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Oil boom, exchange rate and sectoral output: An empirical analysis of Dutch disease in oil-rich countries

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ABSTRACT

This paper examines the Dutch disease in a global sample of 36 oil-rich developed and developing countries for the period 1970 to 2016. It also examines the theory comprehensively by considering the two Dutch disease intermediate effects: spending and resource movement. Using panel data fixed effect with Driscoll-Kraay standard errors estimation approach, our results show that an oil boom causes appreciation in the real exchange rate and a fall in sectoral output, which is consistent with the theory. However, there is significant difference in the effects of oil boom on the real exchange rate and sectoral output among sub-regional groupings, possibly because of differences in the extent of institutional quality and economic policy. The implications of these results are that policy makers of countries affected by Dutch disease should improve institutional quality, minimise real exchange rate appreciation and promote domestic investment in the manufacturing and agriculture sectors. These are necessarily conditions to escape the Dutch disease problem, which hinders economic growth and development.

1. Introduction

Dutch disease theory has been identified as one of the key explanations for the resource curse, where countries with an abundance of natural resources experience slower economic growth and development than countries with fewer natural resources (Sachs and Warner, 1995; Frankel, 2012; Badeeb et al., 2017; Stevens et al., 2015). The expression ‘Dutch disease’ was coined in November 1977 in *The Economist* to describe the impact of the discovery of a natural gas field in 1959 on the economy of the Netherlands. It refers to the discovery of the natural gas field having a negative effect on the manufacturing sector following on from exchange rate appreciation, with a negative effect on the economy (Corden and Neary, 1982; Corden, 1984; Apergis and Payne, 2014; Gerard, 2011; Kakanov et al., 2018).

Corden and Neary (1982) concluded that appreciation of the exchange rate and reduction in the productivity of the competitive tradable sector (manufacturing and agriculture) are key symptoms of the Dutch disease phenomenon. This leads to direct and indirect de-industrialisation, which harm the economy, leading to the resource curse (Frankel, 2012; Zubikova, 2018; James and Aadland, 2011; Apergis et al., 2014).

The aim of this paper is to examine two key symptoms of the Dutch disease that have been widely discussed in the literature: spending and the resource movement effects, in a selected panel data sample of 36 oil-rich countries and their sub-regional levels, for the period 1970–2016. More specifically, the paper explores whether an oil boom appreciates the real exchange rate, representing the spending effect. It also examines whether an oil boom deteriorates the competitive tradable sector (manufacturing and agriculture), representing the resource movement effect. It further investigates whether the oil boom increases or decreases the service sector, representing both the spending and the resource movement effects.

This paper contributes to the extant literature on the Dutch disease in three different ways. First, only one study has attempted to examine the Dutch disease phenomenon by using both the spending and the resource movement effects simultaneously (Gasmi and Laourari, 2017). This approach might be the best, as it helps to provide accurate and strong evidence as to whether oil-rich countries are affected by the Dutch disease as a result of a large inflow of oil income. However, Gasmi and Laourari (2017) utilised a case study to explore the phenomenon and also focused on the manufacturing sector as a proxy for the competitive tradable sector. This paper extends their analysis by focusing on a panel data approach. It provides more informative data, more variability, less collinearity among the variables, a greater degree of freedom and more

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efficiency (Baltaji, 2008). It is able to identify and measure effects that are simply not detectable in pure time-series data. We also extend their analysis by examining the Dutch disease impact on the agriculture sector, which is considered as a major economic activity and a significant source of exports in developing countries (Mehdi and Reza, 2012; Abdlaziz et al., 2018). Corden (1984) argued that the competitive tradable sector not only includes manufacturing, but also agriculture, with a possible effect of de-agriculturalisation. We further broaden their work by assessing the Dutch disease impact on the service sector. This is considered as one of the main explanations for the Dutch disease via both spending and resource movement effects, as discussed in the seminal papers of Corden and Neary (1982) and Corden (1984). This also helps to determine whether the service sector is affected by the spending or the resource movement effect of Dutch disease.

Second, this paper conducts comparative analysis of the Dutch disease phenomenon based on regional groupings. This analysis helps to detect which groups of countries experience Dutch disease and provides precise and interesting outcomes. It further helps to understand the differences among regions as well as planning more focused policies to alleviate the Dutch disease problem.

Third, this paper employs panel data fixed effect with Driscoll-Kraay standard errors approach to account for common regression problems such as cross-sectional dependence bias, heteroscedasticity and serial correlation. Gujarati (2012), Baltagi (2008) and Pesaran (2015) argued that neglecting these problems might lead to biased and inefficient OLS estimates. This approach therefore improves the quality of the study's estimates.

Our results provide novel insights into empirical literature of the Dutch disease theory. We find that an oil boom causes appreciation in the real exchange rate and a fall in sectoral outputs: manufacturing, agriculture and service sectors in a global panel data sample of 36 oil-rich developed and developing countries. This is primarily attributed to spending and resource movement effects respectively, as suggested by the seminal paper on the Dutch disease proposed by Corden and Neary (1982). Such results show a clearer and stronger evidence of the Dutch disease, leading to poor economic growth and development. To the best of our knowledge, these findings are new evidence in the literature.

Our results also added new evidence to the literature by understanding significant differences of Dutch disease impacts among sub-regional groupings of oil-rich countries. The results suggest that an oil boom appreciates the real exchange rate in Middle East and North African (MENA), Latin American, European and North American and Sub-Sahara African (SSA) countries, indicting spending effect of the Dutch disease. However, it depreciates the real exchange rate in Asian and Pacific, contrary to the theoretical predictions. The results further show that oil boom is found to have significantly reduced the output of the manufacturing sector in MENA, Latin American and SSA countries, confirming resource movement effect of the Dutch disease theory. In contrast with the theory, our results show that oil boom increases output of manufacturing sector in Asian and Pacific and European and North American, challenging the theoretical argument of Corden and Neary (1982), who suggest that Dutch disease affects both developed and developing countries.

Other results also support the presence of the Dutch disease. Oil booms have significantly deteriorated the output of the agriculture sector for all sub-regional groups of oil-rich countries, with the exception of Latin American countries. Oil booms have caused a fall in the output of the service sector in all the sub-regional groups, except in Asian and Pacific countries.

The remainder of the paper is organised as follows. Section 2 examines selected current literature. Section 3 presents the econometric approach used for analysis. Section 4 presents the empirical results and discussion, and finally the conclusion and policy implications are outlined in section 5.

2. Literature review

Corden and Neary (1982) proposed the Dutch disease theory to describe the reduction in the Netherland manufacturing sector following discovery large gas deposits in the North Sea. They argued that the Dutch disease affects the economy through two main channels: resource movement effect and spending effect.

Resource movement effect: arises when there is a boom in the oil sector resulting from technological progress, a windfall discovery of new oil resources and a rise in world oil prices. All of this boosts the profitability of the oil sector. Higher profits increase the demand for labour in the oil sector and also push wages up, which motivate labour from the lagging sector (manufacturing and agriculture) and the non-tradable sector (service) to move into the oil boom sector. Such movement leads to a fall in labour and output in the lagging and the non-tradable sectors, which adversely affects the economy. This is known as 'direct de-industrialisation'.

Spending effect: occurs when an additional income obtained from the oil boom sector increases demand and spending on the non-tradable sector (service). This pushes up prices and increases output in the service sector. Higher income also increases the demand for imports. This leads to a reduction in the outputs of the lagging sector (manufacturing and agriculture). Higher prices in the non-tradable sector relative to the tradable sectors also generate appreciation of the domestic currency. The increased outputs in the service sector due to the spending effect also causes further movement of labour from manufacturing and agriculture into the service sector. This scenario has been called *indirect de-industrialisations*, leading to poor growth.

Since then, several studies have extended the Dutch disease argument. For instance, Morshed and Turnovsky (2004) developed a dynamic model, with assumptions of adjustment costs in investment and capital allowed to move among tradable and non-tradable sectors. The model suggested that an increase in the relative prices in the service sector causes an expansion in the output of the sector alongside a contraction of the manufacturing sector. However, Buiter and Purvis (1983) showed that an oil boom responds positively to the manufacturing sector in the long-run in countries with a net oil exporter. They argued that Dutch disease is only a transitional phenomenon. Several studies have also addressed the problem of 'learning by doing' in relation to the subject of the Dutch disease (Van Wijnbergen, 1984; Krugman, 1987; Sachs and Warner, 1995; Gylfason et al., 1999). They believe that the economic gain from learning by doing only arises from the manufacturing sector; a fall in the sector indicates lower productivity, and thus an adverse effect on economic growth. Torvik (2001) suggested that learning by doing is present in more than one sector, as well as concluding that production and productivity in both the service and manufacturing sectors can increase or decrease. This depends on the features of the economy. Auty (1994) stated that an oil boom weakens the subsidies used to support the competitive manufacturing sector, which severely worsens the Dutch disease problem, leading to unsustainability in the sector.

