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“Has Algeria suffered from the dutch disease? Evidence from 1960–2013 data"

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HAS ALGERIA SUFFERED FROM THE DUTCH DISEASE? EVIDENCE FROM 1960–2013 DATA*

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Abstract

Algeria is strongly dependent on oil exports revenues to fuel its economy and following the 1986 oil counter-shock this country has experienced a persistent decline of its manufacturing sector. Although it has benefited from high oil prices over the last decades and implemented a myriad of economic reforms, Algeria has failed to develop its manufacturing sector and diversify its economy. One of the main mechanisms through which fluctuations in oil prices can constitute an impediment to the development of the manufacturing sector, and hence to long-term growth, in an economy that heavily relies on a natural resource exports is referred to in the literature as the Dutch disease. This paper aims to test whether or not Algeria's economy has suffered from the main symptoms of this syndrome by analyzing data covering more than half-a-century. More specifically, we use annual data from 1960 to 2016 and investigate two important implications of this phenomenon that occur following an oil boom, namely, the spending effect and the resource movement effect. We perform some simple tests of these signs of the Dutch disease using a set of regressions while controlling for some other factors that could have led to similar economic symptoms. The results do not allow us to unambiguously claim that the Algerian economy has suffered from the Dutch disease over the period under study.

Keywords: Algeria, Oil revenues, Manufacturing sector, Dutch disease, Real exchange rate, Economic growth, Time series.

JEL-codes: C32, O13, O14, O55, Q32, Q43.

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1. Introduction

A widely spread argument in both academic and institutional circles is that resource-rich countries face the following tradeoff. On the one hand, the resource provides these countries' governments with revenues to foster economic development and increase social welfare. On the other hand, the behavior of the resource market may substantially unbalance growth across sectors. Hence, a resource boom such as a favorable shock in oil prices may lead to a significant appreciation of the domestic currency that will cause a contraction of the country's non-resource sectors, in particular, manufacturing. The latter known to be an important source of innovations and technological spillovers, the consequence would then be a permanent decrease of growth rates in the economy. This phenomenon has been characterized in the literature as the Dutch disease.[1]

A vast literature has investigated, on both theoretical and empirical grounds, this phenomenon seeking to bring evidence for its existence in natural resource-rich economies. Initially though, scholars mainly paid attention to the theoretical foundations of the Dutch disease concept. The seminal work by Corden and Neary (1982) is considered as a breakthrough in understanding the two fundamental mechanisms through which this phenomenon works, namely, the resource movement effect and the spending effect. The first effect refers to how a booming tradable sector drives resources away from a lagging tradable sector, whereas the second effect accounts for the outcome of increasing income from the booming sector being spent on the non-tradable sector and imports. As the literature grew, attention shifted to the empirical examination of the existence of Dutch disease and its consequences. The most recent studies further explore this issue by investigating policy implications and responses to the Dutch disease with an emphasis on fiscal policy.

While Algeria is among the top 10 net oil exporters in the world and the top three oil producers in Africa, this country is strongly dependent on oil exports revenues to fuel its economy since oil exports account for 98% of total exports, contributes over 60% of the total government revenues, and accounts for 30% of GDP. The Algerian economy is thus permanently exposed to oil price fluctuations. During the 1970s, Algeria has benefited from important revenue windfalls thanks to the sharp increase in oil prices following the 1973 and

[1] The Dutch disease is typically associated with mineral resources. Representative examples of events in economic history the consequences of which have been given a Dutch disease-type of interpretation include the discovery of gold in Australia in the 1850s, the gas boom in the Netherlands in the 1960s, the North Sea Oil in the 1970s, and the experience of oil-exporting countries following the boom in oil prices. However, its mechanics are also valid in some other contexts such as a wealth increase that springs from a technological improvement in the non-mining tradable sectors or a large inflow of foreign aid to developing countries.

1979 oil shocks. These substantial revenues gave it the opportunity to design and implement a promising development strategy based on massive investments in infrastructure and heavy industries in order to catch-up with the high-income economies. Algeria's industrialization process was indeed regarded as the *sine qua non* condition to reach sustained levels of economic and social development.

Throughout the 1970s and up to the early 1980s, Algeria gave the impression of a country enjoying economic development and socio-political stability. This period was characterized by sustained levels of economic growth at an annual rate of 4.7% on average over the 1970–1985 period and significant improvements of social welfare. The contribution of the manufacturing sector to GDP increased from 12% in the late 1960s to reach 16% in the 1970s. Following the 1986 oil counter-shock, however, the Algerian economy unveiled its structural vulnerability.

This sudden slump in oil revenues jeopardized the government's ability to support employment and domestic consumption. The country was on the verge of bankruptcy and was forced to implement drastic measures, such as freeze investment spending in the industrial sector. In fact, this period announced the inception of the country's deindustrialization process. Indeed, the share of manufacturing output fell from 11.38% in the 1980s to 7.46% in the 1990s. As a result, the economy plunged into a long recession. The growth of GDP decreased significantly between 1986 and 1994 falling from 4.7% to 1.4% between 1986 and 2002. Moreover, high inflation rates, foreign debt, and unemployment were recorded. The industrial sector in Algeria had continued to experience sluggish growth since shortly after the adoption, in 1994, of the Structural Adjustment Program.

