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Dutch Disease effect of Oil Price on Agriculture Sector: Evidence from Panel Cointegration of Oil Exporting Countries

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ABSTRACT

This study aims to investigate the long-run relationship between oil price and value-added share of GDP of agriculture in 25 oil-exporting countries. We use the panel heterogeneous cointegration test and fully modified ordinary least squares (OLS), dynamic OLS and pooled mean group methods to examine the long-run effect of real oil price and real exchange rate on agriculture. The result of the Pedroni cointegration exposes the long-run relationship between the variables under study. Panel cointegration estimators show the negative and significant effect of oil price and exchange rate on agriculture value added. These results indicate the existence of the Dutch disease and de-agriculturalization in oil-exporting economies. The present study contributes to existing literature that concentrates on the Dutch disease and di-agriculturalization by analyzing the effect of real oil price and real exchange rate on the agricultural sector in the long- and short-run in developing oil-exporting countries.

Keywords: Oil Price, Agriculture, Dutch Disease, Panel Cointegration
JEL Classifications: B4, E3, Z3

1. INTRODUCTION

Investigating the effects of oil price on the agricultural sector among developing oil-importing countries is an important issue that gained serious attention in economic literature. Corden and Neary (1982) used Dutch disease theory to explain the effect of oil boom price on various sectors of the economy. In the core model of the Dutch disease, the economy is divided into three sectors, namely, boomed (e.g., oil sector), producer (of tradable goods, such as industrial output), and non-tradable (such as service sector or housing). The model predicts an increase in national income as a result of increased oil price. Thus, the boomed sector further creates two effects. First, an appreciation in the local currency reduces the export of tradable goods in the international market. Second, factors of output (labor and capital) move from the industrial to the oil or boomed sector, which reduces industrial production relative to the oil sector due to the effect of resource movement.

Corden and Neary (1982) investigated the Dutch disease in developed oil-exporting economies that are solely focused on the industrial sector. They found that high oil price has a negative effect on industrial output. This finding is primarily because developed economies have long-term experiences of producing industrial goods. The industrial sector is the primary sector that produces goods for export in the global market. Second, the movement of capital and labor are highly flexible in developed countries. However, this case may not be true for developing oil-exporting countries. The movement of input factors (labor and capital) between the boomed (oil) and other sectors in the economy is rigid, and the agricultural (not industrial) sector is normally considered the primary sector in nearly all developing economies.

Thus, high national income, which stems from high oil price and revenue, negatively affects agricultural output (Apergis et al., 2014). Fardmanesh (1991) argued that an increase in world oil price leads to the development of the industrial sector and contracts the agricultural sector in developing oil-exporting economies.

The agricultural sector is considered one of the important sectors that push economic growth in developing oil-exporting countries, such as Algeria, Tunisia, Iran, Egypt, Nigeria, Indonesia, and Malaysia. In terms of input–output linkages among different economic sectors, agriculture provides the main support for various economic activities, such as manufacturing, marketing, trade, and services, in developing oil-exporting countries. The sector contributed to the employment rate by approximately 19% at an average of the total employment in major and minor oil-exporting countries from 2000 to 2014. This sector also satisfies the food consumption requirements of the population, especially in rural areas.

Specific reasons justify the significance of the agricultural sector for developing economies in general and developing oil-exporting economies in particular. First, the majority of developing major oil-exporting countries is facing the challenge of high population growth and large unemployment rates. However, the oil and gas sectors, which contain and cover high levels of economic activities in these countries, do not significantly absorb a considerable portion of the unemployment rate because the oil sector is a technological- and capital-intensive one. Hence, its impact on employment and other macroeconomic structures is strongly marginal (Mansfeld and Winckler, 2007). Non-oil sectors, such as agriculture, will have a significant effect in reducing the rate of unemployment.

The majority of oil-exporting countries suffer from long-term high unemployment rate that ranges between 8% and 25% and mostly occurs among the youth and educated population. Therefore, job creation is one of the big challenges of these countries (O'Sullivan et al., 2011). The agricultural sector in these countries remained the major employer. For example, from 2000 to 2014, the agricultural sector in oil-exporting countries absorbed close to 20% of the total employment, which is equal to the worldwide rate of 19%.

Second, in contrast to renewable resources, oil is a depleting resource that will 1 day vanish. Thus, oil-exporting countries have to set long-term strategies to diversify their economies to escape from total oil dependency. Some countries in the GCC concentrate on export diversification by developing service industries, such as banking and tourism (Morakabati et al., 2014). Other oil-exporting countries, such as Algeria, Iran, Malaysia, Indonesia, Egypt, Tunisia, and Nigeria, focus on improving the agricultural sector because they have sufficient agricultural potential, such as land, water, and labor force. Gollin et al. (2002) empirically confirmed that an improvement in agricultural productivity can accelerate and catalyze industrialization and enhance national income per capita. Recently, Diao et al. (2010) concluded that the agricultural sector remains the key sector for economic development in Africa; this conclusion was based on the victory of the Asian green revolution. Finally, oil price instability in the world market dramatically leaves its effect on oil revenue, national income, government budget, government spending, and entire macroeconomic activities for oil exporting economies. Thus, improving the non-oil sectors will contract the severity of oil price fluctuation on their economies.

