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The interactions between agricultural commodity and oil prices: an empirical analysis

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Abstract: The purpose of the study is to analyse the short and long-term relationships between the world oil prices (Europe Brent Spot Price and West Texas Intermediate Spot Price) and the agricultural commodity prices (Wheat, Corn and Soybeans). The analysis is based upon the data set covering the monthly period of 1990.01–2014.05. According to the Johansen co-integration tests results, there are no long-run relationships between each agricultural commodity prices and world oil prices at the 5% significance level. On the other hand, according to the results of the Granger causality tests, there are uni-directional causality relationships from the Europe Brent and West Texas Intermediate oil prices to Wheat at the 1% and 5% significance level respectively, to Corn at the 1% and 1% significance level respectively and to Soybeans at the 1% and 5% significance level respectively. No causality relationship from the agricultural commodity prices to world the oil prices has been observed.

Key words: causality, co-integration, commodity prices, world energy prices

There are several factors that affect the agricultural commodity prices. Hanson et al. (1993) investigate the impact of an oil pri ce shock on the U.S. agriculture sector using the annual data between the periods of 1973–1982 by applying the Computable General Equilibrium model and report that when compared with the other sectors, the agricultural sector is energy-intensive and the effect of oil price shocks on agricultural commodities vary between each commodity. The authors indicate that the oil price shocks have a negative impact on the agricultural sector. Baffes (2013) reveals that the energy prices and food market are interdependent because the high-energy prices increase the cost of producing food commodities and encourage policies to produce biofuels from food crops. He also reports that the high energy prices may increase the amount of the energy content crops, which will cause high food prices. As a result, crude oil prices are the key determinant of food prices.

The results of the study of Abbott et al. (2009) show that the increase in economic growth increases the demand for agricultural commodities whereas decreases the productivity. As the price of the major commodities and the crude oil are from U.S. dollars, a decrease in dollar makes the commodity prices rise because the demand for the U.S. agricultural commodities increases as well as the oil prices. Furthermore, the higher oil prices increase the transportation and input costs, like the fertilizer and biodiesel, decrease productivity and this leads to an increase in the commodity prices. According to the writers, in the last years, the reason that the demand for corn has increased is that its utilization for the ethanol production is increased (Figure 1).

During the mid-2000s, the commodity price boom has taken place. The IMF's Primary Commodity Price Index increased 120 percent from 2005 to 2008 and 100 percent from 2007 to 2008. After the 2008 crisis, there was a sharp decrease in the commodity prices but after 2009, the prices watched an upward trend until 2011. For the last two years (2013–2014), the prices seem to move horizontally (Figure 2). This volatility in the commodity prices hence has attracted the attention of many researchers, global investors and policy makers and this raised the common question

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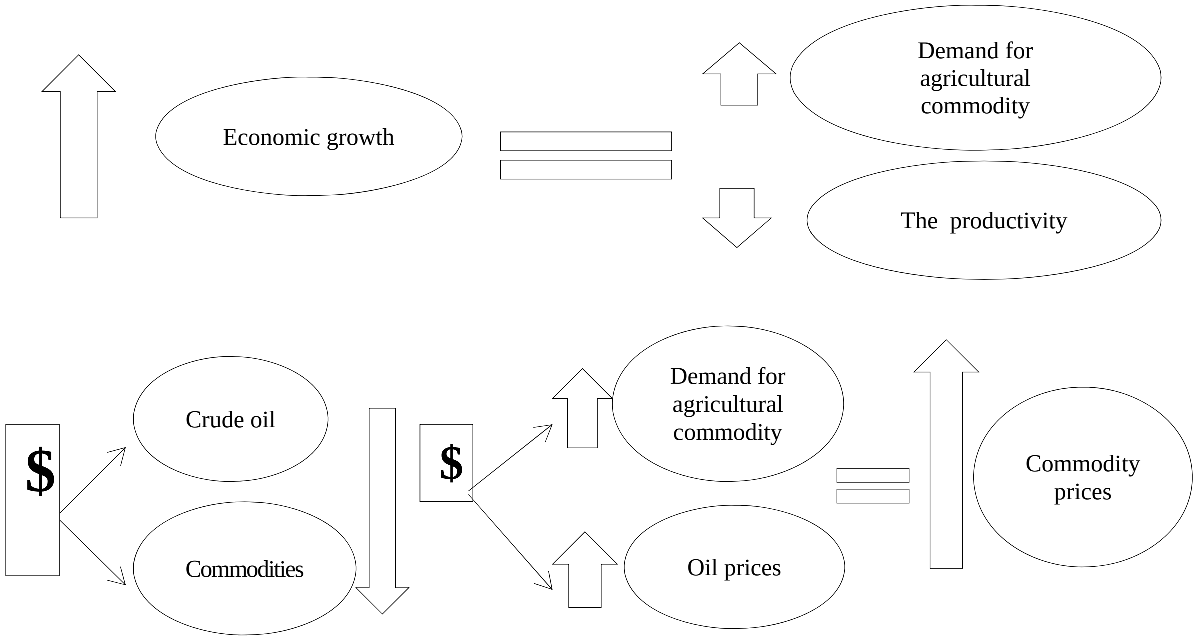

Figure 1. The factors that affect commodity prices

Source: created by the authors

of whether the energy prices have an impact on the commodity prices. Many studies report that there is a causal relationship running from the oil prices to the agricultural commodity prices (Gilbert 2010; Saghaian 2010; Nazlioglu 2011; Nazlioglu and Soytas 2012; Gozgor and Kablamaci 2014; Wang et al. 2014).