Despite some oil revenue windfalls and a myriad of economic reforms introduced by the government to improve the country's industrial performance, Algeria is still struggling to develop its manufacturing sector and diversify its economy. On the contrary, the contribution of manufacturing output to GDP fell from 11.5% to 5.9% during the 1995–2013 period. The daunting questions that these observations call for are then: To what extent can one attribute the steady decline of the Algerian manufacturing sector to the availability of oil resources and why is it that this sector hasn't positively responded to the many governmental policies aimed at diversifying the economy? The answers to these questions clearly take us to the heart of the Dutch disease argument and this study questions its validity as an explanatory story for the evolution of the Algerian economy.

The main purpose of this article is to test whether or not Algeria's economy has suffered from the main symptoms of the Dutch disease by analyzing data covering more than half-a-century. More specifically, we use annual data from 1960 to 2013 to investigate two important implications of this phenomenon, that have been extensively discussed in the literature, the spending effect and the resource movement effect. According to the former, the real exchange rate of the domestic currency should appreciate while the latter merely says that the manufacturing sector should shrink. We test for these signs of the Dutch disease using a set of regressions while controlling for other factors that could have led to similar economic symptoms.

The remainder of this paper is organized as follows. Section 2 overviews some studies that are most related to our work. Section 3 briefly describes our data, and discusses the econometric methodology used to analyze them. Section 4 reports our results and Section 5 summarizes our findings and gives some concluding remarks. An appendix contains complementary material on the data and their sources.

2. Related literature

This section surveys some of the most important theoretical pieces on the Dutch disease phenomenon and discusses some empirical studies that are most related to our work. This review is by no means exhaustive but rather serves the purpose of guiding us in identifying relevant variables and choosing appropriate proxies for these variables.

In the literature on the Dutch disease, the core model is usually associated with Corden and Neary (1982). A presentation of these authors' complete model is clearly beyond the scope of our empirical paper, yet it is useful to recall here its main ingredients and the lessons to be drawn. In its basic form, this model considers a small open economy comprising three sectors, a booming sector, a tradable goods sector, and a non-tradable goods sector.[2] The prices of the goods in the booming and the tradable goods sectors are set in the world market whereas those of the non-tradable goods are determined by domestic factors. Output in the three sectors is produced by means of two inputs, a sector-specific input and labor assumed to be mobile among the three sectors.

These authors identify two effects of the booming sector on the economy. The first effect is referred to as the resource movement effect or direct deindustrialization. The increase of labor demand in the booming sector leads to a shift of labor from the tradable sector to the booming sector and thus will directly decrease output in the tradable sector. Moreover, the movement of labor from the non-tradable sector to the booming sector at constant prices will reduce the

[2] The booming sector is typically the oil or gas sector but can include other minerals. The tradable goods sector generally refers to manufacturing and/or agriculture and the non-tradable goods sector to services.

supply of non-tradable goods and create an excess demand in this market. Consequently, the price of non-tradable goods in terms of tradable goods rises and this real appreciation of non-tradable goods further shift resources out of the tradable goods sector into the non-tradable goods sector.

The second effect, known as the spending effect or indirect deindustrialization, stems from the fact that the boom brings in national income and hence increases demand for both the tradable and non-tradable sectors' products. The price of the non-tradable good will thus rise while those of the other sectors' products remain unchanged as they are determined in international markets. As a result, the non-tradable sector's output diminishes because the increase in their relative price harms domestic production and makes it less attractive.

The combination of these two effects creates the so-called Dutch disease. Although Corden and Neary (1982) focus on describing the mechanism through which the tradable goods sector contracts subsequent to a boom in the mineral sector, they indicate that their conclusions may be altered in several ways. In particular, they show that by modifying some of the underlying assumptions, the predicted negative effects of the boom on the tradable goods sector may be less severe and even, in some cases, that there may not be a Dutch disease at all.[3]

A large stream of the literature has contributed to the Dutch disease theory based on Corden and Neary's model. For instance, Wijnbergen (1984) points out that the Dutch disease phenomenon becomes a real issue when a process of *learning by doing* that stimulates technological progress is trapped in the tradable goods sector. This author presents a straightforward two-sector-two-period model in which productivity in the second period depends on the first period's output and tests the assumption that a temporary decline in the "new technology" producing sector permanently lowers productivity and hence the country's income per capita. The author also investigates the question of whether oil revenues from a boom and their negative impact upon the tradable goods sector could be alleviated by increasing production subsidies. He finds that the optimal size of the production subsidy is the result of a tradeoff between current welfare losses and future benefits associated with such a subsidy.

A whole strand of the literature has attempted to customize the above theoretical framework to less developed economies. Focusing on the impact of oil resources in Cameroon, Benjamin, *et al*. (1989) argue that if some important characteristics of developing countries, such as imperfect substitutability between domestic and imported goods, are

[3] For instance, Corden (1984) shows that if an economy is initially in a situation where all domestic resources are not fully employed before the boom, the latter may actually have a stimulating effect on the tradable sector.

included in the basic model, then the standard conclusions may change. Using a multisectoral computable general equilibrium model to assess the impact of an oil revenue increase on the economy, they find rather poor support for Dutch disease. Indeed, they conclude that not only the boom of the resource sector had no significant negative effect on manufacturing, but also, strikingly, that some industrial sectors have even shown signs of growth. Nevertheless, they find that the agricultural sector has seemingly declined following the boom.