Policy tools, which are necessary for managing oil revenue and government spending and optimizing resource allocation during and after oil boom periods, differ among oil-exporting countries. Pinto (1987) provided a substantial evidence of contrast in policy and performance between Nigeria and Indonesia during and after the first oil boom. In contrast to Indonesia, Nigeria experienced severe economic problem decades after the first oil boom, which covers severe contraction in its agricultural output and export. For instance, during the oil boom between 1970 and 1982, the annual production of Nigeria's central crops, cocoa, rubber, cotton, and groundnuts decreased by 43%, 29%, 65%, and 64%, respectively, whereas the share of agriculture imports in total imports increased from 3% to 7% from 1960 to 1980. In the case of Indonesia, an improved policy successfully avoided severe interruption in agricultural output. Indonesia's rice production increased by approximately 5% per annum from 1968 to 1984.

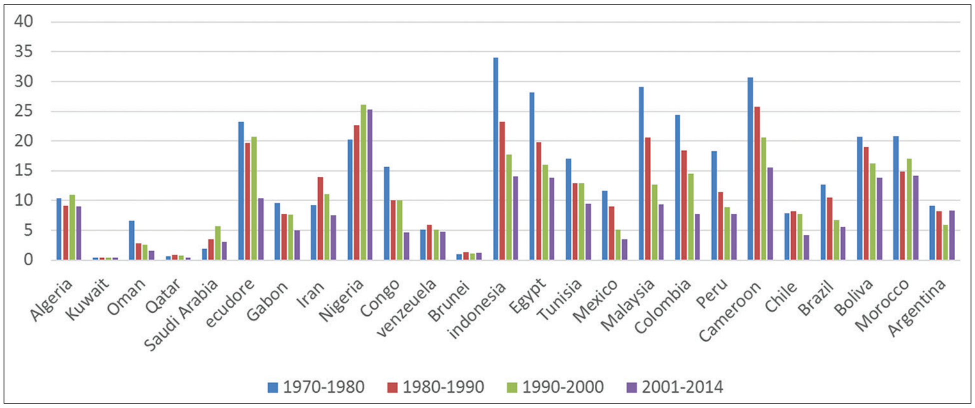
Most oil-exporting countries possess a high potential in agriculture for the various types of agricultural products and they have a long history of farming. The majority of these economies heavily depend on crude oil exporting as their main source of foreign exchange, but the share of agriculture value-added in GDP in minor oil exporting economies (14.45%) is approximately twice higher than the average agricultural shares in GDP (8.3%) of major oil-exporting countries from 1970 to 2014. Furthermore, oil exporting economies lagged behind non-oil economies in terms of share of agriculture in GDP from 1970 to 2014. One possible explanation for the neglect of major oil-exporting economies of the agricultural sector is their high oil production that shaped the total exports and government budgets and spending of their countries.

Heterogeneity exists among oil-exporting countries in terms of the share of agriculture value-added to GDP. Indonesia, Malaysia, Egypt, Ecuador, and Tunisia recorded high levels of agricultural share to GDP (34%, 29%, 28%, 23%, and 17%, respectively, from 1970 to 1980. Nigeria, Algeria, and Saudi Arabia reached their optimal levels at 26%, 10%, and 5%, respectively, from 1990 to 2000. Other oil-exporting states in GCC, Kuwait, Qatar, and Oman displayed marginal agricultural contribution to GDP, as shown in Figure 1.

Dutch disease theory, which was developed by Corden and Neary (1982), can explain and shed light on the relationship between oil revenue and the agricultural sector. The classical Dutch disease theory was proposed for developed oil-exporting countries and concentrated on the industrial sector. The theory revealed an adverse effect of high oil revenue on the output and export of the industrial sector. However, the core model of Dutch disease is not an appropriate theory for developing oil-exporting countries. Thus, based on the core model of Dutch disease, Fardmanesh (1991) argued that agricultural output and export are negatively affected by high oil price during oil boom periods in developing oil-exporting countries. Apergis et al. (2014) investigated the effect of oil rent on agriculture value-added for selected oil-exporting countries to reveal an adverse effect of oil revenue on agriculture value-added.

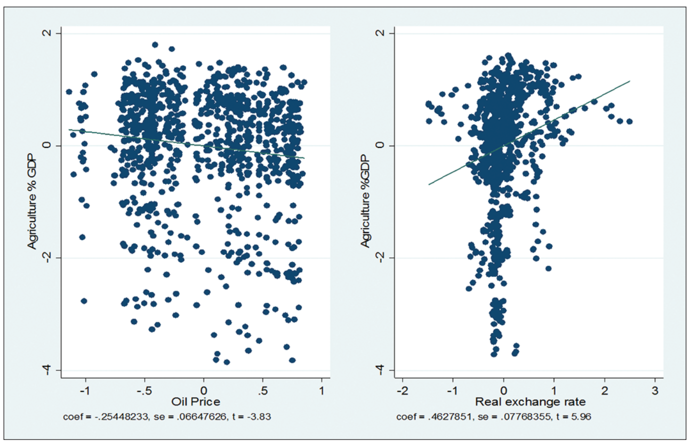
Figure 2 displays a scatter plot between oil revenue and real exchange rate, wherein agriculture value added is indicated as a percentage of GDP from 1970 to 2014. The relationship between oil price and agriculture is negative, whereas the relationship

Figure 1: Agriculture % GDP in the oil exporting countries



Source: World bank 2015

Figure 2: Oil price, real exchange rate and agriculture share of GDP



between real exchange rate and agriculture share of GDP is positive. These preliminary data support Dutch disease theory for oil-exporting countries, which state the adverse effects of oil price on agricultural output.

