implying the Granger causality test. The procedure involves testing the joint null hypothesis: $\gamma_{12ij} = 0$, $\delta_{12ij} = 0$, $\varphi_{12ij} = 0$, $\mu_{12ij} = 0$ and $\lambda_{1i} = 0$ for all i in equation (12). This represents the strong Granger causality test. The joint test identifies variables that bear the burden of short-run adjustment to long-run equilibrium after a shock to the system.

4 Empirical data

In the present paper the Middle East region is defined as a transcontinental region bound by Egypt to the West, the Arab Peninsula to the South, Iran to the East, and Turkey to the North. There are 16 countries in the region, however, due to limited data access resulting from the current political instability in Iran, Iraq, Palestine, Syria, and Yemen, these countries were excluded from the empirical analysis. Thus, 11 countries were included in the empirical analysis consisting of Bahrain, Egypt, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Turkey, and UAE. The fact that this sample countries consists of both oil importing and oil exporting countries will help understand how the effect of oil prices on domestic food prices differs across resource-scarce and resource-abundant economies.

The data employed in the present work consists of monthly observations spanning from January 2010 to October 2018, providing 106 observations for each country considered. This period was grounded on the availability of monthly consumer price indexes (CPI) for food data as higher frequency data are unavailable.

Domestic food prices (*fpl*) are measured by the CPI for food commodity groups (FCPI). FCPI measures the price change between the current and reference periods of an average basket of food commodities purchased by households. Food price index, which is used as a proxy for the world food prices (fpg), is a measure of the monthly change in international prices of a basket of food commodities and consists of the cereal price index, vegetable oil price index, meat price index, sugar price index and dairy price index. The data for *fpl* and *fpg* were obtained from Food and Agriculture Organization of the United Nations database (FAOSTAT).

World oil price (*oil*) is the U.S. dollar price per barrel sourced from the Commodity Prices Database of International Financial Statistics (IFS). The impact of oil prices on agricultural commodity prices is expected to be positive. Oil prices are the important factor in the cost of food production. Hence, the increase in oil prices may cause higher market prices of agricultural commodities. Moreover, oil price growth may also increase demand for agricultural commodities that are also used for biofuels production which in turn results in increased food prices. The expected sign of the global food prices is positive as domestic price levels can be affected by world food prices and fast-growing domestic food demand due to population growth can cause inflationary pressures.

Exchange rates have long played an important role on the price formation and have had an impact on the export and import of products that are traded. The exchange rate (*exr*) represents

the real effective exchange rate of U.S. dollar and sourced from the Commodity Prices Database of IFS. It represents the measure of a weighted average of real exchange rates of the U.S. dollar against the weighted basket of currencies of its main trading partners. The expected sign of the exchange rate is grounded on its definition. The agricultural commodity prices are quoted in U.S. dollars in international markets and due to this exchange rate is described as a value of U.S. dollar in a way that a decrease reflects the depreciation of the currency against major international currencies. As the U.S. dollar weakness can result in growth of agricultural commodity prices through increased purchasing power and foreign demand, the impact of exchange rate on food prices is expected to be negative.

The whole data analysis was performed using natural logarithms and in order to avoid data inconsistency resulting from measuring prices in different units and to work with real values, the price indexes (2010=100) were used. The summary of the descriptive statistics for the variables across Middle East countries in the panel dataset provided in Table 1.

Table 1. Descriptive statistics of the time series variables.

Variable	Description	Unit	Mean	Std.Dev.	Min	Max
fpl	Consumer Price Index corresponding to food	index number (2010=100)	119,3712	32,9629	88,6000	360,3086
oil	Crude Oil Price Index	US dollars per barrel	82,7229	24,7944	33,8376	120,0428
exr	Effective US dollar exchange rate	index number (2010=100)	107,4577	10,0549	92,5988	125,4489
fpg	Global Food Price Index	index number (2010=100)	103,2150	14,5835	82,8905	132,3601

Observations: 1166

Source: own calculations, 2019

5 Results and discussion

The following section provides the results for two data types: the panel data results for the whole sample of the Middle East countries and the time-series data results for each individual country considered in the study. The discussion of the results is also presented in the section.

5.1 Full-sample results

This part of the analysis presents the results of panel unit root tests, Johansen cointegration test, followed by the estimates of VECM and Granger causality tests outcomes. Unit root tests showed that the variables are integrated of order one and Johansen cointegration test can be applied. The test revealed that variables are cointegrated in the long-run and VECM was applied.

5.1.1 Panel unit root tests

The results of the panel unit root tests are reported in Table 2. For the levels of the variables, the results do not present a uniform conclusion that the null hypothesis can be rejected. However, the test–statistics for the first differences strongly reject the null hypothesis of the non-stationarity with the 1% significance level. Therefore, it can be concluded that the variables are integrated of order one, I(1), and this indicates a possibility of the long-run cointegration among the variables analyzed. Hence, the Johansen test for long-run cointegration follows in the next step of the data examination.

Table 2. Results for panel unit root tests.

Variables in levels	log_fpl		log_oil		log_exr		log_fpg	
	Constant	Constant Trend	Constant	Constant Trend	Constant	Constant Trend	Constant	Constant Trend
Null: Unit root (assumes common unit root process)								
Levin, Lin & Chu	-1,40608	-2,87730*	-58,515	0,40182	0,83616	-3,07914**	0,32636	-4,23253*
Null: Unit root (assumes individual unit root process)								
ADF - Fisher Chi-square	30,5520	49,3770*	11,3696	6,35306	3,72275	26,5489	10,1945	36,5535
PP - Fisher Chi-square	36,2908	34,4384*	9,38042	3,65502	3,16052	10,6375	7,61774	17,9509
Variables in first differences	Δlog_fpl		Δlog_oil		Δlog_exr		Δlog_fpg	
	Constant	Constant Trend	Constant	Constant Trend	Constant	Constant Trend	Constant	Constant Trend
Null: Unit root (assumes common unit root process)								
Levin, Lin & Chu	-28,1420***	-31,5818***	-28,4313***	-31,4715***	-25,1677***	-28,5374***	-23,8696***	-26,3061***
Null: Unit root (assumes individual unit root process)								
ADF - Fisher Chi-square	563,128***	520,575***	430,569***	374,072***	379,121***	327,146***	378,101***	334,288***
PP - Fisher Chi-square	579,505***	548,451***	428,733***	372,214***	364,418***	314,609***	378,101***	332,774***

Δ is the first difference operator. The lag length for each variable was automatically selected by the Schwarz Information Criterion.
***$p<0,01$, **$p<0,05$, *$p<0,1$

Source: own calculations, 2019

5.1.2 Johansen Fisher panel cointegration test

The result for panel cointegration test are presented in Table 3. The tests were performed for constant as well as constant and trend cases. The lag length of two was determined using AIC and SIC. All the test statistics reject the null hypothesis of no cointegration at 1% level for trace test and at 5% level for maximum eigenvalue test. The empirical findings provide strong evidence of cointegration among variables. This implies that domestic food prices in the sample of the Middle East countries converge to their long-run equilibrium by correcting the deviations from it in the short-run. Hence, this suggests the existence of long-run relationship among variables. The test results indicate that the model is fit for the estimation of panel VECM to better capture and predict causality results, of which at least one cointegration relationship exists among the variables.

Table 3. Johansen Fisher panel cointegration test results.