A plethora of empirical studies has investigated the existence of the Dutch disease in different countries. For example, Fardmanesh (1991) uses 1966–1986 annual data on five oil-exporting developing countries, namely, Algeria, Ecuador, Indonesia, Nigeria, and Venezuela to estimate a three-sector reduced form model and investigate the impact of an oil boom/price increase on the economy. The author finds that, on the one hand, under the pressure of the spending effect the agricultural sector shrinks and the non-traded goods and the protected manufacturing sectors expand. On the other hand, due to the world-price effect, the agricultural sector contracts and the protected manufacturing sector expands. To illustrate his point, he argues that the oil price surge of the 1970s led to a shrinking of the agricultural sector and an expansion of the (protected) manufacturing sector and, to some large extent, the non-traded goods sector. Conversely, the oil collapse of the 1980s has ultimately promoted the agricultural sector and undermined the manufacturing sector and non-traded goods sectors. In sum, the analysis of these panel data provide empirical support to the Dutch disease hypotheses.

Oomes and Kalcheva (2007) investigate whether from 1995 to 2005 the Russian economy has seen its real exchange rate appreciate and the growth of its manufacturing sector slow down. Regarding the first symptom, they estimate the empirical long-run relationship between the real exchange rate and its determinants. They find evidence of stable cointegration relationships between the real exchange rate, the oil price, and other relevant variables for the period. Regarding the second symptom, they use sector-level data to compare growth rates across Russian sectors for output and employment. They find evidence that Russia also exhibited this symptom of Dutch disease. However, the authors emphasize that it is difficult to conclude that the observed symptoms are indeed the result of the Dutch disease, because they can be explained by other factors that presumably they didn’t control for.

Recently, Mironov and Petronevich (2015) have investigated the effects of the oil boom of the 2000s on the Russian economy. Based on the predictions of the classical model of Corden and Neary (1982), their analysis seeks to characterize the linkages between changes in the real effective exchange rate of the Russian Ruble and the evolution of the Russian economic structure over the 2002–2013 period. Controlling for the existence of large-scale state-owned enterprises, an important feature of the Russian economy, they provide evidence of a negative relationship between the real effective exchange rate and growth of the manufacturing sector as well as total income of workers. Moreover, they find that real effective exchange rate and return on capital are positively related in all of the three sectors considered in the standard model, namely, oil, manufacturing, and services.

It appears from the above, admittedly not exhaustive, literature review that the empirical evidence on the existence of the Dutch disease remains mixed and generally inconclusive. Although it has been observed in many countries, there is a broad consensus among researchers that the phenomenon need not be an unavoidable consequence of a natural resource boom. In some countries, such as the Netherlands and Norway, the negative impact of the real exchange rate appreciation on the manufacturing sector appears to be very small. Relatedly, Sachs and Warner (2001) find that countries with high resource-exports to GDP ratios experience lower growth rates. More recently, Ismail (2010) finds a much stronger evidence of Dutch disease effects with a 10% increase in an oil windfall associated with a 3.4% fall in value added across manufacturing sectors. These effects are larger in economies that are more open to capital flows and with relatively less capital-intensive manufacturing sectors. Other studies corroborate similar findings. For instance, a panel data study of 62 Sub-Saharan and developing countries by Elbadawi *et al*. (1997) and another study by Lartey (2008) for Philippines find evidence of Dutch disease effects.

To conclude this review, we should mention that it has been suggested in the literature on the Dutch disease that the mixed findings may be explained by the failure of most of the studies to take into account the country's political framework and the nature of the country's institutions.[4] An alternative point that the literature has pointed out is the difficulty in claiming that the observed symptoms are indeed the result of the Dutch disease syndrome for these symptoms may have occurred as a consequence of other factors such as the emerging role of China in the world economy or unobservables that haven't been controlled for.

3. Data and econometric methodology

As already indicated, the Dutch disease may occur through two interrelated channels, the spending effect and the resource movement effect channels.[5] As far as empirical identification

[4] This point has been emphasized by Gylfason, (2001) and Robinson *et al*. (2006) among others.

[5] It should be pointed out here that if the booming sector employs relatively few workers and labor mobility is low, then the spending effect is expected to dominate the resource movement effect (Oomes and Kalcheva,

of these two effects is concerned, the literature has typically considered that evidence of the former is provided by the occurrence of a real exchange rate appreciation while the latter reflects in a contraction in the output growth of the manufacturing sector. We should, however, realize that while testing for these effects through the modeling of these outcome variables, it is important to take care of the quite subtle task of controlling for other factors that could lead to similar outcomes.

The existence of a positive nexus between the real effective exchange rate and real oil prices is known to be a necessary condition for the presence of the Dutch disease since it triggers the process through which an increase in oil prices negatively affects local non-booming sectors. Needless to say, that the number and the nature of the economic fundamentals that have an effect on the real effective exchange rate depends on the economic characteristics of a country, in particular, its level of development.[6] Naturally, how complete the equation to be specified for modeling this variable also hinges on the extent to which appropriate data are available.

We collected annual data from 1960 to 2013 on the real effective exchange rate of the Algerian dinar, *reer*, real oil prices, *rop*, the productivity differential between Algeria and its major trading partners, *prod*, government expenditure expressed as a percentage of the gross domestic product (GDP), *gex*, net foreign assets, *nfa*, terms of trade, *tot*, manufacturing value added, *manu*, inflation rate, *inf*, real GDP per capita, *rgdp*, and degree of openness, *open*. Table 1 below lists these variables, while the appendix gives more detailed information on these variables and their data sources, and discuss the effect of these variables that theory allows us to expect.

All the variables were transformed into their natural logarithm prior to performing our econometric analysis in order to minimize the effect of the significant differences in their magnitude and interpret the estimated coefficients as “elasticities” of the dependent variable with respect to the corresponding independent variables. More importantly, this log-transformation has been shown to alleviate the problem of heteroscedasticity (Maddala and Kim, 1998).