Studies of the Dutch disease show mixed support for the theory. For instance, Apergis et al. (2014) examined the impact of oil rents on the agriculture sector in panel data of eight MENA countries (Algeria, Egypt, Iran, Kuwait, Morocco, Saudi Arabia, Tunisia and United Arab Emirates) from 1970 to 2011, employing the GMM approach. Their results showed that oil rents negatively affect the agriculture sector, confirming the resource movement effect of the Dutch disease. They concluded that it would be important to assess social and private benefits of the traded sector to determine if there is a net benefit or a net loss of this Dutch disease phenomenon in these countries. In countries where there is a net benefit at the expense of the lower agriculture sector, policy interventions might not be needed. Conversely, in countries where there is a net loss policy, intervention is certainly needed. Abdlaziz et al. (2018) also investigated the effect of oil price on the agriculture sector in a panel data sample of 25 oil-rich developing countries for the period

1975–2014. Using fully modified ordinary least squares (FM-OLS), dynamic OLS and pool mean group (PMG) approaches, their findings showed that oil prices are associated with a reduction in the agriculture sector, supporting the resource movement effect of the Dutch disease hypothesis. They argued that oil-rich developing countries neglect the agriculture sector due to oil wealth shaping the total exports, government budgets and spending of these countries.

Focusing on the manufacturing sector, Ismail (2010) examined the impact of an oil windfall on the manufacturing sector in 90 developed and developing countries, including 15 oil exporting, for the period 1977–2004, using the panel data fixed effect (FE) approach in the analysis. The analysis showed that an oil price boom negatively affects the output of the manufacturing sector, suggesting the resource movement effect of the Dutch disease. The negative effect is stronger in countries with more capital markets open to foreign investment. This is due to the outflow of investment in the manufacturing sector following a decline in marginal return on capital, resulting from a shift of labour to the non-tradable sector. Omolade and Ngalawa (2014) studied the impact of oil revenue on manufacturing sector growth in a panel data sample of six African oil-exporting countries (Algeria, Cameroon, Egypt, Sudan, Gabon and Nigeria) for the period 1970–2010, using fixed effect and GMM approaches. Their findings showed that oil revenue has a significant negative effect on the manufacturing sector, suggesting the resource movement effect of the Dutch disease. They argued that the manufacturing sector can only be protected from an oil boom if the sector is capital intensive.

Using a large panel data sample of 100 countries, including oil-rich and non-oil-rich, Smith (2014) provided strong evidence against the Dutch disease by showing that an oil boom is positively associated with the manufacturing sector and it increases the output, wages, productivity and investment of the manufacturing sector. However, the analysis provided strong evidence supporting the Dutch disease by showing the negative effect of an oil boom on the agriculture sector.

With regard to exchange rate, Amin and El-Sakka (2016) studied the relationship between the real oil price and real exchange rate in a panel data sample of oil-rich countries of the Gulf Cooperation Council (GCC) for the period 1980–2012. Using the vector error correction model (VECM) for their regression analysis, their outcomes showed that oil price causes appreciation in the real exchange rate, implying the spending effect of the Dutch disease. They concluded that the appreciation of the real exchange rate discourages exports of the competitive tradable sectors, leading to poor growth. Jahan-Parvar and Mohammadi (2011) applied the autoregressive distributed lag (ARDL) method to examine the Dutch disease hypothesis by assessing the impact of real oil price on the real exchange rate, using panel data for a sample of 14 oil-exporting developed and developing countries for the period 1970–2007. Their estimation results showed that real oil price appreciates the real exchange rate in the long-term, providing strong evidence for the spending effect of the Dutch disease. In developing countries, Al-Mulali and Che Sab (2012) studied the impact of real oil price on the real exchange rate in 12 oil-rich developing countries (Algeria, Bahrain, Egypt, Indonesia, Kuwait, Nigeria, Oman, Qatar, Saudi Arabia, Sudan, United Arab Emirates and Venezuela) from 2000 to 2010. They employed the random effect approach in their analysis. Their results showed that real oil price appreciates the real exchange rate, implying the spending effect of the Dutch disease. They argued that a rise in the world oil price generates a higher country income deriving from oil exports. This higher income encourages spending in the non-tradable sector, leading to higher prices in the sector and therefore appreciating the real exchange rate.

3. The econometric model, data and estimation procedure

First, this paper examines the spending effect channel of the Dutch disease by assessing the impact of an oil boom on the real exchange rate in order to identify whether an oil boom appreciates the real exchange rate.

The empirical model of the real exchange rate is as follows:

$$\text{In}(\text{RER})_{it} = \beta_0 + \beta_1 \text{In}(\text{OIL})_{it} + \beta_2 \text{In}(\text{GFCF})_{it} + \beta_3 \text{In}(\text{GE})_{it} + \beta_4 \text{In}(\text{TOPEN})_{it} + \beta_5 \text{FDI}_{it} + \beta_6 \text{GDPG}_{it} + \alpha_i + \mu_{it} \tag{1}$$

where In(*RER*) is the log of the real exchange rate measured as follows:

$$RER = \frac{E\ X\ P}{P^*} \tag{2}$$

where *E* is the nominal exchange rate, expressed as the amount of local currency relative to US dollars, *P* is domestic GDP deflator in US dollars (2010 as a base year) used as a proxy for the local price level, and *P** is US GDP deflator (2010 as a base year) used as a proxy for foreign price level. An increase in the real exchange rate (*RER*) implies appreciation. We employ this measurement due to the accessibility of data for a long time-series. This measurement was also commonly used in previous studies (see, for instance, Gomes, 2016; Taylor and Taylor, 2004; Amin and El-Sakka, 2016; Griffoli et al., 2015).

Concerning the explanatory variables, In*(OILR)* is the log of oil production in million barrels per year and real oil revenue in millions of US dollars, which are used as a proxy for oil boom sector. In*(GFCF)* is the log of the gross fixed capital formation share of GDP, which represents investment. In*(GE)* refers to the log of government expenditure share of GDP, In*(TOPEN)* is the log of trade openness, measured by imports and exports share of GDP. *FDI* represents foreign direct investment share of GDP, *GDPG* is annual percentage GDP growth, i represents country, t is time, α is a country fixed effect capturing all time-invariant, which helps to deal with the omitted variables bias problem, and *u* is the error term.

Second, this paper investigates the resource movement effect of the Dutch disease by estimating the oil boom impacts on three measurements of the sectoral outputs, manufacturing, service and agriculture sectors respectively. Such estimations seek to prove evidence of the Dutch disease from equation (1).

The empirical models of sectoral output are as follows:

$$\text{In}(\text{MAN})_{it} = \beta_0 + \beta_1 \text{In}(\text{OIL})_{it} + \beta_2 \text{In}(\text{GFCF})_{it} + \beta_3 \text{In}(\text{GE})_{it} + \beta_4 \text{In}(\text{TOPEN})_{it} + \beta_5 \text{FDI}_{it} + \beta_6 \text{In}(\text{RGDP})_{it} + \alpha_i + \mu_{it} \tag{3}$$

$$\text{In}(\text{SVC})_{it} = \beta_0 + \beta_1 \text{In}(\text{OIL})_{it} + \beta_2 \text{In}(\text{GFCF})_{it} + \beta_3 \text{In}(\text{GE})_{it} + \beta_4 \text{In}(\text{TOPEN})_{it} + \beta_5 \text{FDI}_{it} + \beta_6 \text{In}(\text{RGDP})_{it} + \alpha_i + \mu_{it} \tag{4}$$

$$\text{In}(\text{AGR})_{it} = \beta_0 + \beta_1 \text{In}(\text{OIL})_{it} + \beta_2 \text{In}(\text{GFCF})_{it} + \beta_3 \text{In}(\text{GE})_{it} + \beta_4 \text{In}(\text{TOPEN})_{it} + \beta_5 \text{FDI}_{it} + \beta_6 \text{In}(\text{RGDP})_{it} + \alpha_i + \mu_{it} \tag{5}$$

Regarding the dependent variables, In*(MAN)* is the log of the manufacturing sector share of GDP, In*(SVC)* is the log of the service sector share of GDP, In*(AGR)* is the log of the agriculture sector share of GDP. The explanatory variables are stated as those under equation (1), with exceptional In(*RGDP*), which is the log of the real GDP at 2010 constant prices.

This paper employs a panel data sample of 36 oil-rich developed and developing countries for the period 1970–2016 to estimate the above Dutch disease models. The panel data is also split into regional groupings (12 Middle Eastern and North African (MENA) countries, 8 Asian and Pacific countries, 6 Latin American countries, 6 European and North American countries and 4 Sub-Saharan African (SSA) countries), enabling us to understand which countries experience the Dutch disease problem. A list of the countries included in the study is presented in Appendix A.

All data for this study was obtained from the United Nations Conference on Trade and Development (UNCTAD) except oil production and real oil revenue, which were sourced from the British Petroleum (BP). A more detailed data description and list of sources is presented in Appendices A and B respectively.