2. LITERATURE REVIEW ON DUTCH DISEASE AND EFFECT OF OIL PRICE ON AGRICULTURE VALUE ADDED

2.1. Theoretical Review

The term Dutch disease became prominent in the economic and politic literature after the discovery of natural gas in the North Sea in the Netherlands during the 1960s. The adverse effect of natural resources on the manufacturing sector in the Netherlands emerged through the frequent appreciation of real exchange rate. This terminology has been used to explain the negative effect of the boomed sector on other lagged sectors in the economy. Despite this fact, Meade and Russell (1957) published their first work on the effect of recourse boom paradox. However, the influential work of Corden and Neary (1982) was considered the fundamental and core model of Dutch disease theory. In the classical model of Dutch disease, the economy is composed of three sectors, namely, the boomed sector (oil or any other natural resource), producer sector of tradable goods at the international level (such as, agriculture and industrial output), and producer sector of non-tradable goods whose prices are determined by internal demand and supply (service sector or housing market).

A rapid increase of income in the boomed sector or windfall discovery of new resource, which rises in the supply side in an economy, means that the boomed (oil) sector produces only for exports in world markets. Conversely, export is affected by fluctuation in world prices. However, the economy enjoys the increase in price in the world market relative to the price of import. Larsen (2006) cited that Dutch disease is intricately linked to the three effects, namely, resource movement, spending, and spillover loss.

Resource movement effect refers to the reallocation of factors of production, such as labor force and fixed capital, from other sectors and activities to the boomed sector in the economy. The output and production of other sectors will decrease as a result, whereas production in the boomed sector will rise rapidly. If the demand for non-traded goods has a positive elastic income and the boom sector (oil sector) generates extra income in the economy, the beneficiaries would spend part of this income inside the economy.

Hence, the demand for non-tradable goods increases, and real exchange rate appreciates. The rise in the relative price of non-tradable goods increases the relative profitability of non-traded goods sector and contracts the (non-resource) traded goods sectors. This case is an example of spending effect. Additionally, the spillover-loss effect states the loss of positive externalities, which is created from the crowding out effect of non-oil traded goods via the effect of the oil sector.

In the case of developing rich resource countries, authors, such as Benjamin et al. (1989) and Fardmanesh (1991), argue that the spending effect is sufficient to establish the Dutch disease effect. The existence of the Dutch disease in an economy has various outcomes and can be summarized as follows: (i) Production of non-boomed sectors (such as agriculture and industrial sectors) will be lower compared to its initial equilibrium and reduce the exports of tradable goods of these sectors, (ii) the price of factor of production will be affected, which may lead to increase in wages in the boomed sector, (iii) the demand on imported goods will increase; and (iv) saving and investment behavior will change through the increase in marginal propensity to consume on non-tradable goods (Corden and Neary, 1982; Fardmanesh, 1991).

The core model of Dutch disease has been developed and designed for industrially developed countries, wherein the movement of capital among sectors has been highly flexible. However, the situation in developing oil-exporting countries has differed from that of the classical model.

3. DUTCH DISEASE AND DE-AGRICULTURALIZATION IN THE DEVELOPING OIL EXPORTING ECONOMIES

Oil export has dominated oil-rich countries in terms of international trade in the global market. Therfore, oil sector domination has adverse impact on other economic sectors such that major oil-exporting countries are called "island economies." In turn, these economies dub the oil sector as "island sector." The oil sector marginally contributes to employment in the local labor force, and local output factors play a minor role in the oil sector and production. In contrast to developed oil-exporting countries, the boomed (oil) sector in developing oil-exporting countries is insufficiently flexible to allow moving output factor in other sectors. Thus, spending effect in developing oil-exporting countries can appropriately explain Dutch disease, whereas the resource movement effect cannot satisfy the investigation on Dutch disease phenomena (Moradi et al., 2010).

According to Van Wijnbergen (1984), the resource movement effect in developing oil-exporting countries will be ignored due to certain logical factors: (i) The oil sector will not affect production factors because it employs the minority of the local labor force, (ii) the movement of capital and labor (production factors) between the boomed (oil) and other sectors is inflexible in developing oil-exporting countries. In other words, the oil sector is monopolized by governments in developing oil-exporting economies. Consequently, the product factors in the oil sector would not be affected by an oil boom.

Therefore, in contrast to the main model of Dutch disease, the industry sector was positively affected by the oil boom in the 1970s, whereas it contracted the agricultural output and exports during the boom years in the majority of developing oil-exporting countries. Based on main model of Dutch disease (that proposed for developed oil-rich economies), Fardmanesh (1991) provided new methods for developing oil-exporting economies. He suggested that an increase in oil price leads to the de-agriculturalization phenomenon in these economies. Thus, the Dutch disease model for developing oil-exporting economies is considered different from that of developed oil-exporting economies.

3.1. Empirical Reviews

Fardmanesh (1991) expected that least developing oil-exporting countries will face the de-agriculturalization phenomenon instead of de-industrialization after an increase in oil income. Fardmanesh (1991) applied various econometric analyses to examine the effect of oil price increase on agriculture and manufacture in five developing oil-exporting economies, namely, Ecuador, Algeria, Indonesia, Nigeria, and Venezuela. He found that in all cases, except for Venezuela, the oil boom and increase in world oil price contracted the agricultural output and expanded the manufacturing output. This notion is a clear evidence of the de-agriculturalization phenomena in developing oil-exporting countries. Benjamin et al. (1989) gathered similar results in the case of the Cameroon economy. A multi-sector computable general equilibrium model was used to examine the impact of oil wealth on all sectors in the economy. They found contraction in traditional exports (agricultural sector) due to oil boom. This decline in agricultural production was caused by an appreciation in the real exchange rate and oil boom, which leads to expansion in the output of the industrial sector.