2007). This seems a priori to be the case in Algeria since employment in the oil sector accounted, on average, for no more than 2% of the country’s total employment over the decade 1980–1992 (ONS, 2012).

[6] The issue of the determinants of the real exchange rate has attracted much interest in applied macroeconomics. For a recent empirical piece, see Kakkar and Yan (2014) and the references cited therein.

Table 1: Variables and designation

Variable	Designation
reer	Real effective exchange rate
rop	Real oil prices
prod	Productivity differential
gex	Government expenditure
nfa	Net foreign assets
tot	Terms of trade
manu	Share of manufacturing sector in GDP
inf	Inflation rate
rgdp	Real GDP per capita
open	Degree of openness

We perform our empirical work in two stages. We first tackle the task of testing the spending effect. To this end, we focus on detecting the existence of a long-term relationship between the real exchange rate and real oil prices while controlling for other factors. We rely on unit root tests to determine the order of integration of the appropriate time series and then apply cointegration and error correction techniques within an Autoregressive-Distributed Lag (ARDL) framework. We then investigate the existence of the resource movement effect in the Algerian data by means of a regression model in which the dependent variable is our proxy for output of the manufacturing sector and the independent variable of interest, next to some control variables, is the real exchange rate. Cross-examining the results obtained in those two stages of the analysis will then allow us to infer on whether the oil price fluctuations have had a long-term negative impact of manufacturing in Algeria.

Valid temporal data analysis requires first checking the stationarity of the time series under consideration. The standard recommendation is to test out the stochastic properties of the variables to be used in the estimation of econometric relationships using a unit root test and a complementary stationarity test. When both types of tests are in agreement, then we are in a position to come to a clear-cut conclusion. Hence, a battery of standard univariate unit root tests was used in this study. More specifically, three tests were conducted, the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test, and the Kwiatkowski, Phillips, Schmidt and Shin (KPSS) test.

The unit root testing procedure is well established in the literature and will therefore not be discussed here with great details. The ADF and PP tests are designed to test the null hypothesis of a unit root against the alternative of no unit root. Unlike the ADF and PP tests, the KPSS test is a test of stationarity with the null being that the series is stationary. A rejection of the null hypothesis of stationarity in the KPSS test would then tend to corroborate a failure to reject the null hypothesis of a unit root in the ADF and PP tests. Three different specifications of these tests are available. The first excludes both the trend and the intercept. A second specification includes the intercept but excludes the trend term. The third specification includes both the trend term and the constant term. Following Harris *et al.* (2002), we include both the trend term and the constant term in our analysis.

The results of unit root tests indicate that the time series under consideration are either integrated of order zero, I(0), i.e., stationary or of order one, I(1).[7] Thus, it is necessary to apply an appropriate econometric technique to tackle the problem of mixed order of integration of the data. We choose to estimate and analyze the long-run relationships and dynamic interactions among our variables of interest by using the bounds testing or ARDL cointegration procedure developed by Pesaran *et al.* (2001).

The appendix provides a formal description of the bounds procedure. Applying this procedure to our variables amounts to taking:

$$z_t = (y_t, X_t) = (reer_t, rop_t, prod_t, tot_t, open_t, nfa_t, gex_t) \quad (1)$$

where $y_t = reer_t$ is the I(1) dependent variable and $X_t = (rop_t, prod_t, tot_t, open_t, nfa_t, gex_t)$ is the matrix of I(0) and I(1) regressors with a multivariate identically and independently distributed zero mean error vector. This leads to the following vector equilibrium correction model (VECM):

$$\begin{aligned}\Delta reer_t = {} & c_0 + \delta_1 reer_{t-1} + \delta_2 rop_{t-1} + \delta_3 prod_{t-1} + \delta_4 tot_{t-1} + \delta_5 nfa_{t-1} + \delta_6 gex_{t-1} \\ & + \sum_{i=1}^{p} \phi_i \Delta reer_{t-i} + \sum_{i=1}^{q} \varphi_i \Delta rop_{t-i} \\ & + \sum_{i=1}^{r} \omega_i \Delta prod_{t-i} + \sum_{i=1}^{s} \vartheta_i \Delta tot_{t-i} \\ & + \sum_{i=1}^{l} \mu_i \Delta nfa_{t-i} + \sum_{i=1}^{k} \xi_i \Delta gex_{t-i} + \varepsilon_t, \qquad t = 1,2, \dots, T\end{aligned} \quad (2)$$

[7] The literature on macroeconomic time series analysis points out the importance of testing for structural breaks in the data. We performed additional unit root tests that allow for the presence of one or multiple structural breaks, namely, the Zivot-Andrews test (ZA) and the Clemente-Montañés-Reyes (CMR) tests. The findings confirmed that our data exhibit mixed orders of integration, and thus, investigating the spending effect requires the use of ARDL bound test procedure. The results of these tests are available upon request.