This paper conducts several diagnostic tests to carefully choose the proper estimation approaches. First, this paper applies the modified Wald test for group-wise to check for the heteroscedasticity problem in the data involved in the analysis. Second, we apply the Wooldridge test to investigate whether the data used for this study experiences a serial correlation problem. Third, this paper follows Pesaran's (2004) cross-sectional dependence (CD) test to check for the contemporaneous correlation across countries. The cross-sectional dependence arises due to spatial effects, common oil price shocks, interactions within socio-economic networks and omitted common effects (Pesaran, 2004, 2015). It is argued that ignoring these tests may result in biased OLS estimates (Gujarati, 2012; Baltagi, 2008; Pesaran, 2015).

The CD test is based on an average of pair-wise correlation coefficient of the OLS residuals from the countries' regressions in the panel (Pesaran, 2004). The equation of the CD test can be expressed as follows:

$$\mathrm{CD} = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N} = \sum_{j=i+1}^{N-1}\sqrt{T_{ij}}\ \widehat{p}_{i\,j}\right) \tag{6}$$

N and T denote to cross section and a time dimension respectively. $\widehat{p}_{i\,j}$ refers to the pair-wise cross-sectional coefficient of the residuals between i[th] and j[th] cross-sectional units. Specifically:

$$\widehat{p}_{ij} = \widehat{p}_{ji} = \frac{\sum_{t=1}^{T} \ell_{it}\ell_{jt}}{\left(\sum_{T=1}^{T}\ell_{it}^{2}\right)^{1/2}\left(\sum_{T=1}^{T}\ell_{jt}^{2}\right)^{1/2}} \tag{7}$$

where ℓ_{it} is the ordinary least squares (OLS). The null hypothesis of the CD test is that there is no cross-sectional dependence against an alternative cross-sectional dependence among countries.

Finally, this study applies the panel data fixed effect with Driscoll-Kraay standard errors approach developed by Driscoll and Kraay (1998) and extended by Hoechle (2007) due to the predicted presence of heteroscedasticity, serial correlation and cross-sectional dependence problems in the data used for this study. This approach is highly effective at dealing with all these problems simultaneously and effectively.

The approach is estimated in two steps. The first step is to transform the dependent and explanatory variables $Z_{it} \in \{y_{it}, x_{it}\}$ as follows:

$$\widetilde{Z}_{it} = z_{it} - \overline{z}_i + \overline{Z} \quad \text{where} \quad \overline{Z}\mathrm{i} \sum_{t=t_{i1}}^{T_i} z_{it} \quad \text{and}\ \overline{Z} = \left(\sum T_i\right)^{-1} \sum\sum z_{it} \tag{8}$$

The second step then estimates the transformed model:

$$\widetilde{y}_{it} = \widetilde{x}_{it}^{\prime}\beta + \widetilde{\varepsilon}_{it} \tag{9}$$

4. Empirical results and discussion

4.1. Heteroscedasticity, serial correlation and cross-sectional dependency test results

Before estimating the empirical models, we check the results of the diagnostic tests for variables studied. We start by checking for heteroscedasticity problem using the modified Wald test for group-wise. The results of the test show that the null hypothesis of homoscedastic ($\sigma_i^2 = \sigma^2$) is rejected at a 1% level for all models, as shown in Table 1. This indicates the presence of a heteroscedasticity problem in data used for analysis. In Table 2, the Wooldridge test results also indicate that the null hypothesis of no first order serial correlation is rejected at a 1% level for all models. This suggests that serial correlation among errors is present in data involved in the analysis. As presented Table 3, the CD test results are statistically significant at a 1% for all variables employed in this study, suggesting that variables considered for analysis experience a cross-sectional dependence problem. The highest CD statistic is recorded for real GDP (148.97), while the lowest is reported for government expenditure (15.87).

The existence of heteroscedasticity, serial correlation and cross-sectional dependence problems suggests the application of the panel data fixed effect regression with Driscoll-Kraay standard errors (1998), which is very effective in dealing with all of these simultaneously and effectively (Hoechle, 2007; Mangır and Kabaklarlı, 2016; Mehmood and Mustafa, 2014; Driscoll and Kraay, 1998).

Table 1
Modified wald test results for heteroscedasticity (1970–2016).

H0: sigma (i)ˆ2 = sigmaˆ2 for all i			
Exchange rate model	Agriculture sector model	Manufacturing sector model	Service sector model
Chi2 = 4.5e+05 Prob > chi2 = 0.0000	Chi2 = 13329.50 Prob > chi2 = 0.0000	Chi2 = 15881.122 Prob > chi2 = 0.0000	Chi2 = 17662.71 Prob > chi2 = 0.0000

Table 2
Wooldridge test results for serial correlation (1970–2016).

H0: sigma (i)ˆ2 = sigmaˆ2 for all i			
Exchange rate model	Agriculture sector model	Manufacturing sector model	Service sector model
F test = 2121.235	F test = 159.851	F test = 18.560	F test = 51.535
Prob > F = 0.0000	Prob > F = 0.0000	Prob > F = 0.0001	Prob > F = 0.0000

Table 3
Pesaran's CD test results (1970–2016).

Variables	CD-test	Average correlation
Log RER	**107.41*****	0.651
Log SVC	**48.65*****	0.459
Log AGR	**67.92*****	0.546
Log MAN	**19.43*****	0.499
Log OILPR	**41.43*****	0.442
Log ROILRV	**129.43*****	0.754
Log GFCF	**18.24*****	0.301
Log GE	**15.87*****	0.397
Log TOPEN	**52.03*****	0.410
FDI	**35.29*****	0.269
GDPG	**18.86*****	0.188
Log Real GDP	**148.97*****	0.866

Note: *** refers to the level of statistically significant at a 1% level.

Table 4
Fixed effect estimation with driscoll and kraay standard errors dependent variable: Log of the real exchange rate (1970–2016).

Variables	(1)	(2)
Log OILPR	**1.282**[a] (0.294)	
Log GFCF	**−1.231**[a] (0.446)	**−1.551**[a] (0.463)
Log GE	**0.768**** (0.349)	**0.875**** (0.347)
Log TOPEN	**2.156**[a] (0.511)	**1.918**[a] (0.497)
FDI	**0.126**[a] (0.044)	**0.148**[a] (0.047)
GDPG	0.013 (0.016)	0.018 (0.016)
Log ROILRV		**0.891**[a] (0.170)
Constant	−13.86[a] (1.678)	−13.56[a] (1.633)
Observations	1652	1652
Number of countries	36	36

Driscoll and Kraay standard errors in parentheses.
[a] p<0.01, **p<0.05, *p<0.1.

4.2. Estimation results of panel data fixed effect (full sample)

4.2.1. Oil boom and the real exchange rate analysis (spending effect)

Table 4 shows estimation results for the real exchange rate equation (1) at the full sample of oil-rich developed and developing countries, with the oil boom sector proxied by *OILPR* and *ROILRV*. Columns (1) and (2) show that oil boom has a significant positive effect on the real exchange rate. These results indicate that the oil boom sector causes appreciation in the real exchange, confirming the spending effect channel of the Dutch disease (Corden and Neary, 1982; Corden, 1984). Therefore, a rise in income as a result of oil boom leads to a greater demand for the service sector. This increases the local prices of the non-tradable (service) sector relative to tradable sectors and therefore appreciates the local currency, which discourages exports of the competitive tradable sector (manufacturing and agriculture), leading to poor growth. These results are consistent with empirical findings (Jahan-Parvar and Mohammadi, 2011; Gomes, 2016; Smith, 2014), showing that an oil boom appreciates the real exchange rate in a global panel data sample of oil-rich developed and developing countries.

However, appreciation of the real exchange rate may not provide strong evidence to support the Dutch disease phenomenon. As Abeysinghe and Yeok (1998) and Kandil (2015) suggested, appreciation of the real exchange rate might lower import prices in relation to production, such as advanced technology and equipment, which helps to boost local production and therefore economic growth and development. Given these arguments, the second set of models are employed to assess the impact of an oil boom sector on sectoral output in the next section. This assessment represents the resource movement effect channel of the Dutch disease, which may provide additional, clearer and stronger proof as to whether oil-rich countries are affected by the Dutch disease.

Concerning the other explanatory variables, the coefficients of *GFCF* are negative and statistically significant, indicating a depreciation in the real exchange rate. On the other hand, the coefficients of *GE*, *TOPEN* and *FDI* are positive and statistically significant, implying that an increase in these variables causes an appreciation of the real exchange rate. The effect of *GDPG* on the real exchange rate is a positive but statistically insignificant.

4.2.2. Oil boom and sectoral output analysis (resource movement effect)

In the previous section, we found that oil boom appreciated the real exchange rate. This provides compelling evidence of the Dutch disease phenomenon. This section attempts to outline further evidence of the phenomenon by analysing the impact of the oil boom sector on sectoral output. This analysis may support the real exchange outcomes and provide better evidence as to whether oil-rich countries experience the Dutch disease problem. To achieve this, this paper investigates the impact of oil boom on three main sectors – manufacturing, agriculture and service – as proposed by the seminal papers on the Dutch disease (Corden and Neary, 1982; Corden, 1984).

