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Unveiling the symptoms of Dutch disease: A comparative and sustainable analysis of two oil-rich countries

Edmund Ntom Udemba[a,*], Selin Yalçıntaş[a,b]

[a] Faculty of Economics Administrative and Social Sciences, Istanbul Gelisim University, Istanbul, Turkey
[b] Social Sciences Institute, Marmara University, Istanbul, Turkey

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A B S T R A C T

This work examines and compares the performance of two oil-rich countries (Norway and Algeria) towards sustainable development amidst dutch disease. Norway and Algeria are both among the top oil exporting countries with same characteristics in terms of oil richness but differs in historical economic operations and development. Norway is among the best performing economies in the world while Algeria is still behind in economic operations and development. Comparing the two economies will form a basis for policy recommendation for the less performing oil exporting economies especially the ones in the category of Algeria. Two times series models were adopted for the two countries in separate form for effective comparison of the economies with the findings of the individual analysis. Quarterly data of 1999Q1-2018Q4 and 1999Q1- 2019Q4 were applied for Algeria and Norway analysis respectively. Autoregressive Distributed Lag (ARDL) dynamics and bound with granger causlity approaches were applied for the in-depth analysis of this study. Findings from the ARDL dynamic and long run cointegration established symptoms of Dutch diseases for both countries with economic growth (GDP), government spending (GGFCE), crude oil price and real exchange rate having negative relationship with agriculture (for Algerian model) and manufacturing sector (for Norwegian model) respectively. Again, FDI is confirmed having significantly positive relationship with agriculture and manufacturing sector for Algeria and Norway respectively. Also, findings from granger causality established nexus among the Dutch disease variables especially from the bi-directional interactions between the variables, and hence, attests to the findings of Dutch disease symptoms from the long run cointegration for both economies.

1. Introduction

The resource curse hypothesis examines all the economic, political and social effects that natural resource revenues create in resource-rich countries. However, our study will be considered in the context of the Dutch Disease, which is the economic aspect of resource curse. In economies with high dependence on natural resources, the effects of revenues from resource exports on the real exchange rate and the manufacturing sector are explained with the Dutch Disease theory. Sudden increases in resource income can occur in two ways. The country may discover a new resource or there may be an unexpected increase in global resource prices. In resource-rich economies experiencing these circumstances, high amounts of foreign currency inflows cause the domestic currency to overvalue and affect the competitive power by shrinking the manufacturing sector.

The term Dutch Disease was first used in the article titled “Dutch Disease” published in The Economist on November 26, 1977. The reason why the “Dutch” named for this disease is due to the impact of natural gas deposits in the North Sea in 1959 on the Dutch economy. The discovered natural gas significantly increased the export revenues of Holland and caused the real exchange rate to appreciate. As a result, the manufacturing sector has weakened due to resource transition from manufacturing sectors to service sectors. The increase in prices and wages prevailing in the service sector will affect the manufacturing sector by means of de-industrialization through resource transition. Similar effects were seen with the 1973 oil crisis, due to the increasing export revenues of other resource-rich countries. Therefore, this unfavorable situation named specifically after the Dutch has created an inclusive research subject that all resource-rich countries can fall into. As can be seen in the commodities sector of the economy, the Dutch Disease is the existence of the sector experiencing a boom in earnings and a contraction on the other hand simultaneously (Corden and Neary,

* Corresponding author.
E-mail addresses: eudemba@gelisim.edu.tr, eddy.ntom@gmail.com (E.N. Udemba), syalcintas@gelisim.edu.tr, sln.alkn@windowslive.com (S. Yalçıntaş).

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1982).

Although the Dutch Disease has not been specifically studied in the past, the experiences of some countries point to the presence of the disease. For instance, the income that Spain gained from the gold and silver mines discovered in America in the 16th century negatively affected the country's economy. The overvaluation of the domestic currency encouraged imports and led to a decrease in production. Inflation and unemployment accompanied this process afterwards. After the article in The Economist, the disease was examined scientifically, and the symptoms were studied by Corden and Neary (1982). In their study, the theoretical framework of the Dutch Disease was drawn, and it has been accepted as the base model in the literature. The model is considered in real terms and monetary effects are ignored. It is also assumed that there are only two factors of production, labor and capital. In an open economy that is too small to affect world prices, a distinction is made between tradable and non-tradable goods. While goods produced in the energy and manufacturing sector are considered tradable goods, service industry outputs are considered non-tradable. The trade of tradable goods is linked to world prices, and the prices of non-tradable goods are determined by the supply and demand conditions inside the country. The relationship between the potential boom in natural resource revenues and the income distribution among these factors has been examined.

In Corden's study published in 1984, the dynamics of the model were detailed with the resource movement effect and the spending effect. When there is a boom in resource revenue in energy sector, production factors tend to take advantage of moving towards energy sector. Transition from other sectors to the energy sector increases the output and employment of the energy sector. On the other hand, the output and employment of the manufacturing and service sector decrease. This shrinkage that may be experienced especially in the manufacturing sector is defined as "direct de-industrialization". Assuming a fixed real exchange rate, there is a movement of resources from the service sector to the energy sector, and the supply in the service sector decreases. However, with the spending effect, changes in the real exchange rate can affect the movement between sectors. Increasing earnings in the energy sector lead to an increase in demand and spending in the economy. Since the prices in the energy and manufacturing sectors are determined by the international market, the prices in these sectors are not affected by domestic demand conditions. However, since the service sector prices are determined in the domestic market, the increasing demand brings along the increasing prices in the sector. The relative price increase in the service sector leads to the appreciation in the real exchange rate. As the output of the sector and the demand for labor increase, wages increase too. In order to prevent the labor transition, the energy and manufacturing sectors also have to increase wages, but since the prices in these sectors are not determined in the domestic market, the increase in costs cannot be reflected. Therefore, the inter-sectoral factor movement of the real exchange rate increase resulting from the spending effect is towards the service sector. This sort of contraction in the manufacturing sector is called "indirect de-industrialization" (Corden, 1984). The net effect in the sum of the resource movement effect and the spending effect is the increase in the price of non-tradable goods. In the model of Corden and Neary, this relative price increase is considered as the real exchange rate increase. In addition to the real exchange rate appreciation, all sectors experience an increase in wages. While the energy sector has a positive effect on exports, the share of the shrinking manufacturing sector in exports decreases gradually. It is assumed that non-tradable goods do not participate in exports with the assumption that they are intended to meet domestic demand.

On the other hand, the net effect for the production in the energy and service sector is depend on which of the resource movement and spending effect will be more dominant. If the resource movement effect is more dominant in the country, the net effect is the increase in the production in the energy sector and the decrease in the production of the service sector. In the case where the spending effect is dominant, the net effect is the decrease in the production in the resource sector and the increase in the production in the service sector. The net effect which stands for the production is also valid for the sectoral employment (Algieri, 2011).

From the above background, the present study seeks to compare the two oil-rich countries (Norway and Algeria) with divergent economic operations and achievements. The experiences of Norway and Algeria in managing resource revenues differs which helps Norway in achieving great result while Algeria is still behind in the management of its oil generated revenue. Many studies have focused on single perspective of research either Algeria economic growth with oil shock or Norwegian economic growth with oil shock. To our knowledge, no study has tried to do a comparative analysis for the both economies. Our study contributes to the literature by comparing the two economies that are considered as two extreme economies in operations and performance under Dutch disease study which will serve as a blue print for policy framing for other less performing oil exporting countries. A breakdown of the contribution of our study are as follows: *a. Separation of the trend of Dutch disease (Agric led Dutch disease and Manufacturing led Dutch disease) in the selected countries, b. Exposing the impact of Dutch disease on both resources, traded and non-traded sectors, c. Does real exchange has the same effect in determining the Dutch disease in the two countries? d. Does government spending has symmetric or asymmetric effect in both countries? e. Does oil price and FDI pose the threat of Dutch disease in both countries?* In our study, a comparative analysis will be made with the consideration of the economic indicators of these two resource-rich countries. It is expected that the review will also benefit the evaluation of other resource-rich countries. In this context, in the second part of the study, there are reviews about the fields in which Norway and Algeria utilize the resource income.