Hypothesized No. Of CE(s)	Fisher Stat.* from trace test		Fisher Stat.* from max-eigen test	
	Constant	Constant Trend	Constant	Constant Trend
None	37,28**	52,66***	33,39**	34,62**
At most 1	18,18	29,07	15,10	18,26
At most 2	16,21	20,55	15,76	24,32
At most 3	17,01	8,441	17,01	8,441

Probabilities are computed using asymptotic Chi-square distribution.

***p<0,01, **p<0,05, *p<0,1

Source: own calculations, 2019

5.1.3 Panel VECM

The results of VECM are reported in Table 4 for the long-run parameters and in Table 5 for the short-run parameters. The long-run estimates reveal that the variables have long-run equilibrium relationship. The guideline is when the coefficient of cointegration equation is negative and significant there exists a long-run causality from the independent variables to the dependent variable. In other words, a negative and significant ECT indicates that short-run movements between independent and dependent variables are associated with a stable long-run relationship between variables (Obadi & Korček, 2014).

The coefficient of cointegration equation in Table 5 is -0,000102 with 5% significance value. This result indicates that domestic food prices are affected by the global oil prices, U.S. dollar strength, and global food prices in the long run. 1% increase in world oil prices, depreciation of the U.S. dollar and world food prices results in 6,35%, 6,21% and 2,67% increase in local

consumer price index for food in the sample of Middle East countries respectively. This is consistent with the literature, such as Rezitis (2015), Cabrera and Schulz (2016), and Zafeiriou *et al.* (2018).

Table 4. VECM long-run parameters.

Variables	CointEq1
log_fpl(-1)	1,000000
log_oil(-1)	6,354506***
	(0,956335)
log_exr(-1)	-6,207403***
	(0,426306)
log_fpg(-1)	2,674144***
	(0,218742)
C	4,415095

Notes: standard errors in ()
***p<0,01, **p<0,05, *p<0,1

Source: own calculations, 2019

As for the short-run coefficients presented in Table 5, results show that domestic food prices do not respond to changes in oil prices, U.S. dollar effective exchange rate, and global food prices. There is no short-run causality from independent variables except to its own lagged one and lagged two price, which show statistical significance at 1% and at 5% level respectively. The lagged one coefficient implies the immediate possible price response of domestic food prices from independent variable, which is 0,17%; while lagged two is associated with response after one period or in this case after one month, which shows 0,08% increase.

Table 5. VECM short-run parameters.

Variables	Coefficient	St.Error	Prob.
ECT	-0,000102	3,58E-05	0,0042
Δ*(log_fpl(-1))*	0,171283	0,031198	0,0000
Δ*(log_fpl(-2))*	-0,080712	-2,549728	0,0108
Δ*(log_oil(-1))*	0,005254	0,008507	0,5368
Δ*(log_oil(-2))*	0,004980	0,008513	0,5586
Δ*(log_exr(-1))*	0,041670	0,040097	0,8369
Δ*(log_exr(-2))*	-0,009105	0,040189	0,1316
Δ*(log_fpg(-1))*	0,003180	0,017939	0,1234
Δ*(log_fpg(-2))*	-0,032810	0,018325	0,3176
C	0,002186	0,000481	0,0000

Source: own calculations, 2019

5.1.4 Granger causality Wald test

Granger causality tests were conducted by testing the joint hypothesis that the coefficient of ECT and coefficients of differenced lagged variables in estimated VECM are zero against the alternative that they are not. The null hypothesis that the independent variable does not Granger cause the dependent variable is tested with the use of F-statistic. The results of Granger causality tests are reported in Table 6. The findings show that only the change in global food prices Granger causes the change in domestic food prices with the 10% significance level. However, on the aggregate level all independent variables Granger cause changes in domestic food prices with 5% level of significance.

Table 6. Granger causality test results.

Excluded	Chi-sq	df	Prob.
Δlog_oil	11,8582	2	0,2214
Δlog_exr	10,8009	2	0,2896
Δlog_fpg	15,4437	2	0,0794
All	39,4514	6	0,0476

Source: own calculations, 2019

Generally, the Granger causality test shows the significant results only on the aggregate level and the VECM model provides evidence of the long-run relationship of the price variables taken into consideration. The short-run dynamics are relatively less helpful and require further examination as most of the estimates are insignificant. Moreover, in order to determine whether oil impact differs across resource rich and resource poor countries in the sample of the Middle East region the investigation proceeds with the time series analysis of individual country cases to obtain deeper understanding of price series interdependencies.

5.2 Country-level results

The current section concentrates on the causality analysis based on the time series data for each individual country in the sample. The same step-by-step procedure has been followed as outlined in Section 3.2 and illustrated in Figure 2 but only for the time series dataset.

For each time series of individual countries the ADF and PP tests were implied to the price series for 11 countries considered. The results are shown in Table 7 and indicate that all variables are I(1), integrated of order one, which implies that in levels the variables have unit roots and thus non-stationary, given that the null hypothesis cannot be rejected at any conventional significance level. However, in first difference, the null hypothesis of unit root is rejected by both ADF and PP unit root tests whether the deterministic trend is included or not.

Table 7. Unit root tests results.

		Test on level variables				Test on first-differenced variables			
		ADF test statistics		PP test statistics		ADF test statistics		PP test statistics	
Variable	*Country*	*Constant*	*C-Trend*	*Constant*	*C-Trend*	*Constant*	*C-Trend*	*Constant*	*C-Trend*
log_fpl	Bahrain	-1,3655	-1,6893	-1,2444	-1,4287**	-7,3243***	-7,2902***	-7,3051***	-7,2703***
log_fpl	Egypt	0,7842	-1,3150	1,1383	-0,8173	-6,3751***	-6,4659***	-5,9281***	-5,8060***
log_fpl	Israel	-2,6454	-2,7313	-2,6065	-2,6670	-10,2570***	-10,2562***	-10,3003**	-10,3233**
log_fpl	Jordan	-2,3182	-1,7827	-2,4221	-1,8085	-9,3608***	-9,5266***	-9,8736***	-10,4065**
log_fpl	Kuwait	-3,3512*	-1,4845	-3,5265*	-1,4565	-9,2787***	-10,0529***	-9,3127***	-10,0710**
log_fpl	Lebanon	-1,6354	-2,5075	-1,8434	-2,2878	-7,8095***	-7,8023***	-7,6382***	-7,7129***
log_fpl	Oman	-2,7907	-2,8002	-2,9758**	-1,9380	-7,9068***	-7,9966***	-7,7347**	-8,4054***
log_fpl	Qatar	-2,2741	-2,6708	-2,2745	-2,6708	-9,5005***	-9,4974**	-9,4771***	-9,4679***
log_fpl	Saudi Arabia	-1,0885	-2,3799	-1,1931	-2,4533	-9,8724***	-9,9359***	-9,8723***	-9,9359***
log_fpl	Turkey	0,9801	-3,6038*	1,8647	-1,9139	-6,6941***	-6,8725***	-8,4921***	-8,9990***
log_fpl	UAE	-1,8714	-2,4663	-2,3331	-2,3866	-9,0196***	-9,1024***	-9,1494***	-10,3120**
log_oil	World	-1,3655	-1,6894	-1,2445	-1,4287	-7,3243***	-7,2902***	-7,3051**	-7,2703***
log_exr	United States	-0,6879	-2,5606	0,5945	-1,9586	-6,7856***	-6,7876***	-6,6313***	-6,6525***
log_fpg	World	-1,2963	-2,8308	-1,1162	-2,2772	-6,7749***	-6,8644***	-6,7749***	-6,8478***

Notes: the critical values are -2,89 and -3,45 at 5% significance for a constant equation and a constant-trend equation, respectively.
Notes: ***p<0,01, **p<0,05, *p<0,1

Source: own calculations, 2019

Johansen cointegration test

The results of Johansen cointegration tests are reported in Table 8. The findings do not show a uniform conclusion for the 11 countries. There exists a long-run relationship in Bahrain, Egypt, and Kuwait as p-values for these countries show the significance at 5% level. It implies that the global crude oil prices and domestic food prices of these countries move together over time providing that in case of the deviation from the mean level or equilibrium level, the variables will be easily brought back to equilibrium. While the variables are nonstationary, their linear combination is stationary and overall oil and food prices have the long-run significant relationship in Bahrain, Egypt and Kuwait.