Columns (1) to (6) of Table 5 show the impact of the oil boom on sectoral output at the full countries sample of oil-rich developed and developing countries. The results show that the relationship between oil boom (*OILPR* and *ROILRV*) and sectoral output (manufacturing, agriculture and service sectors) is a negative and statistically significant. These results imply that there has been a movement of employment from sectoral output to the oil boom sector, leading to a fall in employment and productivity of sectoral output, which adversely affects the economy. The results confirm the resource movement effect of the Dutch disease. The results are also consistent with the findings of Ismail (2010), who found that an oil boom causes a fall in productivity in the manufacturing sector in a panel data sample of 90 oil-rich developed and developing countries. They are further consistent with the findings of Smith (2014), who found that an oil boom reduces the output of the agriculture sector in a panel data sample of 100 oil-rich developed and developing countries.

It can be concluded that appreciation of the real exchange rate and fall in sectoral output provide strong and clear evidence of the Dutch disease phenomenon through spending and resource movement effects respectively, therefore suggesting the existence of the resource curse, leading to poor economic growth.

Regarding the other control variables, the coefficients of *GFCF* are positive and statistically significant, as shown in columns (3) and (6) for the service sector and (4) for the manufacturing sector. These results support endogenous and exogenous economic growth theories. Arrow (1971), Bakari and Mabrouki (2017) and Romer (1986) argued that domestic investment in sectoral output results in a positive technological spill-over effect, job creation and poverty reduction, as well stimulating technological progress and innovation, which plays a very significant role in increasing productivity and therefore growth. On the other hand, the coefficients of *GFCF* are statistically insignificant for the agriculture sector.

GE has a significant positive effect on the agriculture sector, as reported in columns (2) and (5), and also on the service sector, as indicated

Table 5
Fixed effect estimation with driscoll and kraay standard errors dependent variable: Log of sectoral outputs % of GDP (1970–2016).

Variables	Log Manufacturing sector % of GDP	Log Agriculture sector % of GDP	Log Service sector % of GDP	Log Manufacturing sector % of GDP	Log Agriculture sector % of GDP	Log Service sector % of GDP
	(1)	(2)	(3)	(4)	(5)	(6)
Log OILPR	**−0.115**[a] (0.014)	**−0.107**[a] (0.018)	**−0.014*** (0.008)			
Log GFCF	0.065 (0.048)	0.005 (0.049)	**0.130**[a] (0.026)	**0.097**** (0.047)	0.037 (0.044)	**0.137**[a] (0.024)
Log GE	0.041 (0.043)	**0.231**[a] (0.041)	**0.353**[a] (0.023)	0.041 (0.045)	**0.232**[a] (0.039)	**0.355**[a] (0.021)
Log TOPEN	**−0.188**** (0.076)	**−0.158**[a] (0.057)	**−0.136**[a] (0.035)	**−0.154*** (0.078)	**−0.117**** (0.054)	**−0.115**[a] (0.035)
FDI	**−0.004*** (0.002)	0.004 (0.003)	−0.001 (0.002)	**−0.007**** (0.002)	0.001 (0.003)	−0.002 (0.002)
Log Real GDP	**0.160**[a] (0.059)	**−0.398**[a] (0.032)	**0.170**[a] (0.018)	**0.205**[a] (0.060)	**−0.341**[a] (0.024)	**0.202**[a] (0.017)
Log OILRV				**−0.116**[a] (0.018)	**−0.124**[a] (0.021)	**−0.042**[a] (0.013)
Constant	1.629[a] (0.526)	6.916[a] (0.299)	1.095[a] (0.185)	1.317** (0.596)	6.543[a] (0.337)	0.914[a] (0.157)
Observations	1663	1663	1633	1663	1633	1633
Number of countries	36	36	36	36	36	36

Driscoll and Kraay standard errors in parentheses.
[a] p<0.01, **p<0.05, *p<0.1.

in columns (3) and (6). These results support Keynesian economic theory, implying that an increase in government expenditure on the agriculture sector is considered the most successful policy for reducing poverty and hunger, improving agricultural productivity and enhancing sustainable development (Wielechowski, 2019; Keynes, 1937; Solow, 1956). For the service sector, increased government expenditure on socioeconomics and physical infrastructure supports economic growth. For example, government expenditure on health and education supports human knowledge and increases the productivity of labour, which improves the productivity of the economy (Mehrara et al., 2013; Nwosa and Tijani, 2020). The impact of the *GE* manufacturing sector is statistically insignificant.

Unexpectedly, *TOPEN* is significantly negatively related to all sectoral output, as indicated in columns (1) to (6). A possible justification for these findings is that appreciation of the real exchange rate resulting from the Dutch disease decreases the exports and increases the imports of the three sectors (manufacturing, agriculture and service), leading to a trade deficit problem (Corden and Neary, 1982; Corden, 1984).

The impact of *FDI* on sectoral output is statistically insignificant in all the columns, except columns (1) and (4) for the manufacturing sector, which show a significant negative effect. These results support the argument of Aitken and Harrison (1999) that FDI may negatively affect domestic output. They suggested that foreign firms tend to be more competitive than local firms because of their lower marginal costs, forcing local firms to reduce their production.

As expected, the coefficients of real GDP are positive and statistically significant, as presented in columns (1) and (4) for the manufacturing sector and in columns (3) and (6) for the service sector. These results support the argument of Corden and Neary (1982), Corden (1984) and Smith (2014) that an oil boom generates high income, resulting in higher demand for both manufacturing and service sector goods, and thus confirming the spending effect of the Dutch disease. On the other hand, they are negative and statistically significant as reported in columns (2) and (5) for the agriculture sector. There are several possible explanations for these results. Johnston and Mellor (1961) and Martin and Warr (1990) argued that the income elasticity of demand for the agricultural sector, especially food, is lower than 1% and therefore the productivity of the agriculture sector will fall when incomes increase. They also argued that as economic growth rises, the output of the agriculture sector falls relative to the service and manufacturing sectors. This is because of a movement of labour from the agriculture sector to the manufacturing or service sector during the period of growth.

4.3. Estimates for various regional groupings

This section repeats the previous regressions by dividing the full panel into regional groupings of oil-rich developed and developing countries (12 MEAN countries, 6 Asian and Pacific countries, 8 Latin American countries, 6 European and North American countries and 4 Sub-Sahara African countries) to identify the heterogeneity across the results.

4.3.1. Oil boom and the real exchange rate analysis (spending effect)

Table 6 shows estimation results for the real exchange rate model across different sub-regional groups of oil-rich developed and developing countries. The results present that oil boom has a positive and significant effect on the real exchange rate, as shown in columns (1) and (6) for MENA countries, (2) and (7) for Latin American countries, (4) and (9) for European and North American countries and (5) and (10) for SSA countries. These results suggest that an oil boom appreciates the real exchange rate, supporting the spending effect channel of the Dutch disease. The results also show that the coefficients of oil boom are higher in SSA countries than MEAN, Latin American and European and North American countries, implying that the spending effect of the Dutch disease is more problematic in SSA countries than other regional groups. Similar outcomes have been found by Amin and El-Sakka (2016) for MENA countries, Koranchelian (2005) for Algeria, Gelbard and Nagayasu (1999) for Angola, Suleiman and Muhammad (2011) and Osuji (2015) for Nigeria, Zalduendo (2006) for Venezuela, Ross (1986) for the UK, Beine et al. (2012) for Canada, and Bergvall (2004) and Bjørnland and Thorsrud (2016) for Norway.

In contrast, we document a negative and significant effect of *OILPR* on the real exchange rate in Asian and Pacific countries, as presented in column (3), suggesting a deprecation in the real exchange rate. This result contrasts with the spending effect of the Dutch disease. This finding might be driven by the fact that Indonesia depreciates its domestic currency compared to the rest of the region to enhance exports of the non-oil tradable sector (see Appendix 4C1). Saxena (2002) and Siregar (1999) argued that the Indonesian government depreciates its domestic exchange rate relative to other currency in order to enhance

Table 6
Fixed effect estimation with driscoll and kraay standard errors for regional groups dependent variable: Log of the real exchange rate (1970–2016).