A literature review on Dutch Disease is presented in section 3. Other sections are 4, 5, and 6 for data and methodology, empirical results and discussion, conclusion and policy suggestions.

2. Brief summary on the Norwegian and Algerian economies

In Norway oil discovered in the late 1960's. While the activities in the oil sector were initially managed by foreign oil companies, operating and property rights were transferred to domestic companies in the following years (Ramirez-Cendrero and Wirth, 2016). The country, which had a current account deficit problem in the 1970s, increased its oil revenues as a result of the oil shock in the 1980s (Holden, 2013). Although the demand from foreign countries decreased due to the increasing oil prices at that time, Norway had adopted a cautious spending strategy and encouraged the revival of domestic demand. As a result of the utilization of oil revenue with appropriate financial policies; domestic consumption has increased, unemployment has decreased and the country has benefited from this process with the increase in welfare (Eika and Magnussen, 2000).

The tax policy implemented by the state since 1980 has been an important practice in resource income management. Thanks to the special tax system, 80% of the resource income obtained by the sector passes to the state (Gylfason, 2001). Statoil, the national oil company, was privatized in 2001, maintaining a 67% share. The state earns significant income from company dividends (Holden, 2013). Therefore, the state's field of income generation from the oil sector is wide.

Another initiative related to resource revenues is the Petroleum Fund established in 1990. The fund, which has been operating as a Pension Fund since 2006, is under the responsibility of the Norwegian parliament. While 4% of the revenues accumulated in the fund goes to the central budget, the remaining part is invested in foreign financial and real assets. In this way, the pressure on the domestic currency is reduced and a sterilization effect is created in the economy. Therefore, the symptoms of Dutch Disease are prevented (Ramirez-Cendrero and Wirth, 2016).

Norway's success has resulted from its advantages of developed institutions, geographical location, stable economic and political history, yet the result through the management of oil revenues and the regulatory actions taken sets an example for other resource-rich countries. The management of resource revenues through funds, and tax revenues have had positive impact on combating the Dutch Disease.

Algeria is among the countries rich in oil and natural gas. Among OPEC countries, it ranks 9th in crude oil reserves and production, 6th in natural gas reserves and 3rd in production. The first oil discovery in Algeria took place in 1956 and production began in 1958. Known as the largest oil company in Africa, the national oil company Sonatrach was established in 1963. The company controls about 80% of the country's hydrocarbon production. The oil and gas sector accounts for 85% of total exports and about 20% of gross domestic product (Bakirtas and Akpolat, 2020). Therefore, it is seen that the country's economy is highly dependent on resource income.

With the oil revenues that increased after the first and second oil shocks, it became possible for the country to implement its development strategy for infrastructure and heavy industry investments. Considered to have economic development and sustainable stability in this period, the country's structural fragility has emerged with the decrease in oil prices in the following period. The economy has entered a prolonged recession, with declining consumption and employment. There was also a decline in the manufacturing sector activities, and it was referred to as the beginning of the deindustrialization process. Within the framework of the Structural Adjustment Program adopted in 1994, a slight growth was recorded in the manufacturing sector. However, when oil prices increased later, despite many economic reforms, diversification in the manufacturing sector was not created (Gasmi and Laourari, 2017). The fact that the economic reforms made in the country could not create a response and the resource revenues did not support long-term economic growth, revealed the necessity of examining the Dutch Disease in Algeria.

The results obtained by Gasmi and Laourari (2017) in their studies using the data of the Algerian economy for the period 1960–2016 do not clearly confirm the Dutch Disease as the reason for the low diversity in the manufacturing sector. Jbir and Zouari-Ghorbel's (2011) study covering the period 1995Q1-2007Q3 confirms that the effect of oil price increases on the Algerian economy coincides with the spending effect which is one of the symptoms of the Dutch Disease. It is concluded that increasing oil prices during this period triggered inflation and real exchange rate increase.

3. Literature review

After the model of Corden and Neary (1982), the Dutch Disease has begun to be analyzed in various ways and important studies on the subject have contributed to the literature. Bruno and Sachs (1982), through dynamic simulation method, measured the impact of oil discovery in the North Sea on sectors by using UK's data of year 1973. Their study is based on a three-sector model that consists of energy, non-energy tradable and non-tradable sectors. As a result of the discovery of oil, it is observed that while investments in the non-tradable sector increase, profitability decrease with the decreasing investments in the non-energy trade sector. In the study focusing on the spending effect, the validity of the Dutch disease is accepted.

In the work of Cappelen and Eika (2020), titled counterfactual analysis of Norwegian resource with Dutch disease and immigration, it was discovered that economic growth (GDP) and population increased due to the resource boom and higher immigration. They found increase in employment which pushed down the wages and productivity. On the contrary, Allcott and Keniston (2018) found for the case of United State, that domestic wages increase during the period of oil and gas sector boom and this has little or no effect on the manufacturing sector due to alignment with locally traded sub sectors. However, Gjelsvik et al. (2015) for Norway found that increase in immigration increased reduce wages. Shao et al. (2020) researched 30 provinces in China and found the resource boom responsible for factor migration to mining sectors and thereby raises inflation. Abdlaziz et al. (2018) researched the case of Dutch disease between oil price and agriculture for 25 developing oil exporting countries. The study found Dutch disease in form of deagriculturalization. Also, Apergis et al. (2014) utilized panel cointegration in their study of oil producing countries in the Middle East and North Africa. Specifically, they research the effect of oil rent an agriculture for the selected countries, and found negative long run relationship between oil rents and agricultural sector by the means of deagriculturalization. Also, deagriculturalization is found in the work of Lauvsnes (2021) titled Dutch disease in the Norwegian agricultural sector.

In his study in 1984, Wijnbergen made suggestions to prevent the appreciation of the real exchange rate by addressing the reflection of resource income on the economy with the spending effect. It emphasizes that in order to control consumption, some of the oil revenues should be invested in foreign assets. He also argues that it should be supported by subsidies to reduce the negative effects in the manufacturing sector.

Neary and Wijnbergen (1985), in their study examining the response of oil exporting countries against oil shocks in the context of the Dutch Disease, confirmed that de-industrialization and real exchange rate appreciation take place in these economies as a result of resource movement effect and spending effect.

On the other hand, Krugman (1987) discussed the Dutch Disease with foreign transfer payments, which is an item on the balance of payments. In the study, it was concluded that long-term large amounts of transfers reduce the productivity of the country, cause the tradable sector to shrink and the competitiveness decreased. Sachs and Warner (1995) confirm the symptoms of Dutch Disease in their study examining the relationship between resource abundance and economic growth. In another study, the effects of natural resource revenues and foreign aid on economies were examined by Harding and Venables (2010) using the data of 134 countries between 1975 and 2007. The effects of the foreign exchange earnings of countries on the balance of payments were analyzed sector by sector. According to the findings of the study, for every $ 1 increase obtained from natural resource exports, the export income of non-resource tradable sector decreases by 50 cents and the imports increase by 15 cents.

K. İsmail (2010) focused on the mobility of factors between countries by addressing the structural symptoms of the Dutch Disease with the Heckshert Ohlin Factor Endowment Theory. The study confirms the Dutch Disease model and concludes that in resource-rich countries with open capital markets, disease symptoms will be felt more severely than in a closed capital market.

Using vector autoregressive model, Jbir and Zouari-Ghorbel (2011) analyzed Dutch Disease for the case of Algeria, and find positive link between inflation and exchange rate. Also, the study find that spending effect could be the origin of Dutch Disease. Also, Gasmi and Laourari (2017) studied Dutch Disease for the case of Algeria and find similar result, hence, inlation induced exchange rate appreciate which will trigger spending effect.

In the study of Chekouri et al. (2015), which was about the Algerian economy between the years 1963–2008, it was stated that the symptoms of Dutch Disease were encountered. The findings of the study were that while there was a growth in natural resource and service sector incomes, there was a relative contraction in agriculture and manufacturing sectors. It was emphasized that the growth performance of the Algerian economy has not been improved due to the lack of sectoral diversity in the country and the inadequate government measures in this regard.