Substantial literature explored the existence of the Dutch disease and de-agriculturalization phenomena in the case of Iran and Nigeria. Moradi et al. (2010) applied the error correction model (ECM) to investigate the effect of price fluctuation on the amounts of industrial and agricultural value added in GDP and non-oil GDP for the Iranian economy. A symptom of Dutch disease was found by estimating the negative long-run relationship between oil price and share of agricultural value added in GDP and non-oil GDP. Mehdi and Reza (2011) confirmed the previous results using autoregressive distributed lag (ARDL) and ECM techniques. Results confirmed the existence of co-integration between oil export and agriculture value added. In the long term, a 1% increase in oil export in Iran caused a 13% decrease in agriculture value added.

Lotfalipour and Ahmadi (2014) examined the impact of oil revenue on agriculture value added in the Iranian economy using the vector autoregressive regression VAR and VECM frameworks. The Johansen and Juselius approach revealed a long-run equilibrium relationship among the variables. The study confirmed the existence of Dutch disease and de-agriculturalization, wherein the long-run coefficient of oil revenue was estimated at −1.42. This result denotes that a 1% growth in oil revenue reduces agriculture value added by 1.42%. Bakhtiari and Haghi (2001) explained the various aspects of the oil boom on the agricultural sector and exhibited the corroborative evidence of existence of the Dutch disease and de- agriculturalization phenomena in the Iranian economy.

In the case of Nigeria, Olusi and Olagunju (2005) used quarterly data from 1983 to 2003 and applied the VAR model to investigate the impact of oil export on agricultural output. They examined whether the boomed (oil) sector leads to a slowdown in agricultural production. Results demonstrated that Nigeria is suffering from Dutch disease. Impulse response function analysis exposed the contractionary impact of oil export on agricultural output, whereas the variance decomposition approach implied that crude oil export is one of the central variables responsible for the variation in agricultural production after real GDP. Sekumade (2009) analyzed the effect of oil export and production on five agricultural export commodities. Result of ECM showed that the production of oil palm and groundnut is negatively affected by the amount of crude oil production. This finding means that increased production in crude oil in Nigeria causes less production of cocoa, cotton, and palm oil.

Pei et al., (2013) demonstrated that the Granger causality of oil price on the agricultural sector and its fluctuation influenced the performance of the Malaysian agricultural sector. Ackah (2016) demonstrated the inverse effect of oil rent on agriculture value added for the Ghanaian economy. Auty (2001) argued that Botswana experienced more success than Saudi Arabia in deploying its mineral rents, but this difference may be due to its more stable rent stream rather than to its political state alone. Therefore, Botswana has made more progress than Saudi Arabia in diversifying its economy with non-oil exports, which comprises 1–3rd of the total export in Botswana and 1–5th in Saudi Arabia.

Apergis et al. (2014) investigated the Dutch disease phenomena through the effect of oil rent on agriculture value added in selected Middle East and North African (MENA) countries, namely, Algeria, Egypt, Iran, Kuwait, Morocco, Saudi Arabia, Tunisia, and United Arab Emirates. Results obtained using annual time series data and panel co-integration, long-run panel Granger causality and ECM pointed to a long-run relationship between oil rent and agriculture value added. Furthermore, the negative relationship between both variables implied that the boom in the oil sector reduced the output in the agricultural sectors in these countries. Result of ECM shows a slow rate of short-run adjustment of agriculture value added back to equilibrium after the boom in oil rents.

Nazlioglu (2011) found a unidirectional causality running from world oil price to prices of three key agricultural commodities (corn, soybeans, and wheat) using nonlinear causality. Nazlioglu and Soytas (2012) used panel co-integration and Granger causality methods for a panel of 24 agricultural products. They found a strong evidence of the impact of world oil prices on prices of several agricultural commodities. Their finding contradicts those of many studies in the literature that reported neutrality of agricultural prices to oil price changes.

By contrast, Omgba (2011) and Ammani (2011) claimed that the windfall of oil cannot be held responsible for the fall in the agricultural sector. Omgba (2011) utilized time series data for 1978–2009 and applied the VAR model and Granger causality test. Results of the Johansen co-integration and Granger causality did not reveal co-integration between the growth of oil sector and non-oil sectors. However, Granger positively causes non-oil GDP growth in the short-run oil GDP growth. Therefore, they concluded that the windfall of oil cannot be held responsible for the fall in the non-oil sector, such as the agriculture sector. In addition, the oil boom has a positive effect on the traditional non-oil sector in Cameroon. The explanation for these unique results among developing oil-exporting countries is that the Cameroonian government managed the oil rent efficiently and saved approximately 75% of the total revenue during the oil boom period of the 1980s.

Ammani (2011) used a graphic descriptive statistic and one-way analysis of variance technique to answer the following question: “Was agriculture neglected as a result of the oil boom?” Secondary data on capital expenditure for the agriculture and health sectors, education, water resource, and defense sector were collected before and during the oil boom. Outcome showed that the capital expenditure and budgets allocated for the agricultural sector exceeded those of other sectors during the oil boom. However, the author confirmed that agricultural production in Nigeria cannot be attributed to the neglect of the agricultural sector that resulted from the oil boom.

In summary, studies on Dutch disease and de-agriculturalization in developing oil-producing countries witnessed research outcomes in support of de-agriculturalization. However, a few remain skeptical about the adverse effect of oil revenue on the agricultural sector, especially in the case of Cameroon and Botswana. The main reason for these divergent experiences is the differences in the quality of institutions. The quality of regulation in developing countries, such as the predictability of changes in regulations and anti-corruption policies and transparency and accountability in the public sector and governance, are vital for effective natural resource management and growth (Iimi, 2006; Mehlum et al., 2006).