The implementation of the ARDL bounds testing procedure involves three steps. A first step is to estimate equation (2) using OLS and perform an F-test that allows to check the predictive power of the lagged variables. More specifically, we examine the joint significance of the coefficients of the lagged variables by formulating a test of the null hypothesis

$$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0 \tag{3}$$

against the alternative hypothesis

$$H_1: \delta_1 \neq 0 \ \text{ or } \delta_2 \neq 0 \text{ or } \delta_3 \neq 0 \ \text{ or } \delta_4 \neq 0 \text{ or } \delta_5 \neq 0 \text{ or } \delta_6 \neq 0 \tag{4}$$

that is, at least one of the lagged variables has some predictive power. The decision of the cointegration test based on this reer-normalized F-statistic, $F_{reer}(reer/rop, prod, tot, nfa, gex)$, is as follows. There are two asymptotic critical values of the bounds that provide such a test when the independent variables are I (d) where $0 \leq d \leq 1$: A lower value assuming the regressors are I(0) and an upper value assuming purely I(1) regressors. If the F-statistic is above the upper critical value, the null hypothesis of no long-run relationship can be rejected irrespective of the orders of integration of the time series. If the F-statistic falls below the lower critical value, the null hypothesis cannot be rejected. Finally, if the F-statistic falls between the lower and upper critical values, the result is inconclusive.[8]

Once cointegration has been established, the second step of the ARDL bounds testing procedure consists in estimating the conditional ARDL (*p*,*q*,*r*,*s*,*l*,*k*) long-run model of the dependent variable as:

$$\Delta reer_t = c_{0+} \sum_{i=1}^{p} \delta_{1i} reer_{t-i} + \sum_{i=1}^{q} \delta_{2i} rop_{t-i} + \sum_{i=1}^{r} \delta_{3i} prod_{t-i} + \sum_{i=1}^{s} \delta_{4i} tot_{t-i} + \sum_{i=1}^{l} \delta_{5i} nfa_{t-i} + \sum_{i=1}^{k} \delta_{6i} gex_{t-i} + \varepsilon_t, t = 1,2, \dots, T \tag{5}$$

[8] The approximate critical values for the F-statistic were obtained from Pesaran and Pesaran (1997).

where all variables are as previously defined. As it is clear from equation (5), this formulation involves selecting the orders of the ARDL(*p*,*q*,*r*,*s*,*l*,*k*) model in the six right-hand-side variables, which we do using the Akaike information criteria (AIC).

In the third and final step, we obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates. This model is specified as:

$$\Delta reer_t = \lambda + \sum_{i=1}^{p} \phi_i \Delta reer_{t-i} + \sum_{i=1}^{q} \varphi_i \Delta rop_{t-i} + \sum_{i=1}^{r} \omega_i \Delta prod_{t-i} + \sum_{i=1}^{s} \vartheta_i \Delta tot_{t-i} + \sum_{i=1}^{l} \mu_i \Delta nfa_{t-i} + \sum_{i=1}^{k} \xi_i \Delta gex_{t-i} + \gamma ecm_{t-1} + \varepsilon_t, t = 1,2,\dots,T \tag{6}$$

where the $\phi's$, $\varphi's$, $\omega's$, ϑ's, μ's, and ξ's are the short-run dynamic coefficients of the model once it has converged to equilibrium and ecm_{t-1} is the error (or equilibrium) correction term derived from the confirmed long-run equilibrium relationship and γ is the coefficient associated with this error correction term.[9]

To examine the existence of the resource movement effect in our dataset on Algeria, we estimate the following regression with the variables transformed into their natural logarithms:

$$\ln(manu_t) = \beta_0 + \beta_1 \ln(reer_t) + \beta_2 \ln(rop_t) + \beta_3 \ln(inf_t) + \beta_4 \ln(open_t) + \beta_5 \ln(rgdp_t) + \varepsilon_t, t = 1,2,\dots T \tag{7}$$

Then, we check that some key assumptions are verified in the data for the estimates to be reliable. Given the dynamic nature of our data, we have investigated the issues of multicollinearity and heteroscedasticity.

Multicollinearity occurs when there are high correlations among independent variables, leading to unreliable and unstable estimates of regression coefficients. A widely used diagnosis for multicollinearity is the variance inflation factor (VIF). A VIF of 1, its lower bound, means that there is no correlation among the k^{th}predictor and the remaining predictor variables, and hence the variance of the associated coefficient, β_k in the standard regression

[9] This series is obtained from the estimation of equation (5) as the values of the residuals lagged once. It measures the variables' speed of convergence to their equilibrium level after a shock and it is expected to have a significant negative value which usually ranges between -1 and 0.

analysis notation is not inflated at all. The general rule of thumb is that VIFs exceeding 4 warrant further investigations while VIFs exceeding 10 are signs of serious multicollinearity requiring correction (Kutner *et al.*, 2004).

The second problem that potentially plagues dynamic data such as ours is autocorrelation of the error terms meaning that the error terms are not homoscedastic. If the model suffers from autocorrelation, it loses much of its predictive power. To detect the presence of serial correlations in the residuals, the standard practice is to use the Durbin Watson (DW) test. If the DW-statistic lies between 1.5 and 2.5, it indicates no autocorrelation. If it lies below 1.5 or above 2.5, it indicates respectively positive and negative autocorrelation, in which case "robust" rather than standard OLS residuals should be used in the inferences.

4. Empirical results

4.1. Stationarity

The ADF and PP unit root tests discussed in the previous section are applied to our time series in both their levels and their first differences. Table 2 below gives the results of these tests. We see from this table that while the null hypothesis of the existence of a unit root against the alternative hypothesis of stationarity is accepted for all the series in their levels, it is systematically rejected for the series in their first differences. Therefore, we conclude that all variables are I(1), i.e., integrated of order one.