In the study of Alssadek and Benhin (2021), in which they analyzed the Dutch Disease by using the panel data fixed effect with the Driscoll-Kraay standard errors estimation approach, with data of 36 developed and developing oil-rich countries between 1970 and 2016, they concluded that the spending effect and resource movement effect were valid. The boom in the resource sector in selected economies caused the real exchange rate to appreciate and a decrease in sectoral output.

Larsen (2006) stated that the elimination of the dynamics that disrupt the macroeconomic balance, the regulation of the economic and political institutional structure, the systematicity of social norms and the judiciary contributed to the improvement of the growth data after the oil discovery in Norway and not to catch the Dutch Disease in this process. However, it was argued that the success of the Norwegian economy in escaping the Dutch Disease could not be sustained due to the decline in both manufacturing and general growth performance in the late 1990s. Emphasizing a similar situation, Gylfason (2006) argued that compared to its neighboring Scandinavian countries, Norway had the risk of emergence of Dutch Disease due to factors such as the underdevelopment of its high-tech industry, the relatively stagnant foreign direct investment and exports.

In the study of Bjørnland et al. (2019) which researched the dynamic effects of resource activities in the Norwegian economy in the period of 1982:Q2 - 2016:Q2, the results were opposite to the Dutch Disease model. It was revealed that it increased the productivity in manufacturing and other sectors, and the added value per worker increased. As a result of the existence of a strong institutional structure, good management of oil funds, encouraging the development of the domestic manufacturing industry as a supplier to the oil sector, and increasing investments in this direction, there was an increase in welfare that spreads throughout the economy.

4. Modelling, methodology and data

The modelling of our study is followed after the works of Corden and Neary (1982) and Van Wijnbergen (1986) on Dutch disease. From the theory of Dutch disease, discovering and boom of natural resources affects the sectors that are regarded as the bedrock of the economy before the discovering of the natural resources. It is discovered that Agriculture has been the sector that sustains most developing countries, especially from African continent including Algeria before the advent of the natural resources, while manufacturing sector maintained a sustaining sector to the economies of most advanced countries including Norway.

Popular Dutch disease is centered on two effects (spending and resources movement effects) which exposes the implication of government's spending of revenue generated from the resource, and the movement of human resources from the non-traded sector (mostly service) to a more attracting traded sectors (resource inclined and the basic sector). The impact of government of government's spending will be felt from the increase in domestic income and spending which will impact the real exchange rate through appreciation of the local currencies (though, this is mostly experienced on the side of advanced countries like that of Netherland that gave rise to Dutch disease). The appreciation of local currency will disfavor the traded commodities (agricultural and manufacturing products) that are always traded in the international (world) market due to increase of the domestic price. Also, the impact of resource movement is felt from the inability of traded goods sectors to sustain and retain the workers because of increase in wages due to the increase in domestic income and spending. Most workers will move to non-traded goods sectors, resources sectors and other foreign companies. This trend suggests deindustrialization or contraction of the traded goods sectors (agriculture and manufacture) mostly due to shortage in resources including human labor. Again, world price inform of cost of production of the resources and cost of importing the by-products like oil that may be needed in productive or manufacturing operation tends to pose a threat to the survival of the domestic manufacturing sectors.

From the above explanations, our study adopts two models for testing symptoms of Dutch diseases for the case of Algerian and Norwegian economies respectively. We adopt two sectors (agriculture and manufacturing sectors) that are associated with Dutch diseases because of the anticipated negative effect of the boom of the natural resource. Agricultural model is for Algeria while the manufacturing model is for Norway. Because of the associated impacts of the spending and resources movement, general government final consumption expenditure (GGFCE), real exchange rate (RER), foreign direct investment, inflow (FDI), GDP *per capita* (constant, 2010) (for Algeria), GDP (constant, 2010) (for Norway) and crude oil price are adopted as explanatory variables to tests the Dutch disease. .As remarked before, two models (for Algeria and Norway) are adopted in this study for the purpose of the research, that is for comparison purpose which is expected to pave way for better performance of the less efficient performing country. We assume Norway and Algeria as better and less efficient performing countries and believing that at the end of this research, Algeria will definitely consider Norwegian model as a tool to enhance its sustainable development. Hence, Algeria model is specified and designed with agricultural sector expressed as a percentage of its GDP *per capita* as the Dutch disease variable, while Norwegian model is designed with manufacturing sector expressed as a percentage of its GDP as the Dutch disease variable. [1] Note, *the choice of the variables (esp the explanatory variables) is based on the economic history and the features of the targeted country (ies), and must not necessarily be the same. We try to apportion uniform variables to the both countries (Norway and Algeria) because of the comparative nature of this particular work. It is evident that both real gdp per capita and real gdp measures economic growth but per capita gdp captures more of development because of its inclusive nature of capturing the masses welfare through their income when divided with population (GDP/population). However, for Norway, a country that has already undergone the development process, a different variable (not per capita gdp) needs to be included. It is interesting to point out that the manufacturing sectors of most European countries have declined since the late 1960s, but with no single evident factor causing the deindustrialization, the best possible proxy is one that somehow captures this trend. In this study we consider the real GDP, RGDP, as the most appropriate variable.*

Apart from the Dutch disease variables that takes different sectors (agricultural and manufacturing) of the two economies, all other explanatory variables are same for the two economies. All the variables adopted in this study are converted and expressed as natural log form except agricultural, manufacturing and FDI that are already in percentage to GDP form. Following after the model of Dutch disease according to Corden and Neary (1982) and Van Wijnbergen (1984) we modelled the two economies (Algeria and Norway) which we are comparing in our study as follows:

$$AG_t = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnGE_t + \beta_3 FDI_t + \beta_4 lnOP_t + \beta_5 lnRER_t + \varepsilon_i \quad (1)$$

$$Manu_t = \beta_0 + \beta_1 lnGDP_t + \beta_2 lnGE_t + \beta_3 FDI_t + \beta_4 lnOP_t + \beta_5 lnRER_t + \varepsilon_i \quad (2)$$

According Eqns (1) and (2) which represent modes for Algeria and Norway, AG_t and $Manu_t$ are the dependent variables (agriculture and manufacturing sector) which represent the Dutch disease in the two countries of our choice. Y_t represents the real *per capita* GDP for Algeria and real GDP for Norway and proxied for economic growth in both countries, GE_t represents government expenditure in both countries (Algeria and Norway) which is proxied by general government final

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consumption expenditure (GGFCE), FDI_t represents foreign direct investment, net inflow for both countries, OP_t represents crude oil price for both countries, RER_t represents real exchange rate, and ε_i is normally distributed residual term.

The methods adopted in our study are descriptive statistics for ascertaining the features of the data which includes the follow; sample and measures of the data, and normal distribution of the data utilized in this study. Stationarity (unit root) and order of integration of the series is tested with augmented Dickey-Fuller (ADF, 1979), Philip-perron (PP, 1990), and Kwiatkowski et al. (1992) methods. Further, among the methods adopted in this study is autoregressive distributed lag (ARDL) bound test for the confirmation of the existence of cointegration and long run relationship among the variables. The cointegration and long run relationship analysis between the variables is modelled with unrestricted error correction model for the two economies (Algeria and Norway) as follows:

a. For Algeria;

$$\Delta AG_t = \beta_1 + \beta_2 AG_{t-1} + \beta_3 lnGDP_{t-1} + \beta_4 lnGE_{t-1} + \beta_5 FDI_{t-1} + \beta_6 lnOP_{t-1} + \beta_7 lnRER_{t-1} + \sum_{i=0}^{n} a_1 \Delta AG_{t-i} + \sum_{j=0}^{o} a_2 \Delta lnGDP_{t-j} + \sum_{k=0}^{p} a_3 \Delta lnGE_{t-k} + \sum_{l=0}^{q} a_4 \Delta FDI_{t-l} + \sum_{m=0}^{r} a_5 \Delta lnOP_{t-m} + \sum_{n=0}^{s} a_6 \Delta lnRER_{t-n} + ECM_{t-i} + \mu_t \quad (3)$$

b. For Norway

$$\Delta Manu_t = \beta_1 + \beta_2 Manu_{t-1} + \beta_3 lnGDP_{t-1} + \beta_4 lnGE_{t-1} + \beta_5 FDI_{t-1} + \beta_6 lnOP_{t-1} + \beta_7 lnRER_{t-1} + \sum_{i=0}^{n} a_1 \Delta AG_{t-i} + \sum_{j=0}^{o} a_2 \Delta lnGDP_{t-j} + \sum_{k=0}^{p} a_3 \Delta lnGE_{t-k} + \sum_{l=0}^{q} a_4 \Delta FDI_{t-l} + \sum_{m=0}^{r} a_5 \Delta lnOP_{t-m} + \sum_{n=0}^{s} a_6 \Delta lnRER_{t-n} + ECM_{t-i} + \mu_t \quad (4)$$