Previous studies investigated this relationship for a small sample of oil-rich countries. However, the present study aims to examine the relationship between oil price and agriculture value added for a large sample size of oil-exporting countries. In addition, empirical studies neglected important variables, such as exchange rate and arable land, which are theoretically relevant to the agricultural output (Apergis et al., 2014). Therefore, using the panel cointegration technique to examine this relationship is another novelty of this study.

4. DATA AND METHODOLOGY

4.1. Data and Descriptive Statistic

This study aims to investigate the relationship between oil price and the agricultural sector in oil-exporting countries from 1975 to 2014 based on the following long-run equation:

$$AGV_{it} = \alpha_i + \beta_{1i}\, OILP_{it} + \beta_{2i}\, REER_{it} + \beta_{3i}\, ARBL_{it} + \varepsilon_{it} \quad (1)$$

Where $i = 1 \ldots N$ denotes counties and $t = 1 \ldots T$ represents the time period. *AGV* denotes the agricultural share of *GDP*. *OILP* pertains to real oil price, *REER* to real effective exchange rate, and *ARBL* to arable land as a percentage of the total land. α_i stands for country fixed effects; ε_{it} is defined as the residual term.

Different panel unit root and panel cointegration tests and fully modified ordinary least squares (FMOLS) and dynamic OLS (DOLS) are used to expose the relationship between oil price and agriculture value added for 25 developing oil-exporting countries. Data on agriculture value added share of GDP and arable land of total land were obtained from the World Bank Development Indictor. Real oil price was obtained from the U.S Energy Information Administration. REER was derived from Darvas (2012).

Table 1 provides the descriptive statistical result for the 25-developing oil-exporting countries from 1975 to 2014. Results reported that the average agricultural share of GDP is 10.6 with a standard deviation of 7.3. The minimum value is 0.15 for Kuwait, whereas the maximum value reached 38.22 for Nigeria. The average value of arable land stood at 8.62 with a standard deviation of 13.87 because the highest value of arable land (69.40) recorded was for Morocco, whereas the lowest value (0.056) recorded was for Kuwait. The average value of REER is 133 with a large standard error because the minimum value is 27 (Peru), whereas the highest value is 1,373 (Iran). The average real oil price is 56 with a standard deviation of 27.3 because the highest value of real oil price is 109 as recorded in 2011, whereas the lowest value is 17.8, as recorded in 1998.

5. METHODOLOGY

5.1. Panel Unit Root Test

The stationarity of data should be examined using panel unit root test and the order of integration of each variable under study should be determined before applying the cointegration technique. Different panel unit root tests will be applied. Im et al. (2003) (IPS), Levin et al. (2002) (LLC), augmented Dickey–Fuller Fisher Chi-square (ADF-Fisher), and PP Fisher Chi-square (PP-Fisher) tests (Maddala and Wu, 1999) are frequently applied to panel economic analysis. The LLC and IPS unit root tests are presented based on the ADF statistical average across the group. The LLC test assumes that the coefficients are homogenous for all cross-sectional units in the panel. The advantage of the ISP test is that it allows for heterogeneity in the intercept and slope terms for the cross-section units and eliminate serial correlation problems.

The equation below specifies the IPS unit root test for the panel data:

$$y_{it} = \rho_i y_{it-1} + \sum_{j=1}^{p_t} \varphi_{ij} \Delta y_{i,t-j} + z_{it}\gamma + \varepsilon_{it}, \quad (2)$$

Where y_{it} is a vector of variables under study, and p indicates the number of lags that prevent the serial-correlation in the residual (z_{it}) is the vector of deterministic variables in the model, such as fixed effects and individual trend, and γ represents corresponding coefficients.

The null hypothesis states that all series are dynamic or possess unit root H_0: $\rho_i=0$, whereas the alternative hypothesis confers that the series does not have a unit root and becomes stationary if H_1: $\rho_i<0$.

Table 1: Descriptive statistic

Statistics	AGVGDP	ROILP	REER	ARBL
Mean	10.61367	56.19181	133.3744	8.629565
Median	9.107000	53.67270	106.7953	3.149798
Maximum	38.22000	109.6150	1373.856	69.40623
Minimum	0.152968	17.79169	27.08026	0.056117
SD	7.355421	27.34138	95.44952	13.91580
Skewness	0.654315	0.486511	6.234930	3.121600
Kurtosis	2.854319	1.922411	61.27002	12.86857
Observations	985	985	985	985

This alternative test proposes depend on the average of individual unit root test statistics.

$$\bar{t} = 1/N \sum_{i=1}^{N} t_{pt} \quad (3)$$

Where t_{pi} is an individual t statistics.

LLC is a panel-based ADF unit root test, which was proposed by Levin et al. (2002), who assumed that the parameter ρ_i is identical for all cross-sectional units in the panel.

The null hypothesis of the LLC test is H_0: $\rho_1=\rho_2=\rho=0$ for all i against alternative null hypothesis H_0: $\rho_1=\rho_2=\rho<0$ for all i. The test is based on statistics as follows:

$$t_\rho = \hat{\rho} / s.e.\hat{\rho} \quad (4)$$

To test a panel unit root, Breitung (2000) suggested a t-ratio type test statistics. By providing numerical analysis, he argued that his test has excellent power properties within a specific local neighborhood of unity. The Breitung (2000) test differs from the Levin et al. test in two aspects. First, the autoregressive component of the model is removed to generate a standardized process:

$$\Delta Y_{it} = \frac{\Delta Y_{it} - \sum_{k=1}^{pt} \gamma_{ik\Delta Y_{it-k}}}{s_i}$$

$$\hat{Y}_{it-1} = \frac{\Delta Y_{it-1} - \sum_{k=1}^{pt} \gamma_{ik\Delta Y_{it-k}}}{s_i}$$

Second, the proxies are transformed and de-trended:

$$\Delta Y_{it} = \sqrt{\frac{T-t}{T-t+1}} \left[\Delta Y_{it} \frac{\Delta Y_{it} - 1 \ldots\ldots\ldots \Delta Y_{it} - T}{T-t} \right]$$

$$Y_{it} = Y_{it} + V_{it} \quad (5)$$

Where V_{it} is equivalent to 0, Y_{it}, and Y_{it}-(T^{-1} (t−1)Y_{it} if no intercept or trend exists, with intercept no trend, and with intercept and trend, respectively.