The effects of high oil prices on macro-economic activities forced many researchers to study the causes of the oil price shocks. According to Hamilton (2008) the low price elasticity of demand, high demand of strongly industrialized countries, especially China and the Middle East and the inability to raise the global production are the main reasons that cause prices rise. Kilian (2008) reveals that the oil shocks happen from the increase in the global demand of industrial commodities, the demand and supply shifts in the crude oil and the effect of oil shocks on the macro-economy differ whether they are demand-side or supply-side.

Wheat, corn and soybeans have a key importance for the world energy markets. Corn and soybeans

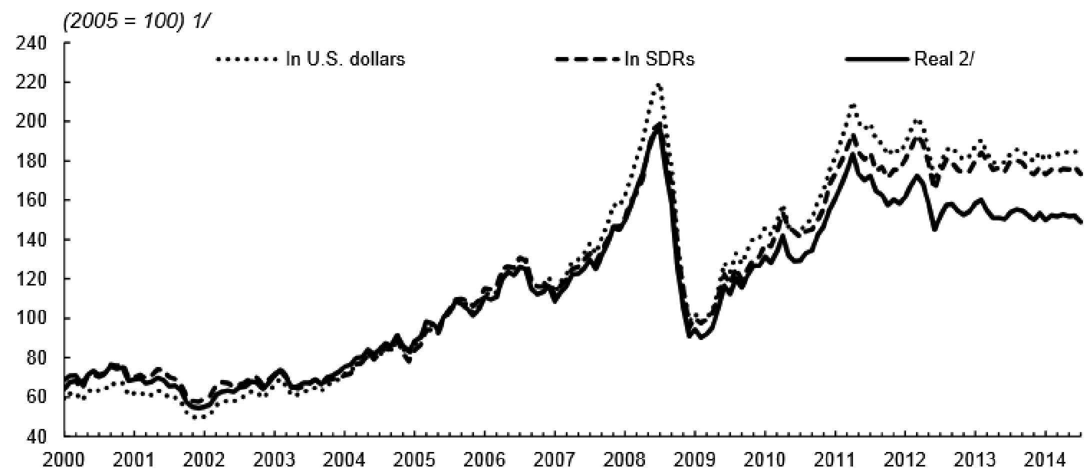

Figure 2. Indices of Primary Commodity Prices

1/ Combines indices of the non-fuel primary commodity prices and energy prices; 2/ Deflated by the U.S. CPI

Source: IMF Primary Commodity Price System)

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are especially used in the production of the ethanol and biofuel. In addition to this, the fluctuations in the prices of corn and soybeans push farmers to enhance production and this situation may cause a potential increase in the wheat prices. Furthermore, the situation of an increase on the demand of biofuels may push the energy prices up as well as the environmental concerns (Nazlioglu 2011). According to the explanations and information stated above, the aim of this study is to investigate the short and long-term relationships between the world oil prices (Europe Brent Spot Price and West Texas Intermediate Spot Price) and the agricultural commodity prices (Wheat, Corn and Soybeans).