The models to investigate of the existence of symmetric cointegration and long run among the selected and already explained variables (*agricultural and manufacturing sector for Algeria and Norway, real GDP per capita (for Algeria) and real GDP (for Norway), government expenditure (GGFCE), foreign direct investment (FDI), crude oil price and real exchange rate*) for the two economies are constructed with the two Eqns (3) and (4). Among the features of Equations (3) and (4) are Δ, β_i and a_i, I and ECM_{t-i} which represent the sign of first difference of the variables, the long-run and short-run parameters of the variables with i = 1, 2 … etc., and the error correction model which reveals the speed of adjustment over a period of time termed long-run period respectively. The estimation and analysis of the cointegration is done by comparing the F and t-stats of the bound with the critical values upper and lower bounds. Null hypothesis and alternative hypothesis are constructed in support and against the statement of non-existence of cointegration among the variables as follows for the two countries: Null $= H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$, against the alternative $= H_a : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$.

For a robust check of the findings from the other approaches and more in-depth revelation on the interactions and forecasting power of the variables, we applied granger causality. When cointegration is established, it is necessary to proceed with granger causality on the basis that causality relationship is anticipated to occur at least from one direction (uni-directional) or both directions (bi-directional). The long run and short run granger causality is expected to be in existence when cointegration is confirmed. Following the likelihood of granger causality among the variables for both countries, we modelled a vector error correction representation in matrix form for Algeria and Norway as follows:

a. For Algeria

$$(1-L)\begin{bmatrix} AG_t \\ lnGDP_t \\ lnGE_t \\ FDI_t \\ lnOP_t \\ lnRER_t \end{bmatrix} = \begin{bmatrix} \varnothing_1 \\ \varnothing_2 \\ \varnothing_3 \\ \varnothing_4 \\ \varnothing_5 \\ \varnothing_6 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} a_{11i} & a_{12i} & a_{13i} & a_{14i} & a_{15i} & a_{16i} \\ \beta_{21i} & \beta_{22i} & \beta_{23i} & \beta_{24i} & \beta_{25i} & \beta_{26i} \\ \delta_{31i} & \delta_{32i} & \delta_{33i} & \delta_{34i} & \delta_{35i} & \delta_{36i} \\ \partial_{41i} & \partial_{42i} & \partial_{43i} & \partial_{44i} & \partial_{45i} & \partial_{46i} \\ \gamma_{51i} & \gamma_{52i} & \gamma_{53i} & \gamma_{54i} & \gamma_{55i} & \gamma_{56i} \\ \rho_{61i} & \rho_{62i} & \rho_{63i} & \rho_{64i} & \rho_{65i} & \rho_{66i} \end{bmatrix} + \begin{bmatrix} \theta \\ \vartheta \\ \tau \\ \varphi \\ \omega \\ \in \end{bmatrix} ECM_{t-1} + \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \\ \eta_{4t} \\ \eta_{5t} \\ \eta_{6t} \end{bmatrix} \quad (5)$$

b. For Norway

$$(1-L)\begin{bmatrix} Manu_t \\ lnGDP_t \\ lnGE_t \\ FDI_t \\ lnOP_t \\ lnRER_t \end{bmatrix} = \begin{bmatrix} \varnothing_1 \\ \varnothing_2 \\ \varnothing_3 \\ \varnothing_4 \\ \varnothing_5 \\ \varnothing_6 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} a_{11i} & a_{12i} & a_{13i} & a_{14i} & a_{15i} & a_{16i} \\ \beta_{21i} & \beta_{22i} & \beta_{23i} & \beta_{24i} & \beta_{25i} & \beta_{26i} \\ \delta_{31i} & \delta_{32i} & \delta_{33i} & \delta_{34i} & \delta_{35i} & \delta_{36i} \\ \partial_{41i} & \partial_{42i} & \partial_{43i} & \partial_{44i} & \partial_{45i} & \partial_{46i} \\ \gamma_{51i} & \gamma_{52i} & \gamma_{53i} & \gamma_{54i} & \gamma_{55i} & \gamma_{56i} \\ \rho_{61i} & \rho_{62i} & \rho_{63i} & \rho_{64i} & \rho_{65i} & \rho_{66i} \end{bmatrix} + \begin{bmatrix} \theta \\ \vartheta \\ \tau \\ \varphi \\ \omega \\ \in \end{bmatrix} ECM_{t-1} + \begin{bmatrix} \eta_{1t} \\ \eta_{2t} \\ \eta_{3t} \\ \eta_{4t} \\ \eta_{5t} \\ \eta_{6t} \end{bmatrix} \quad (6)$$

Table 1
Descriptive statistics (for Algeria).

Variables	AG	GDP	GE	FDI	OP	LRER
Mean	9.403541	4325.332	2.57E+10	1.097418	60.62058	104.0618
Median	9.343900	4405.409	2.52E+10	1.055183	61.34500	101.6392
Maximum	12.21952	4828.626	3.51E+10	2.033265	99.67000	125.3169
Minimum	6.587466	3473.143	1.73E+10	−0.323268	19.34000	93.27864
Std. Dev.	1.520070	407.6994	6.11E+09	0.505233	25.21884	8.171784
Skewness	0.371103	−0.718695	0.080050	−0.211438	0.021114	1.384051
Kurtosis	2.237279	2.359981	1.402395	2.907916	1.668533	3.716438
Jarque-Bera	3.633797	7.942917	8.271003	0.600934	5.693468	26.23027
Probability	0.162529	0.018846	0.015995	0.740472	0.058034	0.000002

Note: *AG, GDP, GE, FDI, OP and RER represent agriculture, economic growth proxy as GDP per capita, government expenditure proxy as general government final consumption expenditure (GGFCE), foreign direct investment, net inflow, crude oil price and real exchange rate respectively.*
Source: Authors computation

Table 2
Summary of statistics (for Norway).

Variable	MAN	GDP	GE	FDI	RER	OP
Mean	8.341	3.94E+11	8.12E+10	2.097	94.18	50.05
Median	8.299	4.09E+11	8.03E+10	2.066	94.20	43.73
Maximum	10.80	4.95E+11	1.07E+11	6.187	100.45	111.6
Minimum	5.899	2.63E+11	5.53E+10	−5.062	83.70	12.72
Std. Dev.	1.545	6.84E+10	1.57E+10	2.296	5.307	32.65
Skewness	0.046	−0.397	0.044	−0.853	−0.642	0.604
Kurtosis	1.595	2.069	1.782	4.675	2.246	2.072
Jarque-Bera	2.395	1.810	1.802	6.906	2.680	2.804
Probability	0.302	0.404	0.406	0.032	0.262	0.246

Note: *Manu, GDP, GE, FDI, OP and RER represent manufacturing sector, economic growth proxy as GDP, government expenditure proxy as general government final consumption expenditure (GGFCE), foreign direct investment, net inflow, crude oil price and real exchange rate respectively.*
Source: Authors computation

The features of Equations (5) and (6) are, $(1-L)$, $\eta_{1t} \ldots \ldots \ldots \ldots \eta_{6t}$ which represent difference operator, lagged error correction term for the identification of long run cointegration relationship and serially independent random errors with mean and zero and finite covariance matrix. Direction of the causal relationship that existed in the short-run is shown in the 1st differences of the variables, while the causal relationship in the long-run is determined by a significant level of either p-value or t-stats on the error correction term (ECM_{t-1}).