Maddala and Wu (1999) proposed a simple panel unit root test on the basis of Fisher (1932). They claim that the Fisher test is better than the ISP and LL tests due to the fact that the Fisher test is simple and straightforward to apply. The test is Chi-square distributed with two degrees of freedom and takes on the following form:

$$\lambda = -2\sum_{i=1}^{N} log_e \ \pi_i \quad (6)$$

Where π_i represents p value in the statistical test in unit i. The p-values are computed from the ADF and PP tests, the null hypothesis is non-stationary against the alternative hypothesis for stationary.

5.1.1. Panel cointegration test

We test for the existence cointegration among variables under investigation. First, we utilize the panel cointegration test, which was proposed by Pedroni (1999; 2004). We then use the residual-based panel cointegration test developed by Kao (1999). The Pedroni panel cointegration test allows for heterogeneous intercepts in trend coefficients across cross-sections.

$$y_{it} = \alpha_i + \delta_t + \beta_{1i} X_{it} + \varepsilon_{it} \quad (7)$$

Where $i = 1 \ldots N$ indicates individual countries, and $t = 1 \ldots T$ is a time period in the study. α_i and δ_t denote countries and time fixed effects, respectively. ε_{it} exposes the estimated residual based on the following structure:

$$\hat{\varepsilon}_{it} = \hat{\rho}_i \hat{\varepsilon}_{it} + \hat{\mu}_{it}$$

Pedroni proposed seven tests for panel data cointegration. Four of the seven statistics are based on pooling or called the "within" dimension, whereas the rest belongs to the "between" dimension. The Pedroni panel cointegration tests within and between dimensions focus on the null hypothesis of no cointegration. However, the difference lies in the specification of the alternative hypothesis. Pedroni tabulated the finite sample distribution for the seven statistics through Monte Carlo simulations. The calculated statistical tests must be smaller than the tabulated critical value to reject the null hypothesis of no cointegration between variables.

The Kao test follows procedures, which are similar to those of the Pedroni test but specifies cross-section specific intercepts and homogeneous coefficients on the first-stage regressors. The null hypothesis in both tests is that residuals are not cointegrated, and the alternative hypothesis is that the residuals are stationary with cointegration between variables.

5.1.2. Panel cointegration estimators, FMOLS, DOLS, and pooled mean group (PMG)

Even though Pedroni cointegration test provides evidence of the existence of cointegration, it cannot present an estimation of the long-run relationship. Thus, several estimators are suggested to estimate the cointegration coefficients in the panel framework. These estimators are FMOLS, DOLS, and PMG. Based on analysis of the properties of OLS, Chen (1999) argued that the FMOLS or DOLS estimator may be a promising approach in cointegrated panel regressions. However, Kao and Chiang (2000) showed that the OLS and FMOLS exhibit small sample bias, and the DOLS estimator appears to outperform both estimators. The present study considers three estimators, namely, FMOLS, DOLS, and PMG, to estimate the effect of oil price on agriculture in developing oil-exporting countries.

5.2. FMOLS and DOLS Estimators

After examining the cointegration test for the model under consideration and the null hypothesis on cointegration is rejected, the next step is estimating the long-run relationship between variables using the FMOLS estimators developed by Pedroni (2000; 2001) and DOLS, which was proposed by Kao and Chiang (2000). If the OLS estimator is utilized in the cointegrated panel, then the results and estimators are likely biased and inconsistent. Hence, we apply the FMOLS and DOLS to estimate the long-run relationship between oil price and the agricultural sector because the FMOLS holds two important advantages. First, FMOLS estimates the consistency parameters in small samples then controls for endogeneity in the regressors and serial correlation.

The following equation shows the relationship between agriculture value added and real oil price, real exchange rate, and arable land in the fixed effects panel regression:

$$lAGV_{it} = \alpha_i + \beta(LOILP)_{it} + \mu_{it} \quad (8)$$

Where $i = 1 \ldots N$ indicates individual countries, and $t = 1 \ldots T$ is a time period in the study. α_i stands for countries' fixed effects. u_{it} is a stationary distributed term. The $(LOILP)_{it}$ vector is assumed to be the integrated process of order one for all i, where

$$LOILP_{it} = LOILP_{it-1} + \varepsilon_{it} \quad (9)$$

As previously discussed, Kao and Chiang (2000) argued that OLS and FMOLS exhibit small sample bias, and the DOLS estimator appears to outperform both estimators. Therefore, DOLS can obtain an unbiased estimator of long-run parameters through a parametric adjustment to the errors by including the past and future values of the differenced I(1) regressors. The following equation provides the DOLS estimator of the effect of oil revenue on agriculture:

$$lAGV_{it} = \alpha_i + \beta(LOILP)_{it} + \sum_{j=q1}^{j=q2} c_{ij} \Delta LOILP_{it+j} + v_{it} \quad (10)$$

Where c_{ij} is the coefficient of lead or lags of first differenced explanatory variables

5.3. PMG Estimators

The PMG estimator which is proposed by Pesaran (1999); is an intermediate that involves pooling and averaging of parameters of the system of equation. PMG is also an intermediate method between the MG methods, which assume heterogeneity of slope and intercept across countries, and DFE methods, which restrict slope coefficients but allow intercepts to differ across countries. The key feature of the PMG estimator is that it allows the short-run coefficients, intercepts, and speed of adjustments to the long-run equilibrium and error variance to differ across countries. However, the long-run slope coefficients remain the same for all countries. Certain prerequisites should be considered in applying PMG estimators. First, the existence of co-integration among variables under study requires that the error correction term coefficient be negative and significant.