The results of the KPSS test, which are presented in Table 3 below, show that, in levels, the null hypothesis of the series being stationary is rejected for *reer*, *prod*, and *nfa* and accepted for *rop*, *tot*, *open*, and *gex*. We also see from this table that all the series are stationary in their first difference. On the basis of these results, we can thus infer that the series *reer*, *rop*, *prod*, and *nfa* are integrated of order one, i.e., I(1), while *tot* and *gex* are I(0). These mixed results from the analysis of unit root properties of our time series further confirm the appropriateness of using an ARDL model to investigate the existence of a cointegration statistical relationship among the variables.

Table 2: ADF and PP unit root tests+

Variable	(ADF-statistic, Lag)	(PP-statistic, Lag)
Series in levels		
reer	(-2.201, 2)	(-2.002, 3)
rop	(-1.584, 1)	(-1.723, 3)
tot	(-2.153, 1)	(-2.221, 3)
prod	(-1.600, 1)	(-2.201, 3)
nfa	(-0.587, 4)	(-0.679, 3)
gex	(-0.887, 1)	(-1.029, 3)
Series in first differences		
reer	(-3.638*, 0)	(-3.819*, 3)
rop	(-5.636*, 0)	(-7.725*, 3)
tot	(-6.736*, 0)	(-6.732*, 3)
prod	(-9.501*, 0)	(-9.355*, 3)
nfa	(-8.684*, 0)	(-9.641*, 3)
gex	(-7.077*, 0)	(-7.081*, 3)

+A "*" attached to a value of the ADF- or the PP-statistic indicates a rejection by the test of the null hypothesis H_0 that the series is a unit root process, in which case it is not stationary, at the 5% statistical significance level.

Table 3: KPSS unit root test+

Variable	(KPSS-statistic, Lag)
Series in levels	
reer	(0.223, 3)
rop	(0.141*, 3)
tot	(0.132*, 3)
prod	(0.149, 3)
nfa	(0.311, 3)
gex	(0.115*, 3)
Series in first differences	
reer	(0.097*, 3)
rop	(0.019*, 3)
tot	(0.067*, 3)
prod	(0.128*, 3)
nfa	(0.109*, 3)
gex	(0.109*, 3)

+A "*" attached to a value of the KPSS-statistic indicates a no rejection, at the 5% significance level, of the null hypothesis H_0 that the series is stationary against the alternative hypothesis H_1 that it is a unit root process.

4.2. The spending effect

To explore the existence of the spending effect in our data we undertake an ARDL cointegration analysis. Recall that the ARDL procedure assumes that only one long run relationship exists between the dependent variable and the exogenous variables (Pesaran *et* *al*., 2001). Accordingly, we estimate equation (2) to test for the presence of a long run relationship between the variable *reer* and the variables *rop, prod*, *tot, nfa*, and *gex*.[10]

Constrained by the length of our data span, we use a general-to-specific modeling approach and a model selection procedure based on the AIC criterion to set a maximum lag order of 2 for the conditional ARDL-VECM.[11] Then, the joint significance of the coefficients associated with the retained lagged variables is tested by means of an F-test of the null hypothesis that these coefficients are all equal to zero meaning that no long-run relationship exists between *reer* and the set of variables *rop, prod, tot, nfa*, and *gex*. The existence of such a cointegration relationship is accepted if this F-test rejects the null. Table 4 below synthesizes the results that are essential for reaching a decision.[12]

Besides showing the value of the reer-normalized F-statistic, $F_{reer}(reer/rop, prod, tot, nfa, gex)$ = 1.52, it gives the critical values of the bounds for small samples.[13] This F-statistic falling below the lower critical bound for all three significance levels typically considered (1%, 5%, and 10%), we conclude the variables *reer* and *rop, prod, tot, nfa*, *gex* are not in a cointegrating long-run relationship, and hence that there is no empirical evidence in our data that would support the occurrence of the spending effect in the Algerian economy throughout the 1960–2013 period.

Table 4: Bounds test for cointegration

Significance level	Critical value	
	I(0) Lower bound	I(1) Upper bound
1%	3.41	4.68
5%	2.62	3.79
10%	2.26	3.35
F-statistic: 1.52		

Instead of contenting ourselves with this conclusion, we may ask the following question. Is there anything structural about the Algerian economy that may have prevented the spending effect from actually occurring? Algeria has implemented a managed float exchange rate policy since 1995 with the objective of maintaining a stable real exchange rate against a

[10] Based on the ZA and CMR unit root tests results, which have indicated the presence of some breakpoints in *reer* and *tot* series, we estimated an ARDL that includes three dummy variables. The results showed that the coefficents associated with these variables are not statistically significant. Moreover, adding these dummies did not affect the bound test outcome as we failed to reject the null hypothesis of no cointegration again. We thus not to include them in our regression.