	MENA	Latin America	Asia and Pacific	Europe and North America	SSA	MENA	Latin America	Asia and Pacific	Europe and North America	SSA
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log OILPR	**1.010**[a] (0.262)	**3.252**[a] (0.952)	**−0.389**[a] (0.071)	**0.071**[a] (0.008)	**4.827**[a] (0.826)					
Log GFCF	**−1.034**[a] (0.257)	**−8.691**[a] (1.081)	**0.307*** (0.154)	**−0.691**[a] (0.101)	1.754 (1.099)	**−1.481**[a] (0.225)	**−9.286**[a] (1.267)	**0.293*** (0.156)	**−0.785**[a] (0.107)	1.113 (1.230)
Log GE	0.276 (0.217)	**3.328**[a] (1.049)	−0.341 (0.274)	0.370 (0.255)	**−1.265** (1.079)	**0.460*** (0.231)	**4.418**[a] (1.114)	−0.272 (0.294)	0.240 (0.278)	−0.658 (1.414)
Log TOPEN	**−0.806**** (0.346)	**2.907*** (1.489)	**1.167**[a] (0.095)	0.119 (0.099)	1.373 (1.550)	**−1.313**[a] (0.354)	**2.649**** (1.143)	**0.792**[a] (0.070)	0.019 (0.100)	2.939 (1.923)
FDI	**0.117**** (0.045)	**0.824**[a] (0.157)	−0.010 (0.009)	0.005 (0.005)	0.026 (0.070)	0.065 (0.040)	**0.993**[a] (0.148)	−0.011 (0.008)	0.007 (0.004)	0.058 (0.067)
GDPG	0.004 (0.006)	−0.017 (0.083)	**−0.015*** (0.008)	**−0.012*** (0.007)	0.061 (0.038)	**0.010*** (0.005)	−0.034 (0.081)	**−0.014*** (0.007)	−0.009 (0.006)	**0.084*** (0.043)
Log ROILRV						**1.034**[a] (0.161)	**1.755**[a] (0.389)	0.042 (0.037)	**0.061**[a] (0.008)	**2.658**[a] (0.453)
Constant	0.835 (2.168)	**−13.78**[a] (4.972)	−0.255 (0.806)	0.486 (1.034)	**−30.66**[a] (9.145)	−0.242 (1.700)	**−13.02**** (5.169)	**−1.411*** (0.726)	1.354 (1.121)	**−36.57**[a] (11.40)
Observations	534	375	272	278	184	534	375	272	278	184
Number of countries	12	8	6	6	4	12	8	6	6	4

Driscoll and Kraay standard errors in parentheses.
[a] $p<0.01$, ** $p<0.05$, * $p<0.1$.

competition, increase the growth of the capital market, encourage inflow of FDI, and to maintain its competitive domestic products in the global markets. Such economic reforms enhance economic growth and development.

For other control variables, as presented in columns (3) and (8) for Asian and Pacific countries, the coefficients of *GFCF* are positive and statistically significant at a 10% level, indicating appreciation in the real exchange rate. In contrast, they are negative and statistically significant in columns (1) and (6) for MEAN countries, (2) and (7) for Latin American countries, (4) and (9) for European and North American countries. These results suggest the depreciation of the real exchange rate. The coefficients of *GFCF* are positive while statistically insignificant in SSA countries as indicted in columns (5) and (10).

The relationship between *GE* and the real exchange rate is a positive and statistically significant, as indicated in columns (6) for MENA countries and (2) and (7) for Latin American countries, showing appreciation in the real exchange rate. Similar results were previously noted by Carrera and Restout (2008), who found that government expenditure appreciates the real exchange rate in Latin America. In contrast, the relationship is a negative and statistically significant in column (5) for SSA countries, supporting deprecation in the real exchange rate. The relationship is statistically insignificant for Asian and Pacific countries and European and North American countries.

It appears from columns (2) and (7) for Latin American countries and (3) and (8) for Asian and Pacific countries that *TOPEN* is positively and significantly associated with the real exchange rate, confirming the appreciation of the real exchange rate. The coefficients of *TOPEN* are negative and statistically significant in MENA countries as reported in columns (1) and (6), implying depreciation. The coefficients of *TOPEN* are statistically insignificant in European and North American countries and SSA countries.

The coefficients of *FDI* are positive and statistically significant in columns (1) for MENA countries and (2) and (7) for Latin American countries, suggesting appreciation in the real exchange rate. The coefficients of *FDI* are statistically insignificant for the remaining subsamples.

Columns (6) and (10) for MENA and SSA countries respectively show that *GDPG* has a significant positive effect on the real exchange rate, supporting appreciation in the real exchange rate. Conversely, this has a significant negative effect in columns (3) and (8) for Asian and Pacific and (4) for European and North American countries, implying deprecation in the real exchange rate.

4.3.2. *Oil boom and sectoral output analysis (resource movement effect)*

4.3.2.1. Oil boom and manufacturing sector analysis. Table 7 shows the impact of the oil boom on the manufacturing sector across sub-regional groups of oil-rich developed and developing countries. We document a significant negative effect of the oil boom on the manufacturing sector in columns (2) and (7) for Latin American countries, (5) and (10) for SSA countries and (6) for MENA countries. These results confirm the resources movement effect of the Dutch disease. Interestingly, the effect is much higher in MENA and SSA countries than in Latin American countries, suggesting that both areas are more affected by the resource movement effect of the Dutch disease. Similar findings were obtained by Chekouri et al. (2013) and Gasmi and Laourari (2017) with regard to Algeria, and Omolade and Ngalawa (2014) for Africa, where a negative relationship was observed between the oil sector and the manufacturing sector.

For MENA and SSA countries, Arezki and Nabli (2012), Bhorat et al. (2017) and Omolade and Ngalawa (2014) suggested that investment in human and physical capital is very poor in these countries, and not of a magnitude and quality to reduce the depletion of oil resources and promote exports from the competitive manufacturing tradable sector. High reliance on oil wealth, civil war and persistent corruption delay the development of the manufacturing sector in these countries. In the case of Latin American countries, Vaz and Baer (2014) argued that appreciation of the real exchange rate threatens the manufacturing sector, which has been built up since the mid-twentieth century. This causes the output of the manufacturing sector to become less competitive in the international markets by increasing imports of foreign manufactured goods, which tend to be cheaper but a challenge to local manufacturing goods.

Appreciation of the real exchange rate (see Table 6) and a fall in output of the manufacturing sector in these countries are key characteristics of the Dutch disease problem due to spending and resource movement effects respectively, thereby adversely affecting economic growth and development.

Conversely, *OILPR* is significantly positively associated with the manufacturing sector, as shown in columns (3) for Asian and Pacific

Table 7
Fixed effect estimation with driscoll and kraay standard errors for regional groups dependent variable: Log manufacturing sector % of GDP (1970–2016).

	MENA	Latin America	Asia and Pacific	Europe and North America	SSA	MENA	Latin America	Asia and Pacific	Europe and North America	SSA
Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log OILPR	−0.004 (0.104)	**−0.103**** (0.049)	**0.086**** (0.032)	**0.025**[a] (0.009)	**−0.459**[a] (0.033)					
Log GFCF	0.071 (0.117)	0.076 (0.077)	**0.307**[a] (0.069)	0.103 (0.075)	0.003 (0.049)	0.203 (0.123)	0.112 (0.071)	**0.305**[a] (0.076)	0.060 (0.085)	0.052 (0.066)
Log GE	**0.364**[a] (0.102)	**−0.242**[a] (0.043)	**−0.770**[a] (0.132)	**−0.407**** (0.153)	**0.165**** (0.063)	**0.280**[a] (0.102)	**−0.273**[a] (0.036)	**−0.777**[a] (0.143)	**−0.363**** (0.157)	0.046 (0.065)
Log TOPEN	−0.077 (0.168)	0.058 (0.043)	**−0.177**[a] (0.058)	**0.090*** (0.045)	−0.061 (0.094)	0.056 (0.172)	0.066 (0.046)	**−0.115*** (0.057)	0.060 (0.048)	**−0.214*** (0.120)
FDI	0.000 (0.016)	0.002 (0.006)	0.001 (0.002)	0.001 (0.004)	**−0.009**[a] (0.002)	−0.000 (0.015)	−0.004 (0.007)	0.000 (0.002)	0.002 (0.005)	**−0.011**[a] (0.002)
Log Real GDP	**0.335**[a] (0.083)	**−0.165**[a] (0.033)	0.011 (0.043)	**−0.652**[a] (0.054)	**0.308**[a] (0.064)	**0.527**[a] (0.082)	**−0.133**[a] (0.042)	0.029 (0.047)	**−0.615**[a] (0.046)	0.176 (0.125)
Log ROILRV						**−0.240**[a] (0.046)	**−0.069**** (0.028)	−0.013 (0.026)	0.004 (0.004)	**−0.225**[a] (0.042)
Constant	**−2.658**[a] (0.844)	**5.607**[a] (0.401)	**4.044**[a] (0.425)	**12.26**[a] (1.192)	0.765 (0.649)	**−3.213**[a] (0.911)	**5.281**[a] (0.526)	**4.198**[a] (0.481)	**11.96**[a] (1.150)	**2.639**** (1.237)
Observations	550	376	273	279	185	550	376	273	279	185
Number of countries	12	8	6	6	4	12	8	6	6	4

Driscoll and Kraay standard errors in parentheses.
[a] p<0.01, **p<0.05, *p<0.1.

countries and (4) for European and North American countries. These results suggest that an oil boom increases investment in the manufacturing sector, which results in higher productivity following increased wages and employment in the sector. This discourages labour from moving from the manufacturing sector to the oil boom sector, which is inconsistent with the Dutch disease effect. The positive coefficient of the *OILPR* in Asian and Pacific countries might be driven by Indonesia and Malaysia. This is consistent with the argument of Usui (1997), who suggested that an oil boom can be a blessing in developing countries. He also confirmed that Indonesia avoided the Dutch disease problem during and after the oil boom of the 1970s by accumulating budget surpluses, which were spent on the manufacturing sector in order to strengthen its output. The country also opened the economy to trade, enhanced investment in the manufacturing tradable sector and liberated the financial sector (Hill, 1996; Cole and Slade, 1998). For Malaysia, Gale (1981) and Sander et al. (2013) mentioned that government revenue from oil wealth supported the economy by enabling it to achieve structural transformation and economic diversification, thereby enhancing economic growth. It is indeed investing the wealth of natural resources into productive capital assets, including infrastructure, machinery, human capital and institutions that is key to promoting economic diversification towards exporting the manufacturing sector.