The dynamic heterogeneous panel regression can be incorporated into the error-correction model using the ARDL (p, q) technique, where p is the lag of the dependent variable, and q is the lag of the independent variables and stated as follows:

$$\Delta LAGV_{it} = \theta_i LAGV_{it-1} + \beta_1' LOILP_{it} + \beta_2' LREER_{it} + \beta_3' ARBL_{it} \sum_{j=1}^{p-1} \Upsilon_{ij} \Delta LAGV_{i,t-j} + \sum_{j=0}^{q-1} \delta_{ij}' \Delta LOILP_{i,t-j} + \delta_{ij}' \Delta LREER_{i,t-j} + \delta_{ij}' \Delta ARBL_{i,t-j}\, u_i + \varepsilon_{it} \quad (11)$$

Where β is the long-run coefficient of the independent variables, and θ is the parameter of speed adjustment to the long-run equilibrium. u is the fixed effect and ε_{it} is the error term. i represents countries and t symbolizes time index. We assume that the error term ε_{it} in the PMG framework is independently distributed across i and t with zero mean and variance . The error term is also distributed independently of the regressor, namely, x_{it}. Furthermore, to capture the long-run relationship between dependant (y_{it}) and independent (x_{it}) variables, we assume that if $\theta < 0$ for all i, then panel co-integration is formulated as follows:

$$LAGV_{it} = \phi_1\, LOIP_{it} + \phi_2\, LREER_{it} + \phi_2\, ARBL_{it} + \eta_{it} \quad (12)$$

Where $\phi_1 = -\beta_1/\theta_i$, $\phi_2 = -\beta_2/\theta_i$, and $\phi_3 = -\beta_3/\theta_i$ are the long-run coefficients of oil price, exchange rate, and arable land, respectively.

6. RESULTS AND DISCUSSION

6.1. The Unit Root Test

Table 2 illustrates the panel unit root test for 25 developing oil exporting countries using Im et al. (2003) (IPS), Levin et al. (2002) (LLC), Breitung (2000) and Maddala and Wu (1999). Results show that the null hypotheses of unit root cannot reject the panel data for all variables under the level consideration, whereas results show a strong rejection of the null hypotheses of unit root in the first difference. This result strongly indicates that variables are non-stationary in the level and stationary in the first difference, which means that all variables are integrated in the same order. The unit root test indicated the possibility of using cointegration test and fulfilling the requirement of cointegration estimators, such as FMOLS and DOLS to estimate the long-run relationship.

6.2. Panel Cointegration Test

Table 3 shows the outcome of Pedroni's (1999) panel cointegration and Kao's (1999) residual-based panel cointegration test between agriculture value-added, oil price, REER, and arable land for oil-exporting countries. Pedroni's results supported cointegration in intercepts with and without trend for both models. Four of the seven test statistics are statistically significant at the 1%, which highly rejects the null hypothesis of no cointegration among variables. The Kao residual based cointegration test is presented in the lower panel of the table. The test rejects the null hypotheses of no cointegration at 1%. We then estimate the long-run relationship using cointegration regression (FMOLS) proposed by Pedroni (2000; 2001), DOLS, which was developed by Kao and Chiang (2000), and PMG, which is proposed by Pesaran (1999); we applied this approach after rejection of the null hypothesis of no cointegration in the Pedroni and Kao methods.

6.3. Panel Cointegration Estimation

We estimate the long-run relationship between agriculture value added and real oil price, real exchange rate, and arable land in oil-exporting countries using three cointegration estimators, namely, FMOLS, DOLS, and PMG. One crucial advantage of the PMG over FMOLS and DOLS is that it provides different short-run coefficients for each country, whereas long-run coefficients remain same. In addition, the PMG allows for the estimation of the parameters of speed of adjustment of the long-run equilibrium. Table 4 presents the results of FMOLS, DOLS, and PMG.

FMOLS outcome exposes the adverse and highly significant effect of oil price on the agricultural sector in oil-exporting countries. The FMOLS coefficient is −0.23, which means that a 1% increase

Table 2: Panel unit root test

Variable	Intercept				Intercept and trend				
	Level								
	LLC	IPS	ADF-Fisher	PP-Fisher	LLC	Breitung	IPS	ADF-Fisher	PP-Fisher
LAGV	−2.86***	−0.6078	52.767	59.80	−1.691**	−0.6618	−1.1925	69.29**	65.06*
LOILP	1.780	1.513	22.35	21.41	1.3056	−0.402	5.108	7.449	7.157
LREER	−3.55***	−3.22***	84.75***	57.52	−0.0529	−0.9816	−0.4008	55.76	31.93
ARBL	−2.54***	0.3798	56.27	52.16	−0.1588	2.4106	1.036	55.15	34.14
	First differences								
ΔLAGV	−26.6***	−26.8***	597.49***	684.64***	−24.9***	−17.3***	−25.5***	562.56***	991.84***
ΔLOILP	−29.4***	−27.3***	619.65***	619.65***	−27.6***	−23.4***	−25.9***	532.6***	536.6***
ΔLREER	−19.6***	−19.9***	429.49***	441.85***	−17.4***	−13.1***	−17.4***	347.47***	405.48***
ΔARBL	−24.1***	−21.9***	486.18***	536.22***	−21.8***	−13.8***	−19.8***	418.09***	717.75***