LITERATURE REVIEW

The literature on the relationship between oil prices and the agricultural commodity prices is quite extensive. Baffes (2007) investigates the impact of the crude oil price on 35 internationally traded commodities by using the annual data from 1960 to 2005 with the OLS regression method. The results of the study show that the pass-through from crude oil prices to fertilizers index, beverages index, fats and oils index, food index, cereals index, agriculture index, other food index, non-energy index, metals index and raw materials index is; 0.33, 0.26, 0.19, 0.18, 0.18, 0.17, 0.17, 0.16, 0.11 and 0.04 respectively. Campiche et al. (2007) use the weekly data, covering the 2003–2007 periods and the Johansen co-integration analysis in order to investigate the long run relationship between the crude oil prices and the agricultural commodity (corn, sorghum, sugar, soybeans, soybeans oil and palm oil) prices and report that during 2003–2005 period there is not any co-integration relationship between the crude oil prices and the agricultural commodity prices, whereas there is a co-integration relationship between the crude oil prices and both corn and soybeans prices during the 2006–2007 time interval. Mitchell (2008) investigates the factors which affect the internationally traded food commodity prices (maize, wheat, rice, soybeans, etc.), covering the monthly period between 2002 to 2008 and reports that one of the most important factors that pushed the food prices up after late-2006 was the increase in both the U.S. and the EU biofuels production which refers to ethanol and biodiesel in his paper. Du et al. (2011) use weekly data from 1998 to 2009 and study the factors that affect the price of crude oil in order to examine the relationship between the crude oil prices and the agricultural commodity prices. By applying a Stochastic Volatility with Merton Jump in Return (SVMJ) model, they find that the oil price shocks induce the agricultural commodity prices to change sharply, especially for corn and wheat. Kwon and Koo (2009) examine the relationship among the energy prices, the exchange rate and food prices by applying the Toda-Yamamoto and Dolado-Lutkepohl (TYDL) Granger causality test, covering the monthly period from January 1998 to July 2008. The authors report that there is a uni-directional causality running from the energy prices to food prices. Saghaian (2010) applies the Vector Error Correction Model (VECM) and the Granger causality analyses using the monthly data from 1996 to 2008 in order to determine the impact of the oil market on commodity prices. The author concludes that there is a uni-directional causality running from the world crude oil prices to corn, soybeans and wheat prices. Chen et al. (2010) use the Autoregressive Distributed Lag Modelling (ARDL), covering the weekly periods from 1983 to 2010 in order to investigate the relationship between the crude oil price and the global grain prices (corn, soybeans and wheat). Their first period findings report that a 1% increase on oil price will raise corn, soybeans and wheat prices by 29.41%, 155.50% and 41.30% respectively. The authors conclude that each grain price is affected by the crude oil and other grain prices and the increasing demand of bio-fuels is a strong rival for grain products in order to produce ethanol or biodiesel by using soybeans or corn when the crude oil prices are high. Nazlioglu (2011) evaluates the relationship between the world oil prices and the three key agricultural commodity prices (wheat, corn and soybeans) by using weekly period from 1994 to 2010 and the Toda-Yamamoto (TY) and the Disk-Panchenko (DP) causality analyses. While the results of the linear causality analysis support the neutrality hypothesis, which suggests that there is not any causality between oil prices and the agricultural commodity prices, the results of the non-linear causality analysis show that there is a very strong uni-directional non-linear causality running from oil prices to corn and soybeans prices. On the other hand, Adämmer and Bohl (2015) use the monthly data from 1993 to 2012 and the Momentum Treshold Autoregressive Method (MTAR), the VEC model and the Granger causality analysis and find out that there is a uni-directional causality running from oil prices to wheat prices whereas they is not any long-run relationship for

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corn and soybeans. The authors also conclude that there is a bi-directional causality between the real oil price and the real exchange rate. Nazlioglu and Soytas (2012) investigate the relationship between the world oil prices and the agricultural commodity prices by using the monthly data from 1980 to 2010 and the panel co-integration and the Granger causality techniques. The results of their study show that the change in oil prices and the weak dollar have a strong impact on many agricultural commodity prices. Nazlioglu et al. (2013) investigate the volatility spillover between oil and agricultural commodity (wheat, corn, soybeans and sugar) prices. The authors use the daily data from 1986 to 2011 and separate their sample group into two groups: the pre-food crisis and the post-food crisis by applying the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) technique. According to the results, although there is no volatility spillover from oil to agricultural commodities in the pre-crisis period, for the post-crisis period there is a uni-directional volatility spillover from oil to corn prices and a bi-directional volatility spillover between oil-soybeans and oil-wheat. The authors could not find any volatility spillover between oil and sugar prices. Gozgor and Kablamaci (2014) applied the Panel-Wald Causality test, covering the monthly periods of January 1990 and June 2013 in order to investigate the relationship among the world oil prices, the real effective U.S. dollars, the global market risks and 27 agricultural commodity prices. The results show that there is a uni-directional causality running from oil prices, the real effective U.S. exchange rate and the VIX index to 25 agricultural commodity prices and the weak U.S. dollar has a positive effect on agricultural commodity prices. Moreover, the authors report that the agricultural industry is an energy intensive industry and oil plays a very important role in the production process of agricultural commodities.

Some researchers investigate the effects of the oil demand and supply shocks on commodity prices. Mutuc et al. (2010) perform the Structural Vector Autoregression (SVAR) analysis, covering the monthly period from 1976 to 2008 and report that while the increase in the global oil demand impacts the U.S. agricultural commodity (cotton, soybeans, corn and wheat) prices; the oil supply shocks do not have any impact on these commodity prices. By using the SVAR analysis between the monthly periods from 1980 to 2012, Wang et al. (2014) address the impact of three oil price shocks; the oil supply shocks, the aggregate demand shocks and other-oil specific shocks on nine agricultural commodity prices; cocoa, soybean, barley, wheat, corn, cotton, rice, coffee and tea. The authors divide their sample periods into two groups, the pre-crisis and the post-crisis, and report that the oil price changes have more impact on the agricultural commodity prices in the post-crisis period than in the pre-crisis period.

Not only oil price changes, but also the exchange rates are one of the key factors that affect the agricultural commodity prices. By using the Granger causality analysis, Chen et al. (2008) examine Australia, Canada, Chile, New Zealand and South Africa in their study and state that the exchange rates can be used to forecast future commodity prices. Harri et al. (2009) use the VAR model, covering the monthly period from 2000 to 2008 and find out that while there is a co-integration relationship between corn, cotton, soybeans and crude oil prices and exchange rates, the same result is not valid for wheat. Frank and Garcia (2010) analyse the relationship among the crude oil prices, exchange rates and the agricultural commodity prices. The authors divide their sample into two groups. For the weekly data from 1998 to 2006 and from 2006 to 2009, they use the VAR and VEC models, respectively. The results indicate that between 2006–2009 periods the effects of oil price and exchange rates on the agricultural commodity prices are greater than the 1998–2006 period. By using the Granger causality technique, covering the quarterly period from 1969 to 2008, Gilbert (2010) addresses that the world GDP growth, the monetary expansion, oil price and the dollar exchange rate have a causal impact on the agricultural commodity prices.