We applied quarterly (1999Q1-2018Q4 and 1999Q1-2019Q4) data for the selected variables (*agricultural and manufacturing sector for Algeria and Norway, real GDP per capita for Algeria and real GDP for Norway, government expenditure, foreign direct investment, oil price and real exchange rate*) which amounted to 77 and 81 observations for both countries (Algeria and Norway). We applied slightly different data in terms of observation in both country, hence, it does not make any difference and this, is not anyways affect our analysis and findings. The data is meant to be the same but due to non-availability of data led to the disparity in the data. The data are sourced from the 2018 updated World Bank development indicator.

5. Empirical results and discussions

5.1. Descriptive statistics

Descriptive outputs for the two countries are displayed in Tables 1 and 2 below with exposition of the features of the applied data. From the result as shown with the probability of Jarque-Bera, we found evidence of the normal distributed data except in few cases (GDP, GE and RER for Algeria, and FDI for Norway) where the outputs are significant at 5

Table 3
Stationarity test (for Algeria).

Variables	@ LEVEL		1st Diff		
	With intercept	intercept & trend	With intercept	intercept & trend	Decision
			PP		
AGR	−1.0492	−2.2227	−3.9771***	−3.9681***	I(1)
LGDP	−3.3273**	−0.5174	−2.1432	−3.1121	I(0)
LGE	0.0687	−1.8676	−2.9415**	−2.8927	I(1)
FDI	−2.1878	−2.6561	−4.0465***	−4.0551**	I(1)
LOP	−1.7834	−1.4330	−3.5787***	−3.5846**	I(1)
LRER	−2.4165	−2.2135	−3.6737***	−3.6713**	I(1)
			ADF		
AGR	−1.0336	−1.7824	−2.5893***	−2.8084**	I(1)
LGDP	−2.4931	−1.2792	−2.0068	−2.9376*	I(1)
LGE	−0.5824	−2.3588	−2.7958*	−2.7443	I(1)
FDI	−2.0073	−4.1392***	−2.6526*	−2.4790	MIXED
LOP	−2.1323	−2.3064	−3.3335**	−3.3177*	I(1)
LRER	−1.9063	−2.5668	−3.4413**	−3.4071*	I(1)
			KPSS		
AGR	0.5231**	0.2794***	0.4048*	0.0544 MIXED	
LGDP	1.1144***	0.2548***	0.6183	0.0755 I(1)	
LGE	1.1802***	0.1421*	0.1590	0.1404* MIXED	
FDI	0.4102*	0.1467**	0.0969	0.0564 I(1)	
LOP	0.5881**	0.2388***	0.1908	0.0622 I(1)	
LRER	0.8381***	0.2121**	0.2684	0.1122 I(1)	

Notes: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%(b): P-value according to (1) Maclean et al., (1996) one-sided p-values (2) Kwiatkowski-Phillips-Schmidt-Shin (1992).

Table 4
Stationarity test (for Norway).

Variables	@ LEVEL		1st Diff		
	With intercept	intercept & trend	With intercept	intercept & trend	Decision
			PP		
MANU	−0.646	−2.729	−4.902***	−4.865***	I(1)
LGDP	−2.278	−1.674	−4.603***	−4.779***	I(1)
LGE	−0.376	−3.011	−4.625***	−4.559***	I(1)
FDI	−2.201	−2.185	−6.127***	−6.136***	I(1)
LOP	−1.511	−1.746	−4.813***	−4.798***	I(1)
LRER	−0.951	−0.966	−4.962***	−4.988***	I(1)
			ADF		
MANU	−0.749	−2.386	−3.359**	−3.235*	I(1)
LGDP	−2.015	−2.678	−2.278	−2.757*	I(1)
LGE	0.279	−4.568***	−4.621***	−4.581***	MIXED
FDI	−3.469**	−3.229*	−0.744	−0.365	I(0)
LOP	−1.544	−1.576	−3.050**	−3.115	I(1)
LRER	−0.744	−0.966	−3.107**	−3.358*	I(1)
			KPSS		
MANU	1.209***	0.109	0.085	0.084 I(1)	
LGDP	1.234***	0.266***	0.403*	0.077 MIXED	
LGE	1.269***	0.074	0.039	0.040 I(1)	
FDI	0.232	0.216**	0.110	0.103 I(1)	
LOP	0.867***	0.141*	0.103	0.082 I(1)	
LRER	0.288	0.214**	0.176	0.075 I(1)	

Notes: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% (b): P-value according to (1) Maclean et al., (1996) one-sided p-values (2) Kwiatkowski-Phillips-Schmidt-Shin (1992).

Table 5
Cointegration (ARDL) of AGRIC model (for Algeria) [1999Q1- 2018Q4/77 OBSERV].

Variables	Coefficients	SE	t-statistics	P-value
		Short-path		
D(LGDP)	−0.008710	0.000873	−9.982274	0.000***
D(LGE)	−3.04E-10	4.92E-11	−6.169010	0.0000***
D(FDI)	0.198984	0.045036	4.418357	0.0001***
D(LOP)	−0.030504	0.002396	−12.72902	0.0000***
D(LRER)	−0.0079164	0.010426	−7.592930	0.0000***
CointEq(-1)*	−0.129217	0.014073	−9.181945	0.000***
		Long-path		
LGDP	−0.008710	0.001080	−8.067705	0.0000***
LGE	−3.04E-10	6.08E-11	−4.993221	0.0000***
FDI	0.198984	0.055663	3.574788	0.0010***
LOP	−0.030504	0.003185	−9.576693	0.0000***
LRER	−0.079164	0.012742	−6.212756	0.0000***
Constant	−2.783668	1.553163	−1.792258	0.0809*
R^2	0.999597			
Adj.R^2	0.999278			
D.Watson	2.0940			
Bound test(Long-path)				
F-statistics	10.43815***	K = 5,@ 1%	I(0)bound = 3.373	I(1)bound = 4.717
Wald test(short-path)				
F-statistics	3124.132***			
P-value	0.0000***			
Serial Correlation test				
F-statistics	0.4083			
Chi-square	3.355586			
P-value	0.1868			
Heteroscedasticity Test				
F-statistics	0.3592			
Chi-square	33.53783			
P-value	0.9994			

Note: *, **, *** Denotes rejection of the null hypothesis at the 1%, 5% and 10%.
Sources: Authors computation

Table 6
Cointegration (ARDL) of MANU model (for Norway) [1999Q1- 2019Q4/81 OBSERV].

Variables	Coefficients	SE	t-statistics	P-value
		Short-run		
D(LGDP)	−2.29E-11	6.43E-12	−3.560	0.000***
D(LGE)	−7.70E-11	1.95E-11	−3.944	0.000***
D(FDI)	0.031	0.008	4.057	0.000***
D(LOP)	−0.008	0.002	−4.079	0.000***
D(LRER)	−0.002	0.003	−0.580	0.563
CointEq(-1)*	−0.286	0.047	−6.100	0.000***
		Long-run		
LGDP	−2.29E-11	8.28E-12	−2.764	0.007***
LGE	−7.70E-11	1.95E-11	−3.944	0.000***
LFDI	0.031	0.009	3.583	0.001***
LOP	−0.008	0.002	−3.434	0.001***
LRER	−0.002	0.003	−0.580	0.563
Constant	1.964	0.405	4.853	0.000***
R^2	0.998			
Adj.R^2	0.997			
D.Watson	2.023			
Bound test(Long-path)				
F-statistics	4.980***	K = 5,@ 1%	I(0)bound = 3.351	I(1)bound = 4.587
Wald test(short-path)				
F-statistics	1937.9***			
P-value	0.000***			
Serial Correlation test				
F-statistics	0.076			
Chi-square	0.192			
P-value	0.909			
Heteroscedasticity Test				
F-statistics	0.778			
Chi-square	16.36			
P-value	0.694			

Note: *, **, *** Denotes rejection of the null hypothesis at the 1%, 5% and 10%.
Sources: Authors computation

percent.