The coefficients of *GFCF* are positive and statistically significant in columns (3) and (8) for Asian and Pacific. These results are consistent with endogenous and exogenous economic growth theories. They are also positive but statistically insignificant for MENA countries, Latin American countries, European and North American countries and SSA countries.

The coefficients of *GE* are positive and statistically significant, as indicated in columns (1) and (6) for MENA countries and (5) for SSA countries. These results support Keynesian economic growth theory. In contrast, the coefficients are negative and statistically significant for the remaining sub-samples. The adverse effect might be due to the crowded-out hypothesis. Barro (1991), Mehrara et al. (2013) and Diamond (1989) suggested that increased government spending, which can be financially supported by taxes or debt, deters private investment and reduces income because of higher income taxes. This crowds out private investment in the manufacturing sector, thereby harming economic growth. Şen and Kaya (2014) also suggested that an increase in government spending can lead to a fall in savings and thus an increase in the interest rates to balance the reduction of savings, again deterring private investment in the manufacturing sector and thereby making it less profitable.

TOPEN is positively and significantly linked to the manufacturing sector, as indicated in column (4) only for European and North American countries. This result reinforces the argument of trade liberalisation. It suggests that trade openness enhances the productivity of the manufacturing sector and therefore economic growth by transferring technology, expanding the economy size, attracting foreign direct investment, exploiting comparative advantages, establishing new businesses and increasing economies of scale (Chang et al., 2009; Levine and Renelt, 1992; Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991; Rodriguez and Rodrik, 2000). However, the coefficients of *TOPEN* are negative and statistically significant, as reported in columns (3) and (8), for Asian and Pacific countries and (10) for SSA countries. These results might be attributed to appreciation of the real exchange rate resulting from the spending effect of the Dutch disease, making exports of domestic products more expensive relative to global markets. This adversely affects exports and therefore economic growth.

The relationship between *FDI* and the manufacturing sector is observed to be negative and statistically significant in columns (5) and (10) for SSA countries. These results suggest that *FDI* may not inflow into the manufacturing sector, which results in a decline in the sector. One plausible explanation for the adverse impact of *FDI* is that foreign firms are likely to be more competitive than local firms because their marginal costs are very low (Aitken and Harrison, 1999). This forces domestic firms to reduce their output. *FDI* has no significant effect on the manufacturing sector in the remaining sub-samples.

Columns (1) and (6) for MENA countries and (5) for SSA countries show that real GDP has a positive effect on the manufacturing sector, suggesting that the higher income resulting from an oil boom increases spending on manufacturing goods. This supports the spending effect of the Dutch disease theory. However, this has a negative effect in columns (2) and (7) for Latin American countries and in (4) and (9) for European and North American countries, challenging the argument of the spending effect of the Dutch disease. The coefficients of real GDP are statistically insignificant for Asian and Pacific countries.

4.3.2.2. Oil boom and agriculture sector analysis. The results of the effect of an oil boom on the agriculture sector across sub-regional groups of oil-rich developed and developing countries are summarised in Table 8. The results show that the coefficients of the oil boom sector are negative and statistically significant, as reported in columns (4) for European and North American countries, (6) for MENA countries, (8) for Asian and Pacific countries and (10) for SSA countries. These results support the resource movement effect of the Dutch disease. The coefficients in MENA and SSA countries are higher than in Asian and Pacific and European and North American countries. This suggests that the resource movement effect of the Dutch disease is more problematic in MENA and SSA countries. Similar outcomes have been found by Olusi and Olagunju (2005) for Nigeria, Chekouri et al. (2013) for Algeria, Apergis et al. (2014) for MENA countries, Rudd (1996) for Indonesia, and Heeks (1998) for Brunei, who found a significant negative effect of an oil boom on the agriculture sector.

Contrary to the Dutch disease hypothesis, an oil boom shows a positive and significant impact on the agriculture sector in Latin American countries, as indicated in columns (2) and (7). These results suggest that the agriculture sector plays a very significant and positive role in Latin American economies, leading to more rapid economic growth. The outcomes might be driven by outlier observations of Ecuador (see Appendices 4C2 and 4C3), which has developed its agriculture sector compared to the rest of the region by implementing effective policies to ensure the agriculture sector benefits from oil wealth. For example, the oil sector funds institutions for marketing, storage, research, long-term irrigation and rural development schemes. It also finances banks to provide credit for agriculture (Ruff, 1984). Ahmed et al, (2015) highlighted that the Ecuadorian government reduces dependency on exports of the natural resources sector by undertaking a national economic diversification program through developing greater value products in the agriculture sector.

With regard to the other explanatory variables, the coefficients of *GFCF* are positive and statistically significant, as seen in columns (2) for Latin American and (3) and (8) for Asian and Pacific countries, which are consistent with endogenous and exogenous economic growth theories. In contrast, they are negative and statistically significant, as indicted in columns (1) and (6) for MENA countries and (5) and (10) for SSA countries. These results might be due to the fact that MENA countries experience a difficult environment for agriculture investment (OECD, 2018; Gehem et al., 2015). Land and water are limited. Rainfed and irrigated land are subject to continuing degradation due to wind and water erosion, in addition to unsustainable farming practices. There is also a lack of land productivity, local food markets and higher quality education. SSA countries are unable to meet the standards for a successful agricultural revolution and output of the agriculture sector is slowed down relative to the rest of the world (Diao et al., 2010). This is due to poor institutional quality and investment environment, including a lack of capital and government financial support, high levels of taxation and civil war. Such environments have a negative impact on investment in the agriculture sector (Collier, 2003; Ellis, 2005; Maxwell and Slater, 2003). The coefficients of *GFCF* are positive although statistically insignificant in European and North American countries.

Table 8
Fixed effect estimation with driscoll and kraay standard errors for regional groups dependent variable: Log agriculture sector % of GDP (1970–2016).

Variables	MENA	Latin America	Asia and Pacific	Europe and North America	SSA	MENA	Latin America	Asia and Pacific	Europe and North America	SSA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
OILPR	0.0938 (0.060)	0.074[a] (0.016)	−0.014 (0.024)	−0.030** (0.015)	−0.378[a] (0.076)					
GFCF	−0.291[a] (0.070)	0.175* (0.099)	0.309[a] (0.048)	0.016 (0.190)	−0.378[a] (0.076)	−0.160** (0.068)	0.145 (0.107)	0.306[a] (0.050)	0.060 (0.183)	−0.293[a] (0.074)
GE	0.587[a] (0.079)	0.028 (0.068)	0.432[a] (0.117)	−0.537** (0.216)	0.072 (0.101)	0.475[a] (0.072)	0.047 (0.066)	0.442[a] (0.113)	−0.514** (0.213)	0.064 (0.083)
TOPEN	−0.143 (0.124)	0.196[a] (0.062)	−0.150[a] (0.045)	−0.400[a] (0.136)	−0.004 (0.123)	−0.003 (0.094)	0.186[a] (0.065)	−0.135[a] (0.037)	−0.358[a] (0.132)	−0.048 (0.099)
FDI	0.013 (0.013)	0.010 (0.012)	0.005* (0.002)	−0.006 (0.009)	0.000 (0.004)	0.010 (0.012)	0.016 (0.013)	0.004 (0.003)	−0.007 (0.009)	−0.003 (0.004)
Real GDP	−0.370[a] (0.041)	−1.011[a] (0.059)	−0.436[a] (0.024)	−0.934[a] (0.106)	−0.099 (0.099)	−0.152[a] (0.046)	−1.044[a] (0.075)	−0.418[a] (0.024)	−0.951[a] (0.103)	0.069 (0.121)
ROILRV						−0.219[a] (0.049)	0.057** (0.024)	−0.042[a] (0.013)	−0.018 (0.014)	−0.292[a] (0.047)
Constant	4.740[a] (0.718)	12.29[a] (0.722)	6.040[a] (0.449)	17.12[a] (2.143)	5.895[a] (1.237)	4.338[a] (0.702)	12.63[a] (0.886)	6.064[a] (0.389)	16.99[a] (1.962)	5.198[a] (1.241)
Observations	550	376	273	279	185	550	376	273	279	185
Number of countries	12	8	6	6	4	12	8	6	6	4

Driscoll and Kraay standard errors in parentheses.
[a] p<0.01, **p<0.05, *p<0.1.