The statistics provide strong evidence for the cointegration, which suggests that local prices in Bahrain, Egypt and Kuwait converge to their long-run equilibrium by correcting any deviation from this equilibrium in the short-run. For other countries in the sample Johansen test did not reveal cointegration relationship between the variables. Thus, for Bahrain, Egypt, and Kuwait the VECM is estimated, while for Israel, Jordan, Lebanon, Oman, Qatar, Saudi Arabia, Turkey and UAE the unrestricted VAR is applied.

Table 8. Johansen cointegration tests results.

Lags interval (in first differences): 1 to 2				Lags interval (in first differences): 1 to 2			
Unrestricted Cointegration Rank Test (Trace)				Unrestricted Cointegration Rank Test (Trace)			

		Bahrain				*Oman*		
Hypothesized		Trace	0,05		Hypothesized		Trace	0,05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None*	0,227249	47,80989	47,85613	0,0405	None	0,151519	38,43538	47,85613	0,2834
At most 1	0,117204	20,99881	29,79707	0,3577	At most 1	0,124101	21,51170	29,79707	0,3265
At most 2	0,072934	8,034025	15,49471	0,4618	At most 2	0,064232	7,863761	15,49471	0,4801
At most 3	0,001519	0,158107	3,841466	0,6909	At most 3	0,009910	1,025833	3,841466	0,3111

		Egypt				*Qatar*		
Hypothesized		Trace	0,05		Hypothesized		Trace	0,05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None*	0,210158	49,98470	47,85613	0,0311	None	0,142646	36,32264	47,85613	0,3803
At most 1	0,176688	26,15654	29,79707	0,1241	At most 1	0,118949	20,47054	29,79707	0,3915
At most 2	0,052773	6,520165	15,49471	0,6340	At most 2	0,060822	7,426620	15,49471	0,5286
At most 3	0,010286	1,04427	3,841466	0,3068	At most 3	0,00931	0,963374	3,841466	0,3263

		Israel				*Saudi Arabia*		
Hypothesized		Trace	0,05		Hypothesized		Trace	0,05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0,150247	34,35543	47,85613	0,4825	None	0,191655	40,16600	47,85613	0,2166
At most 1	0,091727	17,59821	29,79707	0,5958	At most 1	0,136407	18,25106	29,79707	0,5476
At most 2	0,066395	7,688582	15,49471	0,4993	At most 2	0,029826	3,145713	15,49471	0,9599
At most 3	0,005927	0,612277	3,841466	0,4339	At most 3	0,000261	0,026847	3,841466	0,8698

		Jordan				*Turkey*		
Hypothesized		Trace	0,05		Hypothesized		Trace	0,05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0,137971	38,31124	47,85613	0,2886	None	0,179047	42,06682	47,85613	0,1569
At most 1	0,112483	23,01915	29,79707	0,2451	At most 1	0,141974	21,74603	29,79707	0,3128
At most 2	0,080913	10,72844	15,49471	0,2287	At most 2	0,049970	5,974595	15,49471	0,6985
At most 3	0,019591	2,037884	3,841466	0,1534	At most 3	0,006721	0,694651	3,841466	0,4046

		Kuwait				*United Arab Emirates*		
Hypothesized		Trace	0,05		Hypothesized		Trace	0,05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**	No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None*	0,284294	53,83633	47,85613	0,0124	None	0,176198	43,80608	47,85613	0,1141
At most 1	0,112042	20,05323	29,79707	0,4193	At most 1	0,146479	23,84210	29,79707	0,2072
At most 2	0,050928	8,051352	15,49471	0,4599	At most 2	0,057526	7,528476	15,49471	0,5171
At most 3	0,027072	2,771989	3,841466	0,0959	At most 3	0,013749	1,426005	3,841466	0,2324

		Lebanon		
Hypothesized		Trace	0,05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0,170806	40,28667	47,85613	0,2124
At most 1	0,136014	20,99471	29,79707	0,3580
At most 2	0,047616	5,936202	15,49471	0,7031
At most 3	0,008807	0,911165	3,841466	0,3398

Notes: * denotes rejection of the hypothesis at the 5% level.

** MacKinnon-Haug-Michelis (1999) p-values

Source: own calculations, 2019

VECM short- and long-run estimates

The VECM short-run parameters' coefficients outlined in Table 9 show no significant results related to oil and food price relationship for the countries of Bahrain, Kuwait and Egypt. Thus, the results support the neutrality hypothesis concerning the causality of global oil on domestic food prices. The exception is the lagged two international oil prices, which negatively affect domestic food prices in Bahrain by 0,097% in the short run with 5% significance level, *ceteris paribus*. During the first half of 2011 a number of countries including Bahrain, Kuwait, Oman, UAE, Jordan, and Egypt introduced food subsidies and imposed price controls (Ianchovichina, Loening and Wood, 2014). This can be an explanation of negative relationship between food and oil prices in Bahrain and insignificant results for other countries. Ötker *et al.* (2014) in the IMF working paper analysed the monetary policy response to increased inflation in emerging and developing countries associated with food and oil price shocks during global economic and financial crisis. The authors also attributed the statistical insignificance and/or negative relationship between oil and food prices to subsidies and price controls in the Middle East countries.

Table 9. VECM short-run parameters.

Variables	Bahrain Δlog_fpl	Egypt Δlog_fpl	Kuwait Δlog_fpl
ECT	-0,259346	-0,030598**	-0,015390**
	(0,06253)	(0,01087)	(0,00550)
$\Delta(log\_fpl(-1))$	0,058247	0,399610**	0,022084
	(0,09661)	(0,10192)	(0,10544)
$\Delta(log\_fpl(-2))$	-0,183570	-0,199011	-0,020321
	(0,09491)	(0,10398)	(0,10518)
$\Delta(log\_oil(-1))$	-0,015437	0,026106	-0,000111
	(0,03435)	(0,02811)	(0,01146)
$\Delta(log\_oil(-2))$	-0,096647**	-0,040497	0,008779
	(0,03500)	(0,02885)	(0,01152)
$\Delta(log\_exr(-1))$	-0,237256	0,037796	0,020677
	(0,18754)	(0,16000)	(0,06374)
$\Delta(log\_exr(-2))$	-0,170743	0,004427	0,016978
	(0,19708)	(0,17177)	(0,06362)
$\Delta(log\_fpg(-1))$	-0,006767	0,059228	0,016146
	(0,08217)	(0,06703)	(0,02801)
$\Delta(log\_fpg(-2))$	-0,033911	0,029235	0,008483
	(0,08175)	(0,06777)	(0,02794)
C	0,002707	0,010456***	0,002578***
	(0,00196)	(0,00230)	(0,00074)

Source: own calculations, 2019

The VECM long-run parameters' coefficients shown in Table 10 show significant results of the global oil and domestic food price relationship for Bahrain and Egypt. The parameters indicate domestic food prices of Bahrain in the long-run are positively correlated to global oil and global food prices and negatively to U.S. dollar exchange rate. A 1% increase in oil prices results in 0,16% increase in domestic food prices with the significance level of 5%, *ceteris paribus*. The depreciation of U.S. dollar increases domestic food prices by 1,19% at 1% significance, *ceteris paribus*. This can be explained by the Bahrain's monetary policy of fixed exchange rate to the U.S. dollar. Moreover, the result is consistent with the studies that analysed global oil price, U.S. dollar exchange rate and local food price relationship in the developing countries (Harri, Nalley and Hudson, 2015; Rezitis, 2015; Olayungbo and Hassan, 2016).