5.2. Unit root test

The unit root test was performed for the two countries with the outputs shown in Tables 3 and 4. As noted from the above section on the reason for adopting unit root test, that is, for stationarity and order of integration check. Most times, time series variables are associated with instability due to some structural events such as macroeconomic problems and policies to control them, natural and health threatening issues such as earthquake, pandemic and epidemic like the case of COVID-19. These events always come as shock and create a permanent break on the smooth running of the economy. Because of events like this, it is always good to undertake a unit root test to ascertain the stationarity of the variables. Different approaches for the test of stationarity were applied which includes augmented Dickey-Fuller test, (1979); Philip-perron, (1990) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS, 1992). The outputs expose mixed order of integration at I(0) and I(1) which established unit root. This is part of the reasons for adopting autoregressive distributed lag (ARDL) for this study because its ability to accommodate different order of integration without any bias on the criteria to adopt except order I(2). Hence, the unit root test results for both countries are presented below.

5.3. ARDL dynamics and long run cointegration analysis

After the confirmation of order of integration among the series,

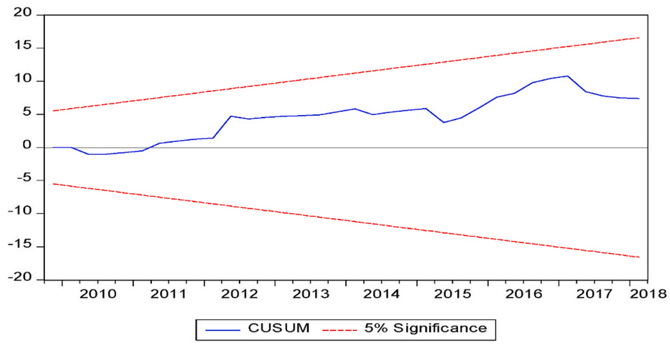

Fig. 1. CUSUM residual graphical plots for Algeria
Source: Authors' compilation.

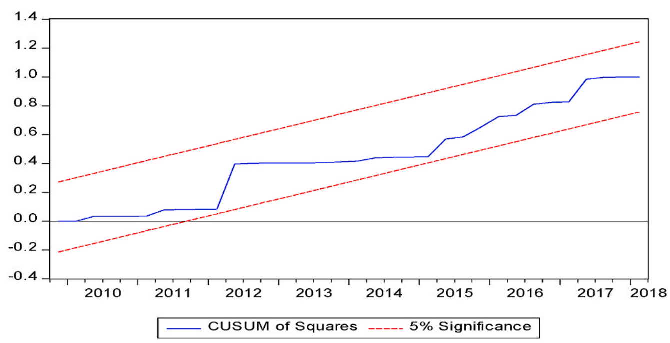

Fig. 2. CUSUM square residual graphical plots for Algeria
Source: Authors' compilation.

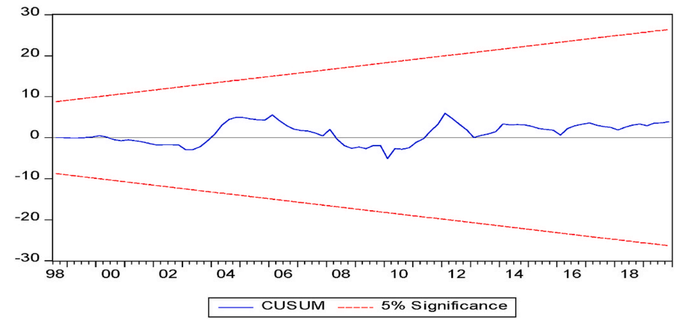

Fig. 3. CUSUM residual graphical plots for Norway
Source: Authors' compilation.

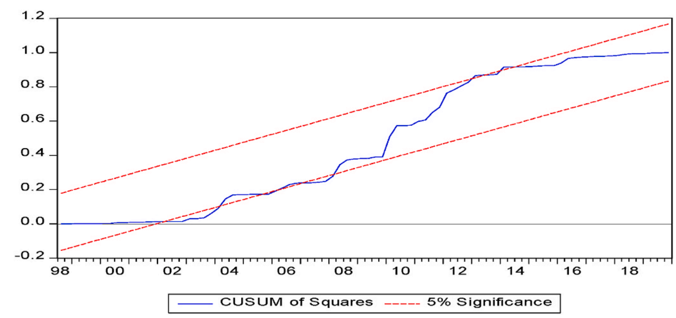

Fig. 4. CUSUM square residual graphical plots for Norway
Source: Authors' compilation.

ARDL dynamics and long run cointegration analyses are performed to determine the long run and short run relationship between the selected variables. As noted from the above sections, two analysis were performed for the two economies (Algeria and Norway) based on the expressed models (agriculture and manufacturing models). The results from the two analysis will be presented and discussed separately based on the findings.

First, we start with the presentation and discussion of findings from the Algerian and Norway estimation together as follows: For the appropriate lag length of the variables we calculate the lag length with the Akaike Information Criterion (AIC). The output for the selected lag length is 5 for both countries respectively and the results will be made available on request. Cointegration estimates were done and cointegration with long run was confirmed for the two countries with the values of F-stats at 10.43815(for Algeria) and 4.980(for Norway) and critical upper bound 4.717 for Algeria and 4.587 for Norway respectively. The results are included as among the Algerian and Norwegian findings in Tables 5 and 6. This confirmed the existence of long run relationship between the selected variables. Diagnostic tests such as normality of error term, serial correlation, autocorrelation, conditional heteroscedasticity, white heteroscedasticity, and functional form of the two models were performed to make sure that the models pass the classical assumptions. Also, stability of the models are tested and confirmed with cumulative sum and cumulative sum square (CUSUM and CUSUM^2). The CUSUM and CUSUM^2 findings are presented immediately after each of Tables 5 and 6 for the two economies (Algeria and Norway). The result of the diagnostic tests are presented with Figs. 1-4 in the lower part of Tables 5 and 6. The result confirmed the absence of serial and autocorrelations, heteroscedasticity and the error term normally distributed. Error correction model (ECM) was found to be −0.129 and −0.286 at 1 percent significant level for Algeria and Norway respectively. This points to the existence of long run relationship between the selected variables in both models. It equally confirms the ability of the two models for the two countries to adjust to long run equilibrium from the short run disequilibrium at 13 and 29 percent respectively.

We further present and discuss the long run and short run findings of the two models (Algerian and Norwegian economies) separately as follows: Starting with the findings from Algerian analysis, the long and short run results confirmed negative relationship between economic growth (GDP *per capita*) and the agriculture at −0.008710 and at 1 percent significant level respectively. This means that the Algerian economic growth does not depend on nor add to the agricultural input and sector. In the other way round, it shows that Algerian economic growth does not impact positively on the agricultural sector, and as the Algerian economy is growing, the agricultural sector is contracting. This portrays Dutch disease symptom where attentions are moved out of the agricultural sector to the resourced-based sector (e.g. Oil sector). This follows the remarked theory of Dutch disease with regards to government spending and resources movement. The increase in government spending in the domestic economy which will definitely cause increase in domestic income and general price, and movement of human resource from agricultural sector can be part of the dwindling of the agricultural sector. Statistically put, a percentage increase in Algerian economic growth will cause a 0.008710 (−0.008710) decrease on agricultural sector in both periods (short run and long run). This is consistent with the findings of Dutch disease for the case of Norway by Rodriguez et al. (2017); Fardmanesh (1991).