In the literature, there are also some studies that do not find any causal relationship between oil prices and the agricultural commodity prices, which support the neutrality hypothesis. For example, Yu et al. (2006) investigate the long-run relationship among soybean, sunflower, rapeseed, palm oil and world crude oil prices by using the co-integration and causality analyses, covering the weekly period from 1999 to 2008. The authors report that the world crude oil prices do not have any significant impact on the edible oil prices. Zhang and Reed (2008) examine the relationship between the world crude oil prices and China's agricultural commodity prices (corn, soybean and pork) based on monthly data from 2000 to 2007 and the Granger causality analysis. The authors report that even though the high crude oil prices increase the cost of production, they are not a significant factor for the prices of the selected agricultural com-

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modities in China. Zhang et al. (2010) use the VEC model and the Granger causality analysis based on the monthly data from 1989 to 2008 and report that there is not any long run and short-run causality between the fuel (oil, gasoline and ethanol) and agricultural commodity (corn, soybeans, wheat, sugar and rice) prices. Kaltalioglu and Soytas (2011) examine the volatility spillover among oil, food and agricultural raw markets by using the monthly data from 1980 to 2008 and the Cheung-Ng Granger causality approach. The results of the study show that there is no causality running from oil prices to food and agricultural raw markets. Nazlioglu and Soytas (2011) apply the TY causality analysis, covering the monthly period between 1994 and 2010. The authors state that the world oil prices and agricultural commodity (wheat, maize, cotton, soybeans, and sunflower) prices do not cause each other in Turkey, which supports the neutrality hypothesis. Reboredo (2012) investigates the relationship between the world oil prices and the agricultural commodity (corn, soybean and wheat) prices using the weekly data from 1998 to 2011. The author applies several copula models and the results support the neutrality hypothesis, which suggests that there is a non-co-integration relationship between oil prices and the agricultural commodity prices. Rosa and Vasciaveo (2012) investigate the relationship between oil prices and the agricultural commodity prices in Italy and the United States, covering the weekly period between 1999 and 2012. The authors apply the linear and non-linear Granger causality tests and report that there is no causal relationship between oil and the agricultural commodity prices both in Italy and the United States. Fang et al. (2014) perform the TY causality analysis using the weekly data for the period from 2004 to 2012 and report that there is no causal relationship running from domestic oil price to the agricultural commodity (rice, flour, soybean oil, peanut oil, grape seed oil, salad oil, egg, white granulated sugar, salt and white chicken meat) prices in China. Zhang and Chen (2014) investigate the impact of oil price shocks on China's metals, petrochemicals, grains and oil fats industries by using the Autoregressive Moving Average (ARMA) and the GARCH techniques using the daily data from 2001 to 2011. The authors report that oil price shocks do

Table 1. Causality Studies between the Oil and Agricultural Commodity Prices

Author	Period	Methodology	Causal Relation
Adämmer and Bohl (2015)	1993–2012	MTAR, VECM, Granger Causality	Oil → Wheat Real Exchange Rate ⟷ Real Oil Price
Fang et al. (2014)	2004–2012	Toda-Yamamoto Causality	No causal relation
Gilbert (2010)	1969–2008	Granger Causality	GDP growth, monetary expansion, oil price and dollar → agricultural commodity prices
Gozgor and Kablamaci (2014)	1990–2013	Panel-Wald Causality Analysis	Oil and reel effective U.S. exchange rate and VIX index → agricultural commodity prices
Kaltalioglu and Soyas (2011)	1980–2008	Granger Causality	No causal relation
Kwon and Koo (2009)	1998–2008	Toda-Yamamoto Granger Causality	Energy Price → Food Price
Nazlioglu (2011)	1994–2010	Toda-Yamamoto and Disk-Panchenko Causality Analysis	The Non-Linear Causality Analysis: Oil → Corn and Soybeans
Nazlioglu and Soytas (2011)	1994–2010	VAR, Toda-Yamamoto Causality	No causal relation
Nazlioglu and Soytas (2012)	1980–2010	Panel Co-integration and Granger Causality	Oil price and Dollar → Agricultural Commodity
Nazlioglu et al. (2013)	1986–2011	Causality in Variance Test (GARCH)	For Post-Crisis Period: Volatility Spillover Oil → Corn, Oil ⟷ soybeans and Oil ⟷ Wheat No Volatility Spillover Oil → Sugar
Rosa and Vasciaveo (2012)	1999–2012	Co-integration Analysis, Granger Causality	No causal relation
Saghaian (2010)	1996–2008	VECM, Granger Causality	Crude Oil → Corn, Soybeans and Wheat
Yu et al. (2006)	1999–2006	Co-integration, Granger Causality	No causal relation
Zhang and Reed (2008)	2000–2007	Granger Causality	No causal relation
Zhang et al. (2010)	1989–2008	VECM, Granger Causality	No causal relation