Table 10. VECM long-run parameters.

Variables	Bahrain CointEq1	Egypt CointEq1	Kuwait CointEq1
log_fpl(-1)	1,000000	1,000000	1,000000
log_oil(-1)	0,161865**	1,562608***	0,140783
	(0,05038)	(0,21253)	(0,19585)
log_exr(-1)	-1,194320***	-8,493876***	1,913607**
	(0,19007)	(0,80943)	(8,73368)
log_fpg(-1)	0,085621	0,355749	1,083173**
	(0,10543)	(0,43954)	(0,40973)
C	1,979051	39,74276	19,34154

Notes: standard errors in (), ***p<0,01, **p<0,05, *p<0,1

Source: own calculations, 2019

As for the Egypt, international oil prices show significant results and an increase in oil prices by 1% causes 1,56% increase in domestic food prices in the long-run, *ceteris paribus*. The same negative relationship between food and US dollar exchange rate as in Bahrain is revealed for Egypt and the negative sign of the outcome is expected and consistent with previous studies. The exchange rate of U.S. dollar show negative effect towards food prices of 8,49% at 1% significance level. Although the short-run parameters are insignificant, the long-run estimates can indirectly show the food subsidies and price controls in the Egypt are less effective in the long run.

The international oil prices show positive relationship with local food prices in Kuwait as well, but results are insignificant. World food prices play significant role here: an increase in world food prices by 1% results in 1,08% increase in food CPI of Kuwait at 5% significance. The positive relationship is shown between domestic food prices and exchange rates as opposed to Bahrain and Egypt. This can be explained by Kuwait's high dependency on food exports from

Europe. Here a 1% decrease in U.S. dollar strength is associated with 1,91% increase in food CPI with 5% level of significance. The majority food imports come from Europe and priced in euros and thus, the weakening of dollar causes increase in food inflation.

VAR short-run estimates

The VAR short-run parameters' coefficients outlined in Table 11 show positive relationship between world oil and domestic food prices in Qatar and Saudi Arabia but only with 10% level of significance. For these countries, which represent oil exporting countries in the analysed sample, a 1% increase in oil prices results in 0,0315% and 0,0405% increase in domestic food prices of Qatar and Saudi Arabia respectively with 10% significance level. The results are consistent with Olayungbo and Hassan (2016) and rejects the neutrality hypothesis about the relationship between oil and food prices. The low level of transmission can be explained by high government subsidies for food and fuel and without such policy measures, the causality will be much more significant given the high dependency on food imports in these countries.

Table 11. VAR short-run parameters.

	Israel	Jordan	Lebanon	Oman	Qatar	Saudi Arabia	Turkey	UAE
	log_fpl	*log_fpl*	*log_fpl*	*log_fpl*	*log_fpl*	*log_fpl*	*log_fpl*	*log_fpl*
log_fpl(-1)	0,843182***	0,984810***	1,173097***	1,155742***	0,944378***	0,889646***	1,154184***	1,027908***
	(0,10599)	(0,101783)	(0,098696)	(0,098158)	(0,106298)	(0,098863)	(0,094749)	(0,101600)
log_fpl(-2)	0,020536	-0,049244	-0,235832**	-0,230068**	-0,061416	-0,006697	-0,168840*	-0,087829
	(0,10195)	(0,099935)	(0,095689)	(0,094905)	(0,102684)	(0,098632)	(0,094023)	(0,101113)
log_oil(-1)	0,015239	0,012307	-0,004040	0,003946	-0,019616	-0,013267	0,056497	0,014914
	(0,01716)	(0,019534)	(0,016858)	(0,014842)	(0,016012)	(0,022643)	(0,036488)	(0,016541)
log_oil(-2)	-0,003245	0,000322	0,023369	0,005405	0,031465*	0,040516*	-0,018601	-0,006486
	(0,017740)	(0,020499)	(0,017788)	(0,015461)	(0,016545)	(0,023345)	(0,037024)	(0,017232)
log_exr(-1)	0,000787	0,112077	0,086985	-0,035946	-0,055930	-0,228843*	0,633753***	-0,064825
	(0,091014)	(0,105658)	(0,091675)	(0,079088)	(0,088819)	(0,121787)	(0,194251)	(0,091564)
log_exr(-2)	0,074814	-0,056114	0,006684	0,077500	0,144063	0,315006**	-0,445547**	0,122339
	(0,093092)	(0,104473)	(0,090754)	(0,078768)	(0,088962)	(0,121247)	(0,198793)	(0,090030)
log_fpg(-1)	0,006104	0,080729*	0,033549	0,048806	0,009277	0,137455**	0,223516***	-0,030082
	(0,040489)	(0,046525)	(0,040203)	(0,035460)	(0,039793)	(0,054641)	(0,085826)	(0,039654)
log_fpg(-2)	0,011413	-0,069370	-0,026106	-0,043451	0,013966	0,106735*	0,216271**	0,036369
	(0,041520)	(0,048046)	(0,041142)	(0,036643)	(0,040882)	(0,055957)	(0,087276)	(0,040397)
C	0,149913	0,065000	-0,256810	0,089373	-0,022303	0,159870	-0,999321*	-0,048166
	(0,206418)	(0,218650)	(0,209177)	(0,170358)	(0,188015)	(0,331075)	(0,574288)	(0,199115)

Source: own calculations, 2019

U.S. dollar effective exchange rate positively affect food prices of Saudi Arabia by 0,32% at 5% significance and negatively influence food prices in Turkey with the effect of 0,45% decrease at 5% level of significance. Moreover, food prices are also affected by global food price fluctuations - 1% increase in global prices of agricultural commodities result in increase of food prices in Saudi Arabia and Turkey by 0,14% and 0,22% respectively.

The estimates of the countries Israel, Jordan, Lebanon, Oman, and UAE showed no significant results and thus the support of the neutrality hypothesis concerning the relationship between world oil and domestic food prices. These results are consistent with research outcomes of Kaltalioglu and Soytas (2009), Mutuc, Pan and Hudson (2011), and Baumeister and Kilian (2014) and can indicate the short-run efficiency of food subsidies and price controls introduced by these countries during the first half of 2011 under the public pressure in the context of the Arab Spring tensions (World Bank, 2011).

Granger causality tests

Granger causality tests are used to forecast that world crude oil prices have a predictive power to changes in agricultural commodity prices in domestic market for each individual country in the sample considered. The tests in estimated VECM and VAR models showed the results reported in Table 12. As in the section 5.1.4, the null hypothesis that the independent variable does not Granger cause the dependent variable is tested with the use of F-statistic. Significant results of the causal relationship between global oil and domestic food prices are introduced in Bahrain, Lebanon, Qatar, Saudi Arabia and Turkey. At 5% significance level oil prices Granger cause local food prices in Bahrain and Saudi Arabia, while Granger causality between variables is weaker in Lebanon, Qatar and Turkey with significance of 10%. The food prices of Israel, Lebanon, Saudi Arabia, Qatar and Turkey are also Granger caused by the U.S. dollar exchange rate changes. As for the global food prices, here they Granger cause domestic food prices of Saudi Arabia and Turkey showing 5% level of significance, which is consistent with the results of Nazlioglu and Soytas (2011) that found the causality between variables for the case of Turkey.