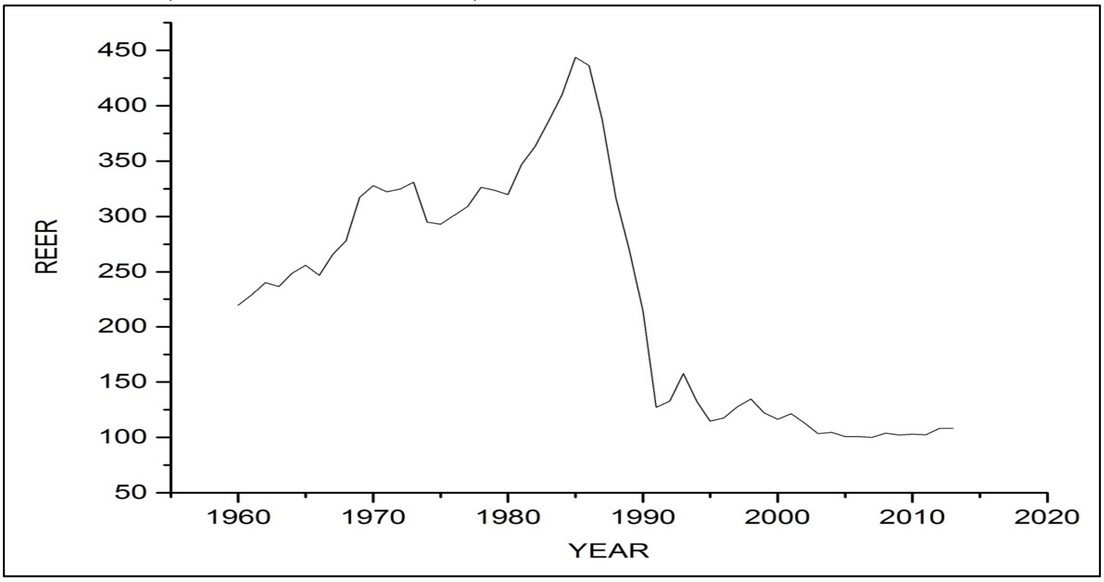
[11] This lead to select an equation with an intercept and with no linear trend.

[12] Detailed estimation results are available from the authors upon request.

[13] These bounds are those that have been generated by Narayan (2004) for samples with size between 30 and 80 observations.

basket of currencies of this country's main trading partners and competitors. As depicted in Figure 1 below, the real exchange rate of the Algerian dinar has persistently depreciated since then by about a yearly average of 0.81%. This could explain, indeed, to some large extent, the fact that oil price increases did not result in an appreciation of the real exchange rate of the Algerian dinar, and thus spared Algeria's economy from the supposedly expected symptom of the spending effect.

Figure 1: The real effective exchange rate of the Algerian dinar (1960-2013, 100 = 2007)



4.3. The resource movement effect

Prior to investigating whether or not the resource movement effect has occurred in Algeria, it is useful to take a glance at the data. Table 5 below gives some descriptive summary statistics of the time series used in the analysis of such an effect. More specifically, this table reports the mean, the standard deviation, the minimum, and the maximum of each variable of equation (7) in addition to the variable *mining*, which represents the value added of the mining sector as a percentage of GDP. We see that, over the 1960–2013 period, the average contribution of the manufacturing sector to GDP is 8.32% and has varied between a minimum of 3.74% and a maximum of 13.57% with a standard deviation of 2.64.

Table 5: Summary statistics

Variable	Mean	St. Dev.	Min	Max
manu (%)	8.32	2.64	3.74	13.57
reer (index)	226.30	111.68	100	443.67
rop ($2014)	48.47	31.62	10.97	117.09
inf (%)	8.57	7.63	1.34	31.68
open (%)	0.55	0.11	0.33	0.77
rgdp ($2005)	2469.36	461.50	1513.22	3243.99
mining (%)	37.07	8.94	17.39	53.01

Unsurprisingly, the mining sector contribution to GDP is practically three times as large as that of the manufacturing sector with a mean of 37.07% and a standard variation from this mean of 8.94 from a minimum of 17.39% and a maximum of 53.01%. The average inflation rate is about 8.67% with a standard deviation of 7.63, indicating that the country has experienced high inflation levels that reached a maximum of 31.68%. The degree of openness of the Algerian economy is also quite high with a ratio of imports plus exports to GDP averaging 0.55, essentially reflecting the high level of both imports and oil exports, and hence the strong dependency of this economy from the rest of the world.

In order to assess whether there exists a causal (negative) relationship between the share of manufacturing value added in GDP and oil price variations in our data, we estimate equation (7) with OLS.[14] The estimation results are presented in Table 6 below. Although quite simplistic, the regression performed well, explaining over 83% of the variation in the dependent variable. The robustness checks indicate that the regression does not suffer from heteroscedasticity, multicollinearity, and autocorrelation problems. There is no problem of multicollinearity since the value of the VIF for each of the independent variable is less than 10. In addition, there is no problem of autocorrelation since the value of DW lies between 1.5 and 2.5. Finally, since the data were log-transformed any heteroscedasticity problem has been attenuated. Therefore, accurate inferences can be derived from this model.

[14] A preliminary indication of this relationship can be obtained from the correlation coefficients between the dependent variable and the various independent variables of equation (7) that are shown in Table A.1 of the appendix. These measures of the sign and strength of the (linear) relationship between these variables are quite informative indeed. We see that the correlation coefficients between the dependent variable, i.e., the share of manufacturing value added in GDP and each of the five independent variables included in equation (7) are no less than 40% showing that these variables are indeed good potential candidates as predictors of the dependent variable as will be confirmed by the performance diagnosis of our regression.

Table 6: The resource movement effect-OLS regression results+

Independent variables	Coefficient	Standard-error	t-statistic	p-value	VIF
ln_reer	0.46	0.05	9.11*	0.000	1.52
ln_rop	-0.32	0.07	-4.38*	0.000	3.64
ln_inf	0.15	0.03	5.75*	0.000	1.10
ln_rgdp	0.66	0.25	1.61	0.712	3.44
ln_open	-0.03	0.13	-0.26	0.797	1.54
Constant	-4.66	1.88	-2.48*	0.017	
F(5, 44): 44.23					
R-squared: 0.83					
Adjusted R-squared: 0.82					
DW-statistic: 2.24					

+ We indicate with a "*" statistical significance at a 5% level.