***,**,* Rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively

Table 3: Panel cointegration test for full sample of 25 oil exporting countries

Test type	Within dimension (panel				Between dimension (group)		
	V-stat	ρ-stat	PP-stat	ADF-stat	P-stat	PP-stat	ADF-stat
Without trend	0.5104	−0.314	−3.98***	−4.63***	0.669	−5.80***	−6.30***
With trend	−1.010	1.884	−1.91***	−3.52***	−0.0566	−2.78***	−4.09***
Kao residual	−2.818***						

***,**,* Rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively

Table 4: FMOLS, DOLS and PMG estimators

Variables	FMOLS	DOLS	PMG	
			Lon- run Coef	Adjustment Coef
LOILP	−0.23*** (0.000)	−0.20*** (0.000)	−0.12*** (000)	−0.142*** (0.000)
LREER	0.14*** (0.000)	0.11** (0.02)	0.38*** (000)	
Arbl	0.019*** (0.000)	0.018*** (0.007)	−0.009 (0.38)	
ΔLOIP			−0.165*** (0.000)	
R^2 adjusted	0.91	0.93		
S.R of Reg	0.30	0.30		
Obs	960	944		

***,**,* Rejection of null hypothesis at the 1%, 5% and 10% level of significance, respectively, the value in the parentheses are *P* value

in oil price leads to a decrease in agricultural output by 23%. The DOLS coefficient of oil price on agriculture is −0.20 and statistically significant at 1%. Result indicates that a 1% increase in oil price reduces the agricultural output by 20%. However, the PMG estimator shows a negative effect of oil price on agriculture but the coefficient is smaller than those of FMOLS and DOLS at −0.12. These results and finding are parallel to those of Apergis et al. (2014) for MENA oil-exporting countries. They found that a 1% increase in oil revenue causes contraction in the agricultural sector by 25%.

The results of REER are positive and significant in FMOLS and DOLS, with coefficients of 0.14 and 0.11, respectively. Both are statistically significant at the 1% and 5% levels, respectively. Result indicates that an increase (depreciation) in real and effective exchange rate by 1% leads to an increase in agriculture value added by 14% and 11%, respectively. In the case of PMG, the coefficient of real exchange rate is positive and statistically significant but twice higher than those of FMOLS and DOLS at 0.38. These results are consistent with those of the studies on Dutch disease theory (Corden, 1981; 1984; Corden and Neary, 1982; Wijnbergen, 1984), where the authors argued that resource income will harm and slow down the outpour of non-oil sectors in oil-exporting countries through appreciation of real exchange rate. The FMOLS and DOLS estimators show a positive and statistically significant effect of arable land on agricultural output, whereas the PMG estimator shows the opposite.

The PMG estimator allows us to estimate short-run coefficients of explanatory variables and speed adjustments of back to long-run equilibrium. Table 4 shows the negative effect of oil price on agricultural output in the short run. A 1% increase in oil price causes diminishing of agriculture by 16%. The rest of the independent variables, real exchange rate, and arable land are non-significant in the short run. Table 4 also shows the error correction term and speed adjustment coefficient, which are negative and statistically significant at the 1% level. The negative and low coefficient shows a slow rate to adjustment back to equilibrium in the long run.

These findings are consistent with majority of the empirical studies, such Fardmanesh (1991) who argued that oil price increase leads to a decrease in the output of agriculture in developing oil-exporting countries. Current results also agree with those of Mehdi and Reza (2011) for Iran, Apergis et al. (2014) for MENA oil-exporting countries, Pei et al., (2013) for Malaysia, and Olusi and Olagunju (2005) for Nigeria.

7. CONCLUDING REMARKS

Policymakers in oil-exporting countries should understand the relationship between oil price and agriculture sector to diversify the economy and escape from the DD phenomena and rent seeking behavior. This study mainly aims to investigate the long-run relationship between oil price and agriculture value added share of GDP for 25 oil-exporting countries from 1975–2014. Various types of panel unit root test (Im et al., 2003; Levin et al., 2002; Maddala and Wu, 1999; Breitung, 2000) were used to investigate the stationarity and integrated order of the variables.

Pedroni's (1999) heterogeneous cointegration test exposes the long-run relationship among variables under investigation. FMOLS, DOLS and PMG are used to investigate the long-run relationship among variables and suggest the negative and statistically significant long-run relationship between oil price and agriculture value added. FMOLS, DOLS, and PMG estimators suggest that a 1% increase in oil price leads to a decrease in the agricultural share of GDP by approximately 0.23, 0.20, and 0.12, respectively.

These outcomes of heterogeneous cointegration are consistent with those of Dutch disease theory, whereas high oil price leads to contract the export and output of the non-oil tradable sector of oil-exporting countries by the appreciation of real exchange rate. FMOLS, DOLS, and PMG estimators show a positive relationship between real exchange rate and agriculture value added. This result confirms that appreciation of real exchange rate is harmful to the agricultural sectors in oil-dependent countries. Moreover, results may help policy makers in oil-exporting economies to rethink and diversify their economies. In particular, governments in oil-exporting countries should concentrate on long-run policies to escape from Dutch diseases phenomena and oppose rentier behaviors by expanding the output of non-oil sectors, such as agriculture. The agricultural sector will contribute to the diversification of their economies and reduction of the degree of future oil dependency for these countries

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