Table 12. VAR short-run parameters.

Bahrain					Oman			
Excluded	Chi-sq	df	Prob.		Excluded	Chi-sq	df	Prob.
log_oil	8,558158	2	0,0139		*log_oil*	1,972113	2	0,3730
log_exr	2,996868	2	0,2235		*log_exr*	2,468451	2	0,2911
log_fpg	0,225035	2	0,8936		*log_fpg*	1,933329	2	0,3803
All	10,18702	6	0,1170		All	5,525575	6	0,4784

Egypt					Qatar			
Excluded	Chi-sq	df	Prob.		Excluded	Chi-sq	df	Prob.
log_oil	2,433539	2	0,2962		*log_oil*	4,849402	2	0,0885
log_exr	0,058952	2	0,9710		*log_exr*	8,567881	2	0,0138
log_fpg	1,362858	2	0,5059		*log_fpg*	2,286449	2	0,3188
All	3,911301	6	0,6887		All	9,371655	6	0,1537

Israel					Saudi Arabia			
Excluded	Chi-sq	df	Prob.		Excluded	Chi-sq	df	Prob.
log_oil	2,790075	2	0,2478		*log_oil*	7,075904	2	0,0291
log_exr	5,160695	2	0,0757		*log_exr*	9,973011	2	0,0068
log_fpg	1,150559	2	0,5625		*log_fpg*	6,932190	2	0,0312
All	6,310557	6	0,3839		All	18,72984	6	0,0046

Jordan					Turkey			
Excluded	Chi-sq	df	Prob.		Excluded	Chi-sq	df	Prob.
log_oil	2,196471	2	0,3335		*log_oil*	4,964140	2	0,0836
log_exr	2,455814	2	0,2929		*log_exr*	11,37908	2	0,0034
log_fpg	3,151252	2	0,2069		*log_fpg*	6,816599	2	0,0331
All	5,624013	6	0,4666		All	16,05739	6	0,0134

Kuwait					United Arab Emirates			
Excluded	Chi-sq	df	Prob.		Excluded	Chi-sq	df	Prob.
log_oil	0,609991	2	0,7371		*log_oil*	1,659468	2	0,4362
log_exr	0,250285	2	0,8824		*log_exr*	3,074478	2	0,2150
log_fpg	0,343684	2	0,8421		*log_fpg*	0,837183	2	0,6580
All	0,999144	6	0,9856		All	5,223015	6	0,5155

Lebanon			
Excluded	Chi-sq	df	Prob.
log_oil	5,186732	2	0,0748
log_exr	4,612479	2	0,0996
log_fpg	0,799817	2	0,6704
All	6,151814	6	0,4064

Source: own calculations, 2019

To sum up, the results of aggregate data provide strong evidence on the long-run price pass-through from international oil to domestic food prices and are not in line with the empirical literature supporting the neutrality hypothesis of the prices. The short-run dynamics are relatively less helpful and further analysis was needed as most of the estimate results are statistically insignificant. The individual country-level estimates provide more insights about price series' interdependencies and help to identify country-specific price transmissions. It is evident that among resource rich countries in the analysed sample, the domestic food prices in Bahrain and Kuwait change in the long-run due to global oil prices fluctuations. The highest long-run positive relationship is presented in Egypt, which represents the resource poor country.

As for the short-run effects, the empirical results show that positive short-run relationship exists between global oil and local food prices in resource rich Bahrain, Saudi Arabia with weaker impact in Qatar. Whereas, the resource poor Lebanon and Turkey also present weak causality running from world oil to domestic food prices as the Granger causality test estimates show low statistical significance. The insignificant results of the countries Jordan, and UAE for both long- and short-run estimates can indirectly show the effectiveness of food subsidy and price control policies in these countries. The support of neutrality hypothesis for the case of Israel can also be explained by the country's developed agriculture. Moreover, the insignificance of the short-run estimates might be due to the limited scope of the present paper as matters such as seasonality patterns, food demand structure, infrastructural issues and market power are not incorporated into the analysis.

6 Conclusions

This study investigated the relationship between international oil prices and domestic food prices across 11 countries of the Middle East region and identified country-specific variations between the prices considered. First, the aggregate panel data analysis has been performed. The cointegration analysis was carried out and long-run relationship was found to exist between world oil and domestic food prices with the control variables employed such as U.S. dollar effective exchange rate and global food prices. The long-run cointegration test results showed positive relationship between oil and food prices. The panel VECM showed that the positive long-run relationship between world oil prices and domestic consumer food prices exists and 1% increase in the global price of oil results in 6,35% increase in domestic food prices. However, the short-run estimates showed positive effect though the results were insignificant. Given that the short-run dynamics were relatively less helpful, the analysis proceeded with time series analysis for each country in the sample of the Middle East region in order to identify the variations between them, i.e. country specific price transmissions.

On the individual level the relationship between global oil and domestic food prices varied within the countries under consideration. The long-run relationship occurred for the countries of Bahrain, Egypt and Kuwait. For all three countries, oil prices positively affect food prices with the highest impact on prices of Egypt in the long-run. As for the short-run estimates, domestic food prices are influenced by oil price fluctuations in Qatar and Saudi Arabia. The Granger causality tests revealed that in the short run the world oil prices have a predictive power for food price fluctuations for the countries of Bahrain, Qatar, Saudi Arabia, Turkey and Lebanon.

The results of the present work vary across the countries in the sample of the Middle East region. The pass-through variations can be explained by specific economic and political measures, such as food price subsidies and controls, that characterize each country in the sample under consideration. However, the presence of oil price effect on domestic food price introduces a concern to both high- and low-income economies as well as resource rich and resource poor countries.

6.1.1 Policy recommendations

Based on the conclusions that world oil prices has a direct effect on domestic food prices for both resource rich and resource poor economies in the sample analysed, the price risk is likely to remain a concern for the countries across the Middle East region. It is recommended for the

governments of Bahrain, Egypt, Kuwait, Qatar, Saudi Arabia, Turkey, and Lebanon to revisit the existing efforts towards maintaining and improving food self-sufficiency and encourage long-run strategies and policies aimed to manage food supply and price risks. The existing policy schemes such as price controls of essential food items, subsidies and strategic stockholding are likely to have limited effect on mitigation of food inflation, work in the short run and become potentially counterproductive in the long-run, unless the issues associated with agricultural productivity are properly addressed. It is recommended for the governments of the Middle East region to tackle domestic issues, such as logistics and poor infrastructure by improving the transportation system and efficiency of food supply chains. Maintaining trade diversification, which implies supply and price risk management by the development of trade relationships within and outside the Middle East region could play an important role in addressing potential food security issues. Another recommendation for policy makers is the investments in developed agricultural sectors of the food secure countries. Such investments present opportunity to develop strategic trade relationships through investments in main trade partners, reduces the start-up times and minimizes the complications related to land-based investments.

6.1.2 Study limitations

There are some potential limitations of the model applied in the analysis. These limitations are mainly related to data problems. The size of the observations and time period covered are quite small due to limited data accessibility of domestic food prices across the Middle East region. As a result, the model parameters' efficiency can be compromised. The model's weakness is mostly related to implementation of FCPI rather than disaggregate data on individual domestic agricultural commodity prices. The use of FCPI is not ideal as it doesn't provide in-depth analysis of the results. Thus, there is a possibility to further improve the model using better market data of individual local agricultural commodity prices of the region considered.