Also, statistically significant negative relationship is confirmed between the explanatory variables that represent Dutch disease indicators (*government spending (GGFCE), crude oil price, real exchange rate*) and Algerian agricultural sector in both periods (short and long run). This follows the Dutch disease theory of spending effect and resources movement effect on the non-resourced sectors (agricultural sector for Algeria, and manufacturing sector for Norway). The impact of government spending in the domestic economy triggers a chain reaction that impact the Algerian agricultural sector through price and wage effects. When domestic income is increased through government spending, it will trigger the positive income elasticity of demand of non-traded sector which will appreciate thereby making non-traded good sector more profitable than the traded good sector (agriculture). This causes shrinking of the traded goods sector (agriculture). Again, following the increasing national (domestic) income, the boom in the resource sector will increase the marginal product of factors already employed in the booming sector (oil cum resourced sector) and likelihood of pulling (human/mobile) resources out of other sectors (most likely agricultural/non-resource sector for the case of Algeria and manufacturing sector for the case of Norway).

The negative relationship that exist between the crude oil price and agricultural sector could be seen having a link with spending and resource movement effects as well. The increase in crude oil price comes with multiplier effects through availability of income to the government disposal which will impact the domestic income, general price, and wage increase and triggers resource movement from non-resource (agriculture) sector to the booming sector (oil). This simply means that increase in crude oil price will translate to contraction of the agricultural sector.

Likewise, the adverse effect of real exchange rate on agricultural sector which is depicted with the negative relationship between real exchange rate and the agriculture. The impact of government spending will reflect on the exchange rate of the country through the appreciation of local currency against foreign currencies. This will reflect on the prices of the domestic produced goods due response to the general increase in the domestic prices, and will eventually discourage the patronage of the traded good sector of the country (Algeria) through increased prices. The reason is that the country is too small to influence the world market price. These findings are all in support of the findings by Neary and Van Wijnbergen (1985); Benjamin et al. (1989); Fardmanesh (1990); Fardmanesh (1991); Westin (2004); Oomes and Kalcheva (2007); Gelb (1988); Hasanov (2013); Rodriguez et al. (2017).

However, a statistically significant positive relationship is confirmed between FDI and Algerian agricultural sector. Resource availability in Algeria is expected to attract foreign investors to invest into viable and prospective sectors including agricultural sector in the economy. The link between FDI and resourced based economy is confirmed by the work of Anyanwu (2012). According to Anyanwu, resources (natural and human) are among the attracting forces of FDI. Scholars (Udemba, 2019a,b; Udemba et al., 2019; Shahbaz et al., 2013) have studied the impact of FDI to economic performance of different countries and found mixed (positive and negative) results. FDI could amount to positive impact on the economy through spillover effects if handled well by the policies of any country. Statistically, a percent increase in FDI will lead to 19 percent (0.198984) increase on Algerian agricultural sector in both periods (short and long run) respectively. This finding supports the findings from Owutuamor and Arene (2018); Msuya (2007); Slimane et al. (2016).

Furthermore, the findings from the Norwegian estimate tend to have the same trend with that of Algeria with signs of Dutch diseases. Hence, we present the result of Norwegian estimate as they appear in Table 6 below and discussions as follows: Statistically significant negative relationships are confirmed between the explanatory (*GDP, government spending (GGFCE), crude oil price, real exchange rate*) variables that proxy Dutch disease and manufacturing sector. From the finding, it is observed that Norwegian economic growth does not impact positively on the manufacturing sector which means that as the national income is growing the manufacturing sector is decreasing. A declining trend of manufacturing sectors of most European countries have been confirmed since early 1970s without a direct evidence of the factor behind the trend (Rodriguez et al., 2017). This might be not separated from the globalization and level of economic integration that have been established across the global economy and markets. Also, often times, money supply is found positively perfectly correlated with real GDP, this could mean that as the Norwegian national income grows the money supply also increases leading to contraction of the manufacturing sector. From the estimate, it could be seen that as the Norwegian Kroner increases in real GDP, it will lead to 0.0000000000229 (−2.29E-11) decrease in manufacturing sector's contribution to non-oil GDP. Again, one can think of the percentage input of manufacturing sector to the national income (GDP) growth of Norway after separating the oil percentage input, it will be no doubt less than the oil sector's contribution. This finding supports the findings by Rodriguez et al. (2017).

Dutch diseases theory of spending and resource movement effects are confirmed for the case of Norway through the government spending, crude oil price and real exchange rate. The responses of manufacturing sector to the increase in government spending, crude oil and real exchange rate are negative. Government spending initiates chain reaction that connect to both resources movement and real exchange rate in interacting with manufacturing sector. Revenue generated from the booming resource sector will empower and trigger government spending which will increase domestic income and induces general increase in demand and prices. This will cause rise in the wages of the mobile resources and the marginal productivity of the mobile resources in the booming sector will equally increase. This will cause resource movement from the traded good sector (manufacturing) to the booming sector because of rise in wages. This occurrences will affect the productivity of manufacturing sector and cause a contraction of the manufacturing sector.

Also, from the crude oil price increase, the manufacturing sector suffers from the world price effects in two ways which is responsible for a decrease in manufacturing sector (Fardmanesh, 1991). Increase in the cost of production of the resource (oil) and the cost of importing the resources (oil) as it amounts to be part of input in manufacturing sector (Marquez, 1986). This will reflect on the manufacturing sector through the increase in world relative prices of manufacturing thereby cause the manufacturing sector to contract. Oil price is a very sensitive parameter in studying impact of oil sector and Dutch diseases when its multi-dimensional effects is considered. It poses as a variable to measure world price with regards to oil production cost and cost of importing oil, and resources movement effects (Fardmanesh, 1991). Also, a drain of workers from manufacturing sector is possible when oil sector is considered juicy for workers.

From the perspective of real exchange rate, the general increase in price will result in the appreciation of domestic currency against the foreign currency that is used in the world market. This will adversely affect the patronage of the domestically produced goods from the world market because of the increase in the prices of the domestic products produced by the manufacturing sector. The above scenario painted buttressed and justifies the negative relationship that existed between government spending, crude oil price, real exchange rate and the dependent variable (manufacturing sector). Hence, statistically, a percent increase in GDP, government spending, crude oil price and real exchange rate will lead to 0.0000000000770 (−7.70E-11), 0.0000000000229 (−2.29E-11), 0.008410 and −0.001941 contraction of Norwegian manufacturing sector. This supports the theory of Dutch disease and confirms the symptom of Dutch diseases for the case of Norway. This is consistency with the findings of Neary and Van Wijnbergen (1985); Benjamin et al. (1989); Fardmanesh (1990); Fardmanesh (1991); Westin (2004); Oomes and Kalcheva (2007); Gelb (1988); Hasanov (2013); Rodriguez et al. (2017); Fardmanesh (1991).

A significantly positive relationship is confirmed between FDI and Norwegian manufacturing sector in both periods (short and long run). As remarked above, FDI impact on any economy could either be positive or negative depends on the efficiency of the country's policies. For a country like Norway, it is expected that the policy will work in favor of the Norwegian economic performance. The FDI impact on the economy is in multiple form through spillover of new skills, knowledge and technological innovation into the manufacturing sector which will cause economies of scale thereby creating new jobs which solves unemployment problem. Most times, the natural resource will attract the FDI but the impact will not be limited to the resourced sector but spread across

Table 7
Granger causality Table (for Algeria).