GE appears to have a positive and statistically significant relationship with the agriculture sector, as illustrated in columns (1) and (6) for MENA countries and (3) and (8) for Asian and Pacific countries, thereby confirming Keynesian economic growth theory. However, *GE* appears to have a negative and statistically significant relationship with the agriculture sector, as indicated in columns (4) and (9) for European and North American countries. This result might be due to the crowding effect of private investment. *GE* has an insignificant impact on the agriculture sector in SSA countries.

The coefficients of *TOPEN* are positive and statistically significant in columns (2) and (8) for Latin American countries, affirming the argument of trade liberalisation, as discussed in the previous section. In contrast, they are negative and statistically significant in columns (3) and (7) for Asian and Pacific countries, and (4) and (8) for European and North American countries, suggesting that some countries in the sample are net importers for the agriculture sector, which causes a deficit trade balance (Anowor et al., 2013). The coefficients are statistically insignificant for both MENA and SSA countries.

The coefficient of *FDI* is only statistically significant with a positive sign in column (3) for Asian and Pacific countries. This finding is consistent with the argument of Adenaeuer (2007): a flow of *FDI* into the agriculture sector significantly increases economic growth by encouraging rural development, dealing with food security and reducing poverty. *FDI* helps to bring in technology, generate job opportunities, increase productivity and integrate developing countries into the world marketplace (Gaonkar, 2019).

The coefficients of real GDP are negative and statistically significant for all regions except SSA countries, which is consistent with the argument presented in the main results.

Table 9
Fixed effect estimation with driscoll and kraay standard errors for regional groups dependent variable: Log service sector % of GDP (1970–2016).

Variables	MENA	Latin America	Asia and Pacific	Europe and North America	SSA	MENA	Latin America	Asia and Pacific	Europe and North America	SSA
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
OILPR	−0.006 (0.044)	0.024* (0.013)	0.028 (0.033)	−0.000 (0.002)	−0.183[a] (0.023)					
GFCF	0.107** (0.041)	−0.123[a] (0.036)	0.344[a] (0.040)	−0.152[a] (0.033)	−0.045 (0.047)	0.167[a] (0.039)	−0.109[a] (0.036)	0.340[a] (0.038)	−0.514** (0.213)	−0.018 (0.058)
GE	0.419[a] (0.031)	0.151[a] (0.024)	0.554[a] (0.065)	0.189[a] (0.050)	0.173[a] (0.061)	0.382[a] (0.018)	0.174[a] (0.025)	0.561[a] (0.059)	0.219[a] (0.051)	0.136* (0.069)
TOPEN	−0.206** (0.079)	−0.068[a] (0.025)	0.006 (0.040)	0.024 (0.020)	−0.241[a] (0.052)	−0.146* (0.076)	−0.050** (0.023)	0.052 (0.041)	0.027 (0.019)	−0.293[a] (0.059)
FDI	5.160 (0.006)	0.010** (0.004)	−0.000 (0.002)	−0.000 (0.001)	−0.004 (0.003)	−0.000 (0.005)	0.009** (0.004)	−0.001 (0.002)	−0.000 (0.001)	−0.006 (0.003)
Real GDP	0.131[a] (0.023)	0.067** (0.025)	0.110[a] (0.023)	0.159[a] (0.018)	0.263[a] (0.050)	0.218[a] (0.015)	0.107[a] (0.027)	0.135[a] (0.021)	0.169[a] (0.017)	0.248[a] (0.085)
ROILRV						−0.111[a] (0.018)	−0.016 (0.011)	−0.048[a] (0.011)	−0.005* (0.002)	−0.111[a] (0.032)
Constant	1.671[a] (0.297)	3.272[a] (0.242)	−0.371* (0.193)	1.787[a] (0.274)	2.646[a] (0.690)	1.411[a] (0.242)	2.897[a] (0.262)	−0.271 (0.161)	1.598[a] (0.288)	3.103[a] (0.958)
Observations	550	376	273	279	185	550	376	273	279	185
Number of countries	12	8	6	6	4	12	8	6	6	4

Driscoll and Kraay standard errors in parentheses.
[a] p<0.01, **p<0.05, *p<0.1.

4.3.2.3. Oil boom and service sector analysis. Table 9 shows the impact of the oil boom on the service sector across sub-regional groups of oil-rich developed and developing countries. The empirical results show that *OILPR* has a negative and significant effect on the service sector, as seen in column (6) for MENA countries, (8) for Asian and Pacific countries, (9) for European and North American and (10) for SSA countries. These results suggest that labour has moved to the oil boom sector, which supports the resource movement effect of the Dutch disease. On the other hand, *OILPR* has a significant positive influence on the service sector, as illustrated in column (2), for Latin American countries. This implies that labour has moved from the manufacturing to the service sector, confirming the spending effect of the Dutch disease.

In columns (1) and (6) for MENA countries and (3) and (8) for Asian and Pacific countries, the estimated coefficients of *GFCF* show a positive and significant effect on the service sector. These results support the argument of Corden (1984) that an increase of domestic investment in the service sector leads to increased prices in the sector. This results in appreciation of the real exchange rate, implying the spending effect of the Dutch disease. In columns (2) and (7) for Latin American countries and (4) and (9) for European and North American countries, however, the coefficients of *GFCF* negative are statistically significant, contradicting the spending effect argument of the Dutch disease.

As shown in columns (1) and (6) for MENA countries, (2) and (7) for Latin American countries and (5) and (10) for SSA countries, the coefficients of *TOPEN* are negative and statistically significant. This might be attributed to appreciation of the real exchange rate, resulting from Dutch disease effect, hampering exports of service sector. Conversely, they are positive but statistically insignificant for Asian and Pacific and European and North American countries.

The relationship between *FDI* and the service sector is a positive and statistically significant at a 5% level, as indicated in columns (2) and (6), for Latin American countries. These results support the argument of Te Velde (2003) that Latin American economies have attracted foreign investors in the service sector by liberalising both their trade and investment regimes, utilising lower labour costs and privatising the public sector. However, the relationship is negative and statistically insignificant for the remaining study sample.

Coefficients of *GE* and real GDP are positive and statistically significant in columns (1) to (8) for all regions. Expansion of both variables implies more spending on service sector resulting from higher income, which derived from oil wealth, leading to spending effect of the Dutch disease.

5. Conclusions and policy implications

This paper examines the Dutch disease phenomenon in a global panel data sample of 36 oil-rich developed and developing countries divided into sub-regional groupings (MENA, Latin American, Asian and Pacific, European and North American and SSA countries). The phenomenon is examined via both spending and resource movement effects. This helps to provide a clearer picture of whether these countries experience the Dutch disease. In the empirical literature, very few studies have simultaneously examined the two effects. We also employ panel data fixed effect with Driscoll-Kraay standard errors to simultaneously and effectively solve the presence of regression property problems: cross-sectional dependence, serial correlation and heteroscedasticity. This improves the quality of the study's estimates.

The empirical results show that an oil boom appreciates the real exchange rate in oil-rich countries as a whole and in other sub-samples at a regional level, including MENA, Latin American, European and North American and SSA countries, confirming the spending effect of the Dutch disease. These results suggest that the appreciation of the real exchange rate makes exports of sectoral outputs more expensive for other countries, thereby adversely affecting the economy.

The empirical results also show that an oil boom causes a fall in productivity in the manufacturing sector in oil-rich countries as a whole and in other sub-samples at the regional level, including MENA, Latin American and SSA countries. We further find that an oil boom significantly harms the productivity of the agriculture sector in oil-rich countries as a whole and in other sub-samples at the regional level, including MENA, Asian and Pacific, European and North American and SSA countries. For the service sector, an oil boom leads to a reduction in the sector in oil-rich countries as a whole for MENA, Asian and Pacific, European and North American and SSA countries. These results suggest the movement of employment from the manufacturing, agriculture and service sectors to the oil boom sector, resulting in a fall in productivity in sectoral output and therefore economic growth, thereby confirming the resource movement effect of the Dutch disease. Appreciation of the real exchange rate and a fall in sectoral output are two key characteristics of the Dutch disease phenomenon due to spending and resource movement effects respectively, leading to poor economic growth and development.

The policy implications drawn from the results are that oil-rich countries that experience appreciation of the real exchange rate need to depreciate their currency by sterilising the inflow of foreign exchange and investing some of the oil revenues from abroad by establishing sovereign wealth funds (SWFs). This might help to reduce the spending effect channel of the Dutch disease (Stevens et al., 2015). Oil-rich countries that experience a reduction in the productivity of the manufacturing and agriculture sectors also need to attract FDI into both sectors by lowering the cost of doing business, developing their institutional quality by reducing corruption and rent-seeking activities and making the rule of law more effective, as well as enhancing labour productivity by increasing investment in education and health. This will lead to an efficient utilisation of oil wealth for economic activities and promote economic diversification away from the oil sector, which leads to sustainable economic growth and development.