Other limitations include the scope and model selection preference of the study and they could be considered as topics for further research. The areas include price symmetry analysis on model disequilibrium and variance decomposition analysis on price transmission, which provide further evidence of the relationship between the variables under investigation. Moreover, implementation of the various dynamic models such Parity Bound and Threshold VECM models will be appropriate. However, in these case large size of observations and additional market data such as transportation and transfer costs, trade policies and geopolitical factors would need to be included in the study.

References

Abbott, C. P., Hurt, C. & Tyner, E. W. (2008) *What's Driving Food Prices?* Available at: https://ageconsearch.umn.edu/record/37951/files/FINAL WDFP REPORT 7-28-08.pdf (Accessed: March 2, 2019).

Ahmadi, M. *et al.* (2015) *How is volatility in commodity markets linked to oil price shocks?* Available at: https://ageconsearch.umn.edu/record/230684/files/NDL2015-101.pdf (Accessed: March 23, 2019).

Ali, A. & Al-Maadid, S. (2016) *Effects of Oil Prices, Food Prices and Macroeconomic News on GCC Stock Markets*. Available at: https://bura.brunel.ac.uk/bitstream/2438/13635/1/FulltextThesis.pdf (Accessed: March 27, 2019).

Arezki, R. & Brückner, M. (2011) *Food Prices and Political Instability*. Available at: https://www-elibrary-imf-org.ezproxy.its.uu.se/doc/IMF001/11718-9781455221066/11718-9781455221066/Other_formats/Source_PDF/11718-9781462349548.pdf (Accessed: March 24, 2019).

Baffes, J. (2007) Oil spills on other commodities. *Resources Policy*, 32(3), pp. 126–134. doi: 10.1016/j.resourpol.2007.08.004.

Bailey, R. & Willoughby, R. (2013) Edible Oil : Food Security in the Gulf. *Chatham House Briefing Paper*, (November). Available at: http://www.metoffice.gov.uk/media/pdf/j/m/ (Accessed: March 27, 2019).

Bakucs, Z. & Fertő, -Imre (2013) World prices and domestic food price spikes. Available at: http://econ.core.hu/file/download/mtdp/MTDP1304.pdf (Accessed: June 5, 2018).

Baumeister, C. & Kilian, L. (2014) Do Oil Price Increase Cause Higher Food Prices, *Bank of Canada Working Paper 2013-52*, pp. 0–70.

Baumeister, C. & Peersman, G. (2013) The role of time-varying price elasticities in accounting for volatility changes in the crude oil market. *Journal of Applied Econometrics*, 28(7), pp. 1087–1109. doi: 10.1002/jae.2283.

Belke, A. & Awad, J. (2015) On the Pass-Through of Food Prices to Local Inflation in MENA Countries. *WSEAS Transactions on Business and Economics*, 12(1), pp. 307–316. Available at: http://www.wseas.org/multimedia/journals/economics/2015/a565707-286.pdf

(Accessed: March 25, 2019).

Belke, A. & Dreger, C. (2015) The transmission of oil and food prices to consumer prices: Evidence for the MENA countries. *International Economics and Economic Policy*, 12(1), pp. 143–161. doi: 10.1007/s10368-014-0283-x.

Breisinger, C., Ecker, O. & Al-Riffai, P. (2011) Economics of the Arab Awakening: From Revolution to Transformation and Food Security. *IFPRI Policy Brief*, 18, p. 2. Available at: http://www.tropentag.de/2011/abstracts/links/Breisinger_TtuLcuBW.pdf (Accessed: March 3, 2019).

Burakov, D. (2016) Oil Prices, Exchange Rate and Prices for Agricultural Commodities: Empirical Evidence from Russia. 2(2), pp. 33–47. doi: 10.7160/aol.2016.080203.

Cabrera, B. L. & Schulz, F. (2016) Volatility linkages between energy and agricultural commodity prices. *Energy Economics*, 54, pp. 190–203. doi: 10.1016/j.eneco.2015.11.018.

Campiche, J. L. *et al.* (2007) Examining the Evolving Correspondence Between Petroleum Prices and Agricultural Commodity Prices. pp. 1–15. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.598.6270&rep=rep1&type=pdf (Accessed: June 5, 2018).

Ceballos, F. *et al.* (2017) Grain Price and Volatility Transmission from International to Domestic Markets in Developing Countries. doi: 10.1016/j.worlddev.2017.01.015.

Chen, S. T., Kuo, H. I. & Chen, C. C. (2010) Modeling the relationship between the oil price and global food prices. *Applied Energy*. Elsevier Ltd, 87(8), pp. 2517–2525. doi: 10.1016/j.apenergy.2010.02.020.

Chiu, F. P. *et al.* (2016) Modeling the price relationships between crude oil, energy crops and biofuels. *Energy*. Elsevier Ltd, 109, pp. 845–857. doi: 10.1016/j.energy.2016.05.016.

Crowley, J. (2010) *Commodity Prices and Inflation in the Middle East, North Africa, and Central Asia IMF Working Paper MCM Commodity Prices and Inflation in the Middle East, North Africa, and Central Asia*. Available at: https://www.imf.org/external/pubs/ft/wp/2010/wp10135.pdf (Accessed: March 26, 2019).

Dickey, D. A. & Fuller, W. A. (1979) Distribution of the Estimators for Autoregressive Time Series With a Unit Root. *Journal of the American Statistical Association*. Taylor & Francis, Ltd.American Statistical Association, 74(366), p. 427. doi: 10.2307/2286348.

Dillon, B. M. *et al.* (2014) Global Oil Prices and Local Food Prices: Evidence from East Africa. Available at: http://barrett.dyson.cornell.edu/files/papers/DillonBarrett_140424.pdf.

Engle, R. F. & Granger, ; C W J (1987) *Co-Integration and Error Correction: Representation, Estimation, and Testing*, *Econometrica*. Available at: http://www.ntuzov.com/Nik_Site/Niks_files/Research/papers/stat_arb/EG_1987.pdf (Accessed: March 4, 2019).

Fisher, R. A. (1926) *Statistical Methods For Research Workers*. Available at: https://www-jstor-org.ezproxy.its.uu.se/stable/pdf/43430361.pdf?refreqid=excelsior%3Ad5639820252645e5a47e616ff77f3d8e (Accessed: March 7, 2019).

Gilbert, C. L. (2010) How to understand high food prices. *Journal of Agricultural Economics*. Wiley/Blackwell (10.1111), 61(2), pp. 398–425. doi: 10.1111/j.1477-9552.2010.00248.x.

Harri, A., Nalley, L. & Hudson, D. (2015) The Relationship between Oil, Exchange Rates, and Commodity Prices. *Journal of Agricultural and Applied Economics*, 41(02), pp. 501–510. doi: 10.1017/s1074070800002959.

Hatab, A. A. (2016) *Food Price Volatility & Political Unrest: The case of the Egyptian Arab Spring.* Watch Letter n36. Available at: https://www.iamm.ciheam.org/publications/89/016_Abu_Hatab.pdf (Accessed: March 23, 2019).

Headey, D. & Fan, S. (2010) *Reflections on the global food crisis: How Did It Happen? How Has It Hurt? And How Can We Prevent the Next One?* International Food Policy Research Institute. doi: 10.2499/9780896291782RM165.