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Table 2. Descriptive Statistics

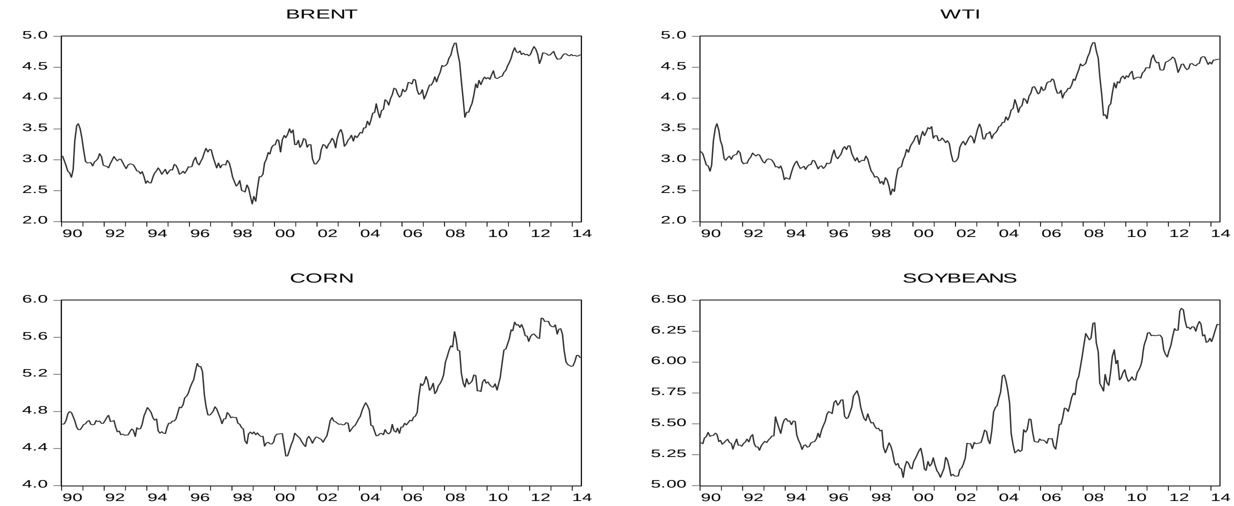
Variable	Mean	Std. Dev.	Min.	Max.	Skewness	Kurtosis	JB	Obs.
Brent Level	46.481	35.076	9.820	132.720	0.913	2.381	45.406***	293
Log	3.565	0.732	2.284	4.888	0.357	1.691	27.135***	293
WTI Level	45.707	31.268	11.350	133.880	0.826	2.310	39.143***	293
Log	3.595	0.670	2.429	4.896	0.316	1.631	27.772***	293
Corn Level	144.094	65.587	75.057	332.947	1.391	3.786	102.145***	293
Log	4.887	0.387	4.318	5.807	0.930	2.658	43.735***	293
Soybeans Level	289.056	118.024	158.312	622.913	1.097	2.932	58.926***	293
Log	5.595	0.365	5.064	6.434	0.699	2.258	30.640***	293
Wheat Level	189.336	74.296	102.161	439.716	1.097	3.176	59.205***	293
Log	5.176	0.355	4.626	6.086	0.616	2.297	24.594***	293

*** denote statistical significance at 1% level of significance

not have any significant impact on the metal and grain indices. We summarized some studies in the literature, in this direction Table 1 is given below:

DATA AND METHODOLOGY

This paper investigates the short and long term relationships between the agricultural commodity prices (Corn/US Dollars per metric Ton, Soybeans/US Dollars per metric Ton and Wheat/US Dollars per metric Ton) and oil prices (Europe Brent Spot Price/US Dollars per Barrel and West Texas Intermediate (WTI) Spot Price/US Dollars per Barrel). The data span the time period from January 1990 to May 2014, thus providing 293 observations for each variable, and the frequency of the data used is monthly. For the empirical analysis, the data on oil prices are collected from the database of the U.S. Energy Information Administration (EIA) and the agricultural commodity price indexes (2005 = 100) are obtained from the statistical database of the International Monetary Fund (IMF). All the price series are measured in US Dollars and expressed in natural logarithms. The de-



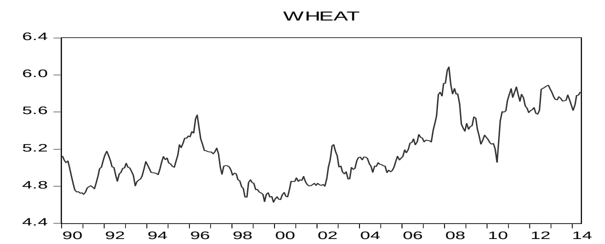


Figure 3. Oil and Agricultural Commodity Prices in Log Level

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scriptive statistics in level and log-level of all related variables are presented in Table 2. From the Jarque-Bera statistic, it is concluded that the variables do not follow the normal distribution.