The empirical results of this study show that domestic and foreign investments have a significant negative impact on sectoral outputs in oil-rich developing countries. These results reflect weakness of domestic investment due to several reasons: civil war, poor institutional quality, lack of appropriate infrastructure, and government support. FDI also seems to focus on the oil sector instead of non-oil sectors. Based on the results, government of these countries need to focus on improving technological development and infrastructure, including investing heavily in electricity, water and sewage treatment, transport and modern telecommunication systems. All of this reduces the cost of doing business, which creates a favourable environment for domestic and foreign investments in the non-oil sector such as manufacturing and agriculture. This can boost investments in both sectors, providing more job opportunities, result in higher growth and productivity in the sectors and, ultimately enhancing economic growth and development. Moreover, governments of these countries should foster domestic and foreign investments by providing incentives for investors such as tax cuts, subsidies and maintaining an appropriate real exchange rate. These efforts must be amalgamated with more openness to global trade, which is considered as a significant factor in driving domestic and foreign investments and therefore enhancing economic growth.

Author statement

Marwan Alssadek: Conceptualization, Methodology, Writing – original draft, Software, Data curation, Visualization, Formal analysis, Investigation. **James Benhin**: Supervision, Conceptualization, Methodology, Review & editing, Visualization.

Declaration of competing interest

None.

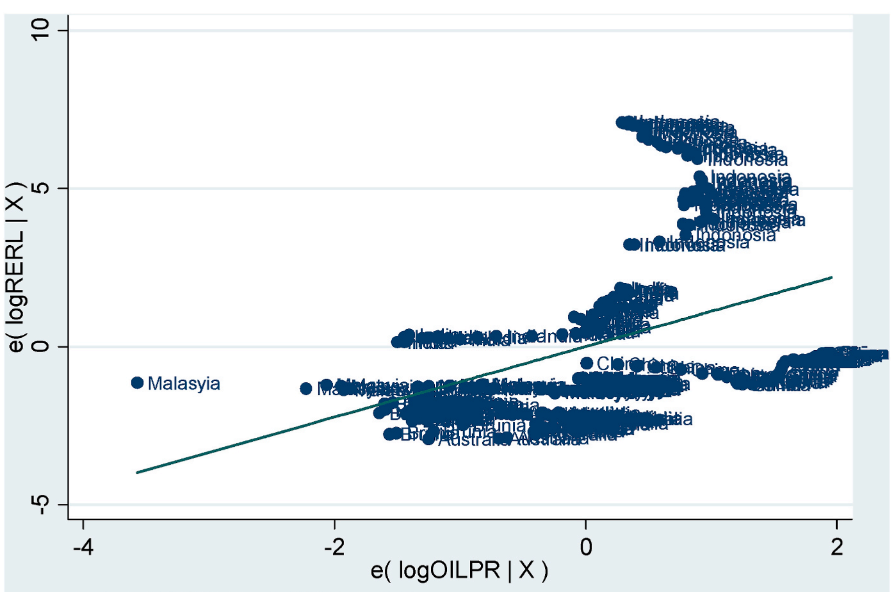
Appendix A. List of Countries Included in the Sample

Europe and North America	MENA	Asia and Pacific	Latin America	Sub-Sahara Africa
Canada	Algeria	Australia	Argentina	Angola
Denmark	Egypt	Brunei	Brazil	Congo Republic
Italy	Iran	China	Colombia	Gabon
Norway	Iraq	India	Ecuador	Nigeria
United Kingdom	Kuwait	Indonesia	Mexico	
United Sates	Libya	Malaysia	Peru	
	Oman		Trinidad and Tobago	
	Qatar		Venezuela	
	Saudi Arabia			
	Syria			
	Tunisia			
	United Arab Emeritus			

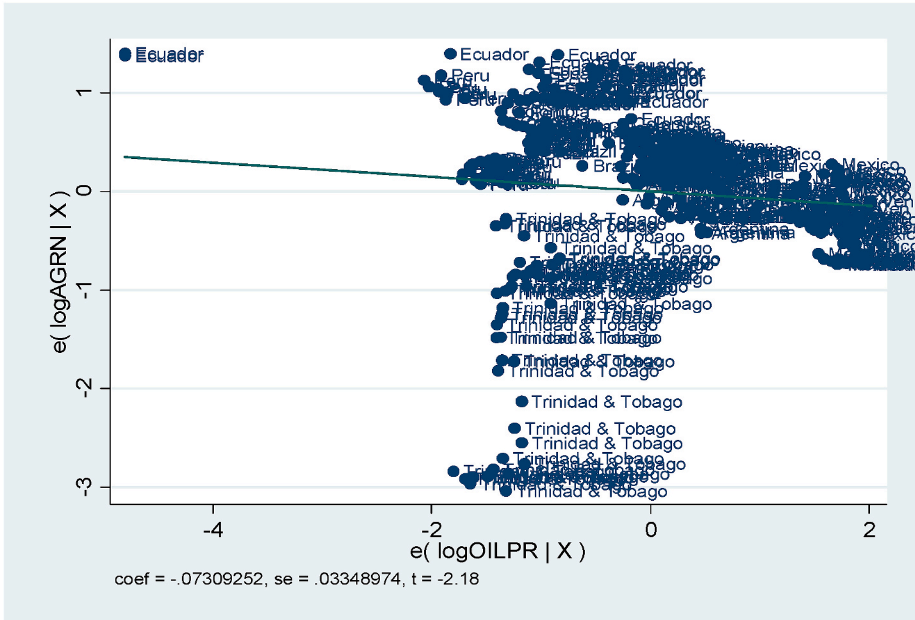
Appendix B. List of Variables Definition and Data Sources

Variables	Definitions	Sources
RER	Real exchange rate is measured by nominal exchange rate (the local currency price of a foreign currency) multiplied by the local price level divided by the foreign price level.	United Nations and author's calculation
OIL	Oil production is measured by million barrels per year	The British Petroleum
	Real oil revenue is measured by oil production multiplied by the real oil price. The real oil price is deflated by CPI.	The British Petroleum and author's calculation
MAN	Manufacturing sector share of GDP	UNCTAD
AGR	Agriculture, hunting, forestry and fishing share of GDP	UNCTAD
SVC	Service (wholesale, retail trade, restaurant, hotel, transport, storage and communication) share of GDP	UNCTAD
GFCF	Gross fixed capital formation share of GDP	UNCTAD
GE	Government expenditure share of GDP	UNCTAD
TOPEN	Trade openness – imports and exports share of GDP	UNCTAD
FDI	Foreign direct investment share of GDP	UNCTAD
RGDPG	Real GDP growth % annual growth	UNCTAD
RGDP	Real GDP (constant 2010 US dollars)	UNCTAD

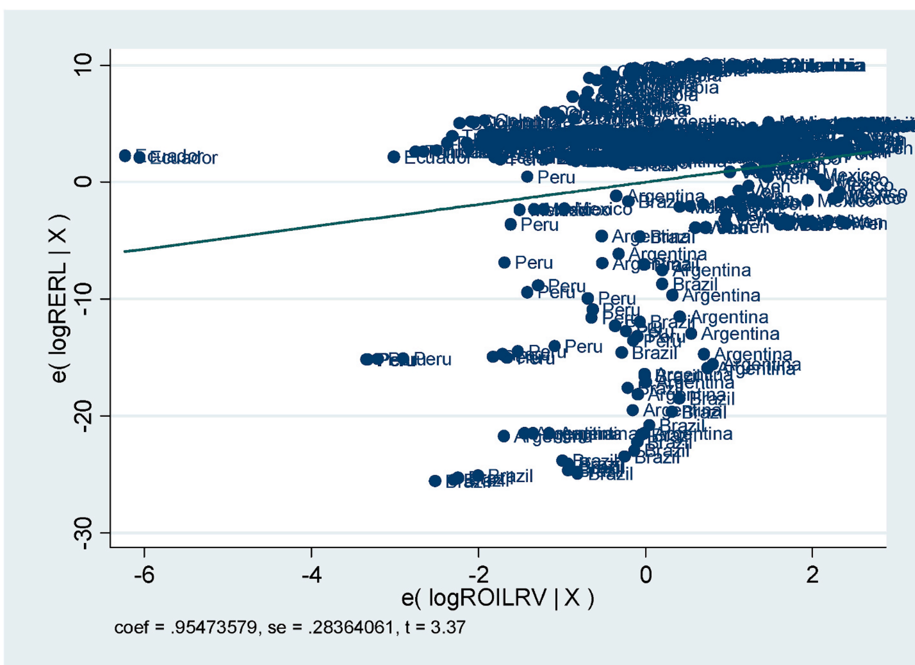
Appendices 4C. Scatter Diagrams



Appendix 4C1. The Relationship between Log Oil Production and Log Exchange Rate in Asian and Pacific Countries.



Appendix 4C2. The Relationship between Log Oil Production and Log Agriculture Sector in Latin American Countries.



Appendix 4C3. The Relationship between Log Real Oil Revenue and Log Agriculture Sector in Latin American Countries.

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