Hochman, G. *et al.* (2012) Biofuel and Food-Commodity Prices. *Agriculture*. Molecular Diversity Preservation International, 2(3), pp. 272–281. doi: 10.3390/agriculture2030272.

Holt-Giménez, E. & Peabody, L. (2008) From Food Rebellions to Food Sovereignty: Urgent call to fix a broken food system. *Food First Backgrounder*, 14(1), pp. 1–6. Available at: https://foodfirst.org/wp-content/uploads/2013/12/BK14_1-spring-2008-Food-Rebellions.pdf (Accessed: June 4, 2018).

Ianchovichina, E. I., Loening, J. L. & Wood, C. A. (2014) How Vulnerable are Arab Countries to Global Food Price Shocks? *Journal of Development Studies*, 50(9), pp. 1302–1319. doi: 10.1080/00220388.2014.928698.

Ianchovichina, E., Loening, J. & Wood, C. (2012) *How Vulnerable are Arab Countries to Global Food Price Shocks?* The World Bank (Policy Research Working Papers). doi: 10.1596/1813-9450-6018.

Irz, X., Niemi, J. & Liu, X. (2013) Determinants of food price inflation in Finland-The role of energy. *Energy Policy*. Elsevier, 63, pp. 656–663. doi: 10.1016/j.enpol.2013.09.023.

Johansen, S. (1988) Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*. North-Holland, 12(2–3), pp. 231–254. doi: 10.1016/0165-1889(88)90041-3.

Kaltalioglu, M. & Soytas, U. (2009) *Price transmission between world food, agricultural raw material, and oil prices*, GBATA International Conference Proceedings.

Katkhuda, N. (2017) *Food Security in the Middle East.* EcoMENA. Available at: https://www.ecomena.org/food-middle-east/ (Accessed: March 3, 2019).

Lagi, M., Bertrand, K. Z. & Bar-Yam, Y. (2011) *The Food Crises and Political Instability in North Africa and the Middle East*. Available at: https://arxiv.org/pdf/1108.2455.pdf (Accessed: March 25, 2019).

Larson, D. F. *et al.* (2014) Food security and storage in the Middle East and North Africa. *World Bank Economic Review*, 28(1), pp. 48–73. doi: 10.1093/wber/lht015.

Levin, A., Lin, C.-F. & James Chu, C.-S. (2002) Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of Econometrics*. North-Holland, 108(1), pp. 1–24. doi: 10.1016/S0304-4076(01)00098-7.

Maddala, G. S. & Wu, S. (1999) A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test. *Oxford Bulletin of Economics and Statistics*. John Wiley & Sons, Ltd (10.1111), 61(s1), pp. 631–652. doi: 10.1111/1468-0084.0610s1631.

Mckee, M. *et al.* (2017) Demographic And Economic Material Factors In The Mena Region. Middle East And North Africa Regional Architecture: Mapping Geopolitical Shifts, Regional Order and Domestic Transformations. Available at: http://www.iai.it/sites/default/files/menara_wp_3.pdf (Accessed: June 11, 2018).

Mutuc, M., Pan, S. & Hudson, D. (2011) Response of cotton to oil price shocks. *Agricultural Economics Review*, 12(2), pp. 40–49. Available at: http://ageconsearch.umn.edu/bitstream/56425/2/Response of Cotton to Oil Price Shocks.pdf (Accessed: June 5, 2018).

Nazlioglu, S. (2011) World oil and agricultural commodity prices: Evidence from nonlinear causality. *Energy Policy*. Elsevier, 39(5), pp. 2935–2943. doi: 10.1016/j.enpol.2011.03.001.

Nazlioglu, S. & Soytas, U. (2011) World oil prices and agricultural commodity prices: Evidence from an emerging market. *Energy Economics*. Elsevier B.V., 33(3), pp. 488–496. doi: 10.1016/j.eneco.2010.11.012.

Nazlioglu, S. & Soytas, U. (2012) Oil price, agricultural commodity prices, and the dollar: A panel cointegration and causality analysis. *Energy Economics*, 34(4), pp. 1098–1104. doi: 10.1016/j.eneco.2011.09.008.

Nwoko, I. C., Aye, G. C. & Asogwa, B. C. (2016) Oil price and food price volatility dynamics: The case of Nigeria. *Cogent Food & Agriculture*. Cogent, 2(1), pp. 1–13. doi: 10.1080/23311932.2016.1142413.

Obadi, S. M. & Korček, M. (2014) Are Food Prices Affected by Crude Oil Price: Causality Investigation. *Rev. Integr. Bus. Econ. Res*, 3(1), p. 411. Available at: www.sibresearch.org (Accessed: March 23, 2019).

Olayungbo, D. & Hassan, W. (2016) Effects of oil price on food prices in developing oil exporting countries: a panel autoregressive distributed lag analysis. *OPEC Energy Review*, 40(4), pp. 397–411. doi: 10.1111/opec.12090.

Ortiz, I., Chai, J. & Cummins, M. (2011) Escalating Food Prices: The Threat to Poor Households and Policies to Safeguard a Recovery for All. *Ssrn*, (February). doi: 10.2139/ssrn.1760162.

Ötker, I. *et al.* (2014) Inflation Pressures and Monetary Policy Options in Emerging and Developing Countries-A Cross Regional Perspective. *IMF Working Papers*, 09(1), p. 1. doi: 10.5089/9781451871487.001.

Phillips, P. C. B. & Perron, P. (1988) Testing for a Unit Root in Time Series Regression. *Biometrika*. Oxford University PressBiometrika Trust, 75(2), p. 335. doi: 10.2307/2336182.

Reboredo, J. C. (2012) Do food and oil prices co-move? *Energy Policy*. Elsevier, 49, pp. 456–467. doi: 10.1016/j.enpol.2012.06.035.

Rezitis, A. N. (2015) Empirical analysis of agricultural commodity prices, crude oil prices and US dollar exchange rates using panel data econometric methods Examining the relation of agricultural commodity prices and energy prices View project International Journal of Energy. *International Journal of Energy Economics and Policy*, 3. Available at:

http:www.econjournals.com (Accessed: March 22, 2019).

Serra, T. & Zilberman, D. (2013) Biofuel-related price transmission literature: A review. *Energy Economics*. Elsevier B.V., 37, pp. 141–151. doi: 10.1016/j.eneco.2013.02.014.

Tadesse, G. *et al.* (2014) Drivers and triggers of international food price spikes and volatility. *Food Policy*, 47, pp. 117–128. doi: 10.1016/j.foodpol.2013.08.014.

UNDESA / United Nations Population Division of the Department of Economic and Social Affairs (2017) *World Population Prospects - Population Division - United Nations*. Available at: https://population.un.org/wpp/ (Accessed: April 18, 2019).

Wang, Y., Wu, C. & Yang, L. (2014) Oil price shocks and agricultural commodity prices. *Energy Economics*, 44, pp. 22–35. doi: 10.1016/j.eneco.2014.03.016.

World Bank (2011) *Economic Developments and Prospects: Middle East and North Africa Region*. Washington, DC. Available at: www.worldbank.org (Accessed: May 3, 2019).

World Bank (2014) Food Price Watch November 2013. *Food price watch*, (16), p. 5. Available at: http://documents.worldbank.org/curated/en/714181468336283123/Food-price-watch (Accessed: March 25, 2019).

World Bank database (2017) *WDI / World Development Indicators. DataBank*. Available at: https://databank.worldbank.org/data/reports.aspx?source=2&country=MEA (Accessed: April 18, 2019).