Figure 3 shows the prices of the all variables during the period of the time. At this stage, it is rather evident that as oil prices, the Europe Brent price and the West Texas Intermediate price exhibit a rather strong co-movement. Moreover, the developments in these agricultural commodity prices also exhibit a rather strong co-movement. As it is understood from the Figure 3, the increase in corn, soybeans and wheat prices seem to be matching the increase in the Brent and West Texas Intermediate prices. In addition to this, the agricultural and oil prices reached their peaks in 2008 because of the dynamic relationships between agricultural and oil prices.

Following Zhang et al. (2010), Nazlioglu (2011), Nazlioglu and Soytas (2012) and Gozgor and Kablamaci (2014), the agricultural commodity prices are the dependent variable in our empirical analysis, because the agricultural commodity prices increase frequently, when the oil prices rise.

Our empirical models are specified as follows:

$$LN(CORN)_t = \beta_0 + \beta_1 LN(BRENT)_t + \beta_2 LN(WTI)_t + \varepsilon_t \quad (1)$$

$$LN(SOYBEANS)_t = \beta_0 + \beta_1 LN(BRENT)_t + \beta_2 LN(WTI)_t + \varepsilon_t \quad (2)$$

$$LN(WHEAT)_t = \beta_0 + \beta_1 LN(BRENT)_t + \beta_2 LN(WTI)_t + \varepsilon_t \quad (3)$$

where $CORN_t$, $SOYBEANS_t$ and $WHEAT_t$ are the corn price, soybeans price and wheat price, respectively. BRENT and WTI are the Europe Brent Oil price and the West Texas Intermediate price, respectively.

In order to investigate the short and long term relationships between the world oil prices (Europe Brent Spot Price and West Texas Intermediate Spot Price) and the agricultural commodity prices (wheat, corn and soybeans), unit root tests are carried out in the first instance in order to examine the stability series. Although there are different unit root tests that investigate the stability of the series, the one which is most frequently used is the Augmented Dickey Fuller (ADF) test. According to that test, the first difference of the variable is that it is regressed onto its own delayed value and the delayed values of its first differences and hence it is tested whether the ADF coefficient is zero or not (Dickey and Fuller 1979). Another unit root test made for the determination of stability is called the Phillips-Perron (PP). The distribution theory on which the Dickey-Fuller tests are based on assumes that the errors are statistically independent and have a fixed variance. The Phillips-Perron (1988) approach allows loosening these assumptions relating to the distribution of errors (Enders 1995).

The excess sensitivity of the results obtained from the ADF and PP tests to the lag length determined has been criticized time to time. In this context, it is observed that the Kwiatkowski-Phillips- Schmidt-Shin (KPSS 1992) stationarity test, which is not sensitive to the lag length, is preferred in recent studies. The null hypothesis of the KPSS stationarity test is the reverse of the null hypothesis of the ADF and the PP unit root tests (Basar and Temurlenk 2007). Thus, the hypothesis to be built for the KPSS test means that the null hypothesis time series is stationary and on the other hand the alternative hypothesis means that the time series is not stationary (Sevuktekin and Nargelecekenler 2005).

If the series of the variables are both integrated of the same order, the presence of a long-term relationship (co-integration vector) between each agricultural commodity and the world oil prices is investigated by using the co-integration test developed by Johansen (1988; 1991) and Johansen and Juselius (1990). In the case of the detection of a relation of co-integration that indicates the existence of a long-term relation between the variables, the relations of the Granger (1969) causality must be analysed by the means of the Vector Error Correction Model (VECM) and by the means of the VAR approach if there is no relation of co-integration (Chimobi and Igwe 2010).

EMPIRICAL FINDINGS

This section provides an insight into the time-series properties of the data obtained. Tables 3–5 show both the level and the first difference results of the natural logarithms of the agricultural commodity and world oil prices. The null hypothesis for the ADF and PP is that the variable has a unit root and is not stationary and the null hypothesis for the KPSS is that the variable has not a unit root and is stationary. As it can be seen from the Tables 2–4, all variables are non-stationary in level-I(0) for the ADF, PP and KPSS unit root tests. When results of the ADF, PP and KPSS unit root test are examined after their performance by taking the differences of

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Table 3. Augmented Dickey Fuller (ADF) Unit Root Test Results

Variable	ADF (Level)		ADF (First Difference)	
	Constant	Trend-Intercept	Constant	Trend-Intercept
L(Brent)	−1.047 [1] (0.736)	−3.270 [1] (0.073)	−12.949 [0]*** (0.000)	−12.939 [0]*** (0.000)
L(WTI)	−1.110 [1] (0.712)	−3.430 [1]** (0.049)	−12.634 [0]*** (0.000)	−12.625 [0]*** (0.000)
L(Corn)	−1.577 [1] (0.492)	−2.484 [1] (0.335)	−12.666 [0]*** (0.000)	−12.651 [0]*** (0.000)
L(Soybeans)	−1.347 [1] (0.608)	−2.511 [1] (0.322)	−12.615 [0]*** (0.000)	−12.614 [0]*** (0.000)
L(Wheat)	−1.582 [1] (0.490)	−2.950 [1] (0.148)	−12.993 [0]*** (0.000)	−12.997 [0]*** (0.000)
Critical Value 1%	−3.452	−3.989	−3.452	−3.989
Critical Value 5%	−2.871	−3.425	−2.871	−3.425