Null Hypothesis	F-stats	P-value	Causality	Direction
LGDP→AG	10.4451	0.0018***	YES	Uni-directional
AG≠LGDP	0.03896	0.8441		
LGE→AG	16.9541	0.0001***	YES	Bi-directional
AG→LGE	21.3377	2.E−05***		
FDI≠AG	0.08895	0.7664	NO	NEUTRAL
AG≠FDI	1.53462	0.2194		
LOP→AG	12.8548	0.0006***	YES	Bi-directional
AG→LOP	3.27395	0.0745*		
LRER→AG	4.35767	0.0403**	YES	Bi-directional
AG→ LRER	5.96098	0.0170***		
LGE≠ LGDP	0.55965	0.4568	YES	Uni-directional
LGDP→LGE	3.36816	0.0705*		
FDI≠LGDP	0.03827	0.8454	YES	Uni-directional
LGDP→FDI	3.05832	0.0845*		
LOP≠LGDP	0.11365	0.7370	NO	NEUTRAL
LGDP≠LOP	0.17917	0.6733		
LRER→LGDP	3.45827	0.0670*	YES	Uni-directional
LGDP≠LRER	0.02288	0.8802		
FDI→LGE	41.4699	1.E−08***	YES	Bi-directional
LGE→FDI	5.12181	0.0266***		
LOP→LGE	11.2444	0.0013***	YES	Uni-directional
LGE≠LOP	1.65487	0.2024		
LRER≠LGE	2.12192	0.1495	NO	NEUTRAL
LGE≠LRER	0.11585	0.7346		
LOP→FDI	2.83744	0.0964*	YES	Bi-directional
FDI→LOP	2.98076	0.0885*		
LRER≠FDI	2.12349	0.1493	NO	NEUTRAL
FDI≠LRER	0.09644	0.7570		
LRER≠LOP	1.37970	0.2440	YES	Uni-directional
LOP→LRER	5.62681	0.0203***		

Note: **, ** and *** represent significant at 10, 5 and 1 percent levels respectively. → and ≠ represent rejection and acceptance of null hypothesis (i.e. statement of no granger causality).*
Source: Authors computation

Table 8
Granger causality test (for Norway).

Null Hypothesis	F-stats	P-value	Causality	Direction
LGDP→MANU	5.94278	0.0164***	YES	Uni-directional
MANU≠LGDP	0.68997	0.4079		
GE≠ MANU	2.71639	0.1021	YES	Uni-directional
MANU→LGE	7.09653	0.0089***		
FDI→MANU	3.44586	0.0660*	YES	Uni-directional
MANU≠FDI	0.02934	0.8643		
LOP≠ MANU	0.15904	0.6908	NO	NEUTRAL
MANU≠LOP	0.05003	0.8234		
LRER≠MANU MANU≠	0.14354	0.7055	NO	NEUTRAL
LRER	1.66041	0.2002		
LGE≠ LGDP	0.01588	0.8999	NO	NEUTRAL
LGDP≠LGE	0.76873	0.3825		
FDI→LGDP	3.18980	0.0768*	YES	Uni-directional
LGDP≠FDI	0.06088	0.8056		
LOP≠LGDP	1.83309	0.1785	NO	NEUTRAL
LGDP≠LOP	0.22874	0.6334		
LRER→LGDP	3.88745	0.0511**	YES	Uni-directional
LGDP≠LRER	1.40870	0.2378		
FDI→LGE	2.77624	0.0985*	YES	Uni-directional
LGE≠FDI	0.02710	0.8695		
LOP≠LGE	0.35851	0.5505	NO	NEUTRAL
LGE≠LOP	0.01679	0.8971		
LRER≠LGE	0.96582	0.3278	NO	NEUTRAL
LGE≠LRER	2.42782	0.1220		
LOP≠FDI	0.00307	0.9559	YES	Uni-directional
FDI→LOP	3.00612	0.0857*		
LRER≠FDI	0.01200	0.9130	NO	NEUTRAL
FDI≠LRER	0.34307	0.5592		
LRER→LOP	5.86448	0.0171***	YES	Bi-directional
LOP→LRER	7.61410	0.0068***		

Note: *, ** and *** represent significant at 10, 5 and 1 percent levels respectively. → and ≠ represent rejection and acceptance of null hypothesis (i.e. statement of no granger causality).
Source: Authors computation.

the length and breadth of the other sectors in the economy including the manufacturing sectors. Hence, a percent increase in FDI will lead to 0.031392 increase in the Norwegian manufacturing sector both in short run and long run. This supports the findings from Owutuamor and Arene (2018); Msuya (2007); Slimane et al. (2016). The results of both Algerian and Norwegian estimates are presented in Tables 5 and 6 below.

5.4. Granger causality

In furtherance of this analysis for in-depth exposition of the symptoms of Dutch disease for the case of Algeria and Norway, we adopt granger causality analysis. This will buttress the findings from the long run cointegration estimations and establish the forecasting power of the variables from the lagged values of the variables. The findings from the granger causality for both countries are presented in Tables 7 and 8. Findings from Algerian granger causality estimation show an uni-directional granger causality from economic growth to agricultural, from oil price to government spending, from government spending to economic growth, from economic growth to FDI, from real exchange rate to economic growth, from oil price to real exchange, while bi-directional granger causality is confirmed between government spending and agriculture, oil price and agriculture, real exchange rate and agriculture, FDI and government spending, oil price and FDI. This finding established nexus among the Dutch disease variables especially from the bi-directional interactions between the variables, and hence, attests to the findings of Dutch disease symptoms from the long run cointegration.

Moreover, for the Norway granger causality analysis, we find uni-directional granger causality from GDP to manufacturing, from manufacturing to government spending, from FDI to manufacturing, from FDI to GDP, from real exchange rate to GDP, from FDI to government spending, from FDI to oil price, however, a bi-directional causality is found between real exchange rate and oil price. This finding reveals the direction of Dutch disease for Norway which is pointing towards the effect of real exchange rate and oil price. This will have immediate effect on manufacturing sector through the appreciation of domestic currency against the foreign currency used in the world market which will discourage the patronage of the products from the Norwegian manufacturing sector. Also, the effect of the relative world price that is triggered by the increase in oil price is seen negatively affecting the manufacturing sector as established by the long run cointegration analysis. Again, the finding reveals the implication of FDI on Norwegian economic performance through the impact of FDI to other variables in the granger causality analysis.

6. Concluding remark and policy discussion

Our study is a comparative analysis between two oil exporting countries (Algeria and Norway). The objective of this research is to test and expose the symptoms of Dutch disease for the two countries and recommend policy adoption for the less performing economy (Algeria) from the better performing economy (Norway). Historically, the two countries have some economic trend and patterns which points towards below (for the case of Algeria) and above (for the case of Norway) average economic performances due to poor (for Algeria) and good (for Norway) management of the two economies respectively. The two economies represent two extreme economies in the world of affluence (for Norway) and poverty (for Algeria) but are endowed with same natural resource. Studying and comparing the two economies will give room for policy adoption for enhancing the economic operations of the less performing economies with same features of natural resources availability.

We applied quantitative and scientific approaches such as ARDL-bound and dynamic long run cointegration and granger causality for clarity of objective in our research. Analyses were done on separate time series basis with two different models for the two countries. Findings from the ARDL dynamic and long run cointegration established symptoms of Dutch diseases for both countries with economic growth (GDP), government spending (GGFCE), crude oil price and real exchange rate having negative relationship with agriculture (for Algerian model) and manufacturing sector (for Norwegian model) respectively. Again, FDI is confirmed having significantly positive relationship with agriculture and manufacturing sector for Algeria and Norway respectively. Also, findings from granger causality established nexus among the Dutch disease variables especially from the bi-directional interactions between the variables, and hence, attests to the findings of Dutch disease symptoms from the long run cointegration for both economies.

However, despite the finding of symptoms of Dutch disease for the case of Norway, currently, Norway has been identified as among the best performing economies in the world. Hence, the policy recommendation should be framed on Norway policies for adoption by the less performing economy (Algeria). Among the policies applied by the Norwegian authority is transparency of oil revenue generation and its utilization in the country for better economic performance (growth and development). Another effective policy adopted by Norwegian authority is the policy of fund sterilization and channeling the sterilized fund into capital project with intention of cushioning the Dutch diseases effect on its manufacturing sector. The sterilized funds which are majorly proceeds from the resource sector are lodged in a special account created for the fund. This aid the authority to diversify the economy through the proceeds from the booming resource sector which are kept in a special account. Another strength of Norwegian authority in mitigating the Dutch disease is the quality of its institution with less impact of corruption. This helps the country to reduce the problem of mismanagement of the sterilized fund. The Algerian authority can adopt these policies for the effective utilization of the proceeds from its resource sectors which will create enabling ground for the revival of other sectors especially agricultural sector.

Conclusively, other oil exporting economies especially the developing countries among them can adopt the recommended policies from the Norway and revive their economies without being discouraged because of the notion of Dutch disease. This topic is still open for research with other sensitive variables like institutional quality.

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Data availability

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