Yang, J. *et al.* (2008) Fighting global food price rises in the developing world: The response of China and its effect on domestic and world markets. *Agricultural Economics*. Wiley/Blackwell (10.1111), 39(SUPPL. 1), pp. 453–464. doi: 10.1111/j.1574-0862.2008.00351.x.

Yu, T.-H. *et al.* (2006) Cointegration and Causality Analysis of World Vegetable Oil and Crude Oil Prices. Available at: http://ageconsearch.umn.edu/bitstream/21439/1/sp06yu02.pdf (Accessed: June 5, 2018).

Zafeiriou, E. *et al.* (2018) Agricultural commodity and crude oil prices: An empirical investigation of their relationship. *Sustainability (Switzerland)*. Multidisciplinary Digital Publishing Institute, 10(4), p. 1199. doi: 10.3390/su10041199.

Zhang, Q. & Reed, M. (2008) *Examining the Impact of the World Crude Oil Price on China's Agricultural Commodity Prices: The Case of Corn, Soybean, and Pork.*

Acknowledgements

I would like to express my sincere gratitude to my research supervisor Assem Abu Hatab at the Department of Economics, Swedish University of Agricultural Sciences, for his continuous support, invaluable suggestions, feedback and professional guidance throughout all stages of the thesis work. I would also like to thank Prof. Yves Surry for taking an interest in my study and providing help and suggestions at the beginning of the research process.

My special thanks go to my family and especially my parents and brother for their support and continuous encouragement throughout my years of study and through the process of writing this thesis. This accomplishment would not have been possible without them.

Thank you.

Madina Alieva

Appendix

Overview of empirical studies on the relationship between oil and food prices

Reference	Modeling approach	Variables used	Period	Frequency	Key findings
Zafeiriou et al., (2018)	ARDL	Futures prices of crude oil, corn, and soybeans	July 1987 – February 2015	Monthly	Crude oil prices affect the prices of agricultural commodities used in the production of biodiesel and ethanol.
Filip, Janda, Kristoufek, & Zilberman (2017)	VECM	Prices of 3 markets: Brazil, EU and US; 26 individual commodity prices, stock indices, interest rates, exchange rates	March 1989 – May 2016	Monthly	No strong support for energy prices link to food prices.
Ali & Al-Maadid (2016)	VAR-GARCH	Prices of thanol, Brent oil, cacao, coffee, corn, soybeans, soybean oil, sugar, steer and wheat	January 2003 – June 2014	Monthly	Strong evidence of variance spillovers from energy to food commodities. Return causality from oil to food prices is affected by the food crisis, the RFS policy and financial crisis.
Burakov, (2016)	VAR, IRF	Prices of world crude oil, Russian ruble/USD exchange rates, domestic prices of buckwheat, barley, potatoes, wheat, oats, rye, and grain crops	January 1999 – October 2015	Monthly	World oil and exchange rate fluctuations do not affect domestic food prices.
Bentivoglio, Finco, & Piedade Bacchi (2016)	VECM, IRF, FEVD	Brazilian prices of gasoline, sugar and ethanol	November 2007 – November 2012	Weekly	Energy prices do not impact food prices.
Nwoko et al. (2016)	VECM	Nigerian food price volatility index, EIA crude oil prices	2000 – 2013	Annual	Positive and significant relationship between oil and food price volatilities.
Chiu et al. (2016)	VAR, VECM	Brent and WTI crude oil prices, US price for ethanol, spot prices of corn from CBOT	January 1986 – August 2015	Monthly	Energy prices cause changes in corn prices, while unidirectional causality from crude oil prices to ethanol prices exists throughout the period.
Dillon et al. (2014)	ECM	Maize prices for number 2 yellow maize in US Gulf and crude oil spot prices	2000 - 2012	Monthly	Charges in world oil prices have large effects on domestic maize prices in east Africa, which is driven more by transport costs.
Harri, Nalley, & Hudson (2015b)	VAR	Prices of corn, soybeans, soybean oil, cotton, wheat, crude oil, and trade weighted average of US dollar value	January 2000 – September 2008	Monthly	Commodity prices are linked to oil for corn, cotton, and soybeans, but not for wheat.

Belke & Awad (2015)	ECM	against currencies of major trade partners CPI, FCPI, Brent oi prices, bilateral exchange rates	January 1990 – December 2011	Quarterly	Exchange rates do not play important role in the linkage between the prices. Oil and food price shocks positively affects domestic food prices in the long run.
Obadi & Korček (2014)	VECM	Average of spot crude oil prices of Brent, WTI and Dubai, Malaysian palm oil price, US barley feed price, US maize, world meat, chicken and sugar prices	January 1975 – September 2013	Monthly	Long-run relationship between food and oil prices exists with causality running from crude oil to food prices.
Wang et al. (2014)	SVAR	Spot Brent oil prices, spot prices of cocoa, soybean, barley, wheat, corn, cotton, rice, coffee, tea	January 1980 – December 2012	Monthly	Oil prices explain minor friction of food price increases before the food crisis of 2006-2008, while the effects are greater in post-crisis period.
Avalos (2014)	VAR	World prices of crude oil, corn, soybean, copper, and gold	January 1986 – April 2012	Daily	Cointegration between oil and food prices exists and price transmission of oil price innovations to corn prices is stronger after 2006.
Baumeister & Kilian (2014b)	VAR	International crude oil prices, prices of cereals and baked goods, meats/poultry/fish/eggs, dairy, fruits and vegetables, nonalcoholic and alcoholic beverages	January 1974 – May 2013	Monthly	No evidence of oil price shocks affecting food prices in US and increasing cost of food processing, packaging, transportation and distribution.
Bakucs & Fertő (2013)	VECM	World agricultural raw materials price index, world crude oil price index, USD/Hungarian forint exchange rate, Hungarian FCPI and output price index	January 1996 – July 2007	Monthly	Hungarian domestic consumer prices are positively impacted by oil prices and international raw agricultural commodity prices and the effect of exchange rate in horizontal price transmission is emphasized.
Reboredo (2012)	Copulas	International prices of corn, soybean, wheat and Brent crude oil	January 1998 – April 2011	Weekly	Non-contagion between crude oil and agricultural markets, the neutrality of food prices to changes in oil prices.
Nazlioglu, (2011)	Toda – Yamamoto causality approach	Brent crude oil price, Turkish Lira/USD exchange rates, prices of wheat, maize, cotton, soybeans, and sunflower	January 1994 – March 2010	Monthly	Turkish agricultural commodity prices do not react to oil price and exchange rate shocks both in the short and long run.

Chen (2010)	ARDL	Futures CBOT prices of soybeans, corn and wheat, futures NYMEX prices of crude oil	March 1983 – January 2010	Weekly	Crude oil prices significantly increase prices of corn, soybeans and wheat. The changes in food prices are influenced by the changes in prices of other grains and the effect varies in different periods.
Kwon & Koo (2009)	TYDL causality approach	PPI indexes of crude energy goods, intermediate energy goods, finished energy goods, crude foodstuffs and feedstuffs, intermediate foods and feeds and finished consumer foods, CPI of food at home, real effective exchange rate	January 1998 – July 2008	Monthly	Crude prices cause increase of the intermediate and finished food prices. Crude, intermediate, and finished energy prices significantly impact crude food prices, which in turn are transmitted to all food prices at different stages of process through cost-push mechanisms.
Baffes (2007a)	OLS	Price indices of metals, fertilizers, agricultural raw materials, food, cereals, fats and oils,	1960 – 2005	Annual	The pass-through of oil prices in significant for fertilizer index, raw materials, and agricultural commodity prices.