Notes: MacKinnon (1996) one-sided *p*-values. The optimal lag-length for the test was selected by Schwarz Information Criterion
** and *** denote statistical significance at 5% and 1% level of significance respectively

series from first degree, it is observed that all variables are not I(0) stationary in their levels and they become stationary when their first degree differences I(1) are taken. Findings found by the ADF unit root test are also supported by the results of the PP test. Findings obtained from the KPSS test are consistent with the results of the ADF and PP tests. According to these results, as all variables are integrated from the first degree I(1), it is concluded that there can be a co-integrated relationship between the variables. Therefore, it will be possible to look into the matter, whether there is a long-term relationship between agricultural commodity and the world oil prices.

The optimum lag length for the Johansen co-integration test is determined on the basis of the minimum information criterions value obtained as a result of the unconstrained VAR analysis. Based on the results reported in Table 6, the study selects the optimal lag to be 2 (two), according to the Final Prediction Error, the Akaike Information Criterion, the Schwarz Information Criterion and the, Hannan-Quinn Information Criterion. Table 7 shows the results of the Johansen co-integration test performed to examine the presence of a co-integration relationship between the agricultural commodity prices and the world oil prices. As demonstrated by the results of the Johansen co-integration test are given in Table 6, it is found that the agricultural commodity prices and world oil prices do not have any co-integration relationships both according to the trace and the maximum eigen value statistical results (H_0: r = 0 not rejected at 5% and 1% levels).

Table 4. Phillips-Perron (PP) Unit Root Test Results

Variable	PP (Level)		PP (First Difference)	
	Constant	Trend–Intercept	Constant	Trend–Intercept
L(Brent)	−0.705 [8] (0.842)	−3.081 [5] (0112)	−12.501 [11]*** (0.000)	−12.482 [12]*** (0.000)
L(WTI)	−0.818 [7] (0.812)	−3.172 [5] (0.092)	−12.133 [11]*** (0.000)	−12.115 [11]*** (0.000)
L(Corn)	−1.448 [3] (0.558)	−2.327 [3] (0.417)	−12.782 [4]*** (0.000)	−12.765 [4]*** (0.000)
L(Soybeans)	−1.034 [3] (0.715)	−2.244 [3] (0.462)	−12.544 [4]*** (0.000)	−12.539 [4]*** (0.000)
L(Wheat)	−1.438 [6] (0.563)	−2.840 [6] (0.184)	−12.920 [3]*** (0.000)	−12.923 [3]*** (0.000)
Critical Value 1%	−3.481	−4.030	−3.452	−3.989
Critical Value 5%	−2.883	−3.444	−2.871	−3.425

Notes: MacKinnon (1996) one-sided *p*-values. The optimal lag-length for the test was selected by Newey-West using Bartlett Kernel
***denotes statistical significance at 1% level of significance

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Table 5. Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Unit Root Test Results

Variable	KPSS (Level)		KPSS (First Difference)	
	Constant	Trend-Intercept	Constant	Trend-Intercept
L(Brent)	1.811 [14]***	0.318 [14]***	0.089 [8]	0.040 [8]
L(WTI)	1.820 [14]***	0.295 [14]***	0.082 [8]	0.039 [8]
L(Corn)	1.170 [14]***	0.359 [14]***	0.068 [2]	0.043 [2]
L(Soybeans)	1.247 [14]***	0.365 [14]***	0.089 [2]	0.030 [2]
L(Wheat)	1.260 [14]***	0.295 [14]***	0.087 [6]	0.027 [5]
Critical Value 1%	0.739	0.216	0.739	0.216
Critical Value 5%	0.463	0.146	0.463	0.146

Notes: Kwiatkowski-Phillips-Schmidt-Shin test statistic (1992, Table 1). The optimal lag-length for the test was selected by Newey-West using Bartlett Kernel
***denotes statistical significance at 1% level of significance

Table 8 presents the results of the Granger causality test results between the agricultural commodity prices and the world oil prices and there are uni-directional causality relationships from the world oil prices to the agricultural commodity prices. The results indicate that: the Brent causes corn, soybeans and wheat at

Table 6. Lag Length Selection Criteria

Variable	Lag	Log	LR	FPE	AIC	SC	HQ	LM-Stat. (Prob.)
L(Brent) L(Corn)	2	720.643	45.054	2.18E–05*	–5.057*	–4.928*	–5.006*	1.111 (0.892)
L(Brent) L(Soybeans)	2	734.024	47.729	1.98E–05*	–5.153*	–5.023*	–5.101*	3.980 (0.408)
L(Brent) L(Wheat)	2	701.449	36.042	2.50E–05*	–4.921*	–4.791*	–4.869*	2.301 (0.680)
L(WTI) L(Corn)	2	740.357	48.816	1.89E–05*	–5.198*	–5.068*	–5.146*	2.095 (0.718)
L(WTI) L(Soybeans)	2	752.521	50.479	1.74E–05*	–5.284*	–5.155*	–5.232*	4.992 (0.288)
L(WTI) L(Wheat)	2	720.540	40.220*	2.18E–05*	–5.057*	–4.927*	–5.005*	2.845 (0.583)