Quite surprisingly, there seems to be a positive relationship between the real effective exchange rate and manufacturing sector contribution to GDP which is inconsistent with the Dutch disease theory. According to the estimation results, a 1% increase in the real effective exchange rate leads to an increase of 0.45% in the manufacturing sector value added in GDP, ceteris paribus. One possible explanation of this finding, as pointed out by Shakeri (2009), is that the Dutch disease effect is very responsive to the country's manufacturing sector structure. The result is very likely to vary depending on whether or not the industries including in the sample are exposed to foreign competition. The industries that cater for the home market as a result of trade protection or that possess monopolistic price-setting power may benefit from the rise in domestic demand as a result of an oil boom. This ambiguous finding certainly calls for a further investigation with a more disaggregated data in order to draw a clear-cut conclusion about the effect of the real effective exchange rate on the growth of the manufacturing sector.

The negative sign of the estimated coefficient associated with the real oil prices variable is statistically significant and indicates that as oil prices increase, there is a contraction in the share of the manufacturing sector contribution to GDP. More specifically, all things equal, a 1% increase in real oil prices leads to a 0.32% decrease in manufacturing sector value added in GDP. At first glance, this finding may appear to be in contradiction with the previous results obtained from the spending effect estimation. Nevertheless, it proves that Algeria has experienced what might be thought of as a "partial" manifestation of the Dutch disease because deindustrialization did in fact happen, although it did not stem from an appreciation of the country's real exchange rate as the theory suggests.

This finding becomes even more interesting when one views it as providing a piece of evidence that oil revenues deriving from real prices hikes were squandered away without any lasting or significant improvements in the country's manufacturing sector.[15] That being said, a certain degree of caution has to be taken when interpreting this result because the series used to conduct this empirical analysis are annual. Indeed, the long period of time over which oil prices are observed can be subject to a multitude of fluctuations, and therefore the cause of the deindustrialization can also be attributed to many other factors.

The coefficient associated with the inflation variable is statistically significant and has the expected sign. It says that, all things equal, a 1% increase in inflation leads to a 0.14% increase in the manufacturing sector contribution in GDP. This result may seem to be in contradiction with the fact that Algeria's manufacturing sector actually experience persistent decline despite high inflation rates recorded over the 1960–2013 period. However, it corroborates the theoretical prediction that stipulates that higher inflation levels should lead to a rise in the price of tradable goods, and hence, to a subsequent expansion of the manufacturing sector. It should be stressed out here that the response of an oil-exporting country to inflation pressures that spring from an oil boom depends on the exchange rate regime.[16]

Although the coefficient associated with real GDP per capita, a variable that is supposed to control for the Algeria's level of overall economic development, is not statistically significant at a 5% level, it displays the correct sign. This finding shows that, ceteris paribus, increases in real GDP per capita have no measurable effect on the manufacturing sector. One possible explanation could be that despite increases in real GDP per capita in Algeria, their levels were not high enough to show in industrial development. Theory suggests that as a country's real GDP per capita augments, this wealth increase is expected to show in some sort of industrial development, which obviously does not seem to be the case, in any significant way, for Algeria.

The coefficient attached to the degree of openness is not significant and has the wrong sign. Indeed, one would expect a positive sign because an increase in the degree of openness of an economy is supposedly associated with a higher capacity of exports (McKinnon, 1963) and in the Dutch disease paradigm, only the manufacturing sector has the ability to export as non-tradable goods are subject to domestic consumption (Corden and Neary, 1982). Hence, a

[15] The question of why and how this has happened requires a deeper analysis of the political economy of the Algerian society which is beyond our current study.

[16] For instance, a recent study by Allegret and Benkhodja (2015) for the 1990–2010 period in Algeria concludes that, in order to stabilize output and inflation, monetary policy should focus on a core inflation target.

rise in exports is an indicator of an expansion of the tradable sector relative to the non-tradable sector. This result makes perfect sense considering the structure of Algeria's international trade, which is dominated to a large extent by oil exports.[17] In fact, this provides further evidence that a rise of the degree of openness in Algeria is essentially due to the increasing volumes of the mining sector exports rather than an expansion of the manufacturing sector exports.

5. Conclusion

This paper has sought to test whether or not Algeria's economy has suffered from the main symptoms of the Dutch disease by analyzing annual data from 1960 to 2013. To investigate the existence of the spending effect, we searched for empirical evidence of a robust long-run relationship between real oil prices and real effective exchange rate of the Algerian dinar. Using an ARDL approach and controlling for a set of relevant variables, we found no empirical evidence of the existence of a cointegration relationship between these variables. This led us to conclude that the data do not provide support to the spending effect.

Does this empirical rejection of the spending effect channel of the Dutch disease mean that the disease itself should be rejected? In view of the importance of the matter from a policy standpoint, we decided to investigate the resource movement channel as well. To this end, we estimated a regression with the share of manufacturing in GDP as the dependent variable and real exchange rate and real oil prices as independent variables next to some control variables that we thought were pertinent for the analysis. The results did not allow us to reach an unambiguous conclusion. Indeed, while the real effective exchange rate was found to have a positive impact on manufacturing, real oil prices had a negative impact on this sector.

While we are tempted to end our investigation by merely arguing that the diagnosis of the Dutch disease for the Algerian economy cannot be confirmed, we choose to give a couple of directions of research that would most likely shed further light on the subject. A first and rather technical issue that obviously needs to be tackled is simultaneity. In addition to carefully testing and accounting for endogeneity of the