LR: sequential modified LR test statistic (each test at the 5% level), FPE: Final Prediction Error, AIC: Akaike Information Criterion, SC: Schwarz Information Criterion, HQ: Hannan-Quinn Information Criterion
*indicates lag order selected by the criterion

Table 7. Johansen Co-integration Test Results

Variable	Hypothesis	Eigenvalue	Trace Statistic	Prob.*	Max-Eigen Statistic	Prob.*
L(Brent)	H_0: r = 0	0.040	12.758	0.124	11.924	0.113
L(Corn) [2]	H_1: r ≤ 1	0.002	0.833	0.361	0.833	0.361
L(Brent)	H_0: r = 0	0.029	9.753	0.300	8.813	0.302
L(Soybeans) [2]	H_1: r ≤ 1	0.003	0.939	0.332	0.939	0.332
L(Brent)	H_0: r = 0	0.043	13.524	0.096	12.988	0.078
L(Wheat) [2]	H_1: r ≤ 1	0.001	0.536	0.464	0.536	0.464
L(WTI)	H_0: r = 0	0.037	12.243	0.145	11.150	0.146
L(Corn) [2]	H_1: r ≤ 1	0.003	1.093	0.295	1.093	0.295
L(WTI)	H_0: r = 0	0.028	9.448	0.325	8.329	0.346
L(Soybeans) [2]	H_1: r ≤ 1	0.003	1.119	0.290	1.119	0.290
L(WTI)	H_0: r = 0	0.041	13.111	0.110	12.380	0.097
L(Wheat) [2]	H_1: r ≤ 1	0.002	0.730	0.392	0.730	0.392

* denotes MacKinnon-Haug-Michelis (1999) *p*-values [ ] Lag Length

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Table 8. VAR Granger Causality/Block Exogeneity Wald Test Results

Null Hypothesis	Chi-sq	Prob.	df	Causal Relation
L(Brent) does not granger cause L(Corn)	11.485	0.003***	2	L(Brent) → L(Corn)
L(Brent) does not granger cause L(Soybeans)	9.249	0.009***	2	L(Brent) → L(Soybeans)
L(Brent) does not granger cause L(Wheat)	9.831	0.007***	2	L(Brent) → L(Wheat)
L(WTI) does not granger cause L(Corn)	10.074	0.006***	2	L(WTI) → L(Corn)
L(WTI) does not granger cause L(Soybeans)	7.617	0.022**	2	L(WTI) → L(Soybeans)
L(WTI) does not granger cause L(Wheat)	8.862	0.011**	2	L(WTI) → L(Wheat)
L(Corn) does not granger cause L(Brent)	2.821	0.243	2	No causal relation
L(Soybeans) does not granger cause L(Brent)	3.292	0.192	2	No causal relation
L(Wheat) does not granger cause L(Brent)	1.293	0.523	2	No causal relation
L(Corn) does not granger cause L(WTI)	2.238	0.326	2	No causal relation
L(Soybeans) does not granger cause L(WTI)	2.586	0.274	2	No causal relation
L(Wheat) does not granger cause L(WTI)	1.662	0.435	2	No causal relation

** and *** denote statistical significance at 5% and 1% level of significance respectively

1% significance level but not vice-versa. In the same manner, the WTI causes corn, soybeans and wheat at 1%, 5% and 5% significance level, respectively, but not vice versa.

CONCLUSION

This study investigates the short and long term relationships between the world oil prices (Europe Brent Spot Price and West Texas Intermediate Spot Price) and the agricultural commodity prices (Wheat, Corn and Soybeans) based upon the data set covering the monthly period of 1990.01–2014.05. As a result of this analysis, we could not the reject the hypothesis that there is no long-term relationship between the agricultural commodity (Corn, Soybeans and Wheat) prices and the world oil prices (Europe Brent and West Texas Intermediate) and it is found that there is not long-term relationship (co-integration vector) between the variables.

Nevertheless, we rejected the hypothesis that there is no short-term causality relationship between the agricultural commodity prices and the world oil prices. In other words, the study finds the uni-directional causality relationships from the world oil prices to the agricultural commodity prices. These findings support Chen et al. (2010), Du et al. (2011), Nazlioglu (2011), Nazlioglu and Soytas (2012), Nazlioglu et al. (2013) and Wang et al. (2014), that the world oil prices play an important role in determining the agricultural commodity prices. However, there are not any causality relationships from the agricultural commodity prices to the world oil prices, in other words, these findings support that the world oil prices do not respond to the agricultural commodity prices (Zhang et al. 2010; Vasciaveo 2013).

Considering the findings, it can be expressed that the policy makers must take into account the effects and changes of the world oil prices on the agricultural commodity prices and policies. And also for the global investors, trading on the global basis can predict the agricultural commodity prices by watching the changes/fluctuations in the oil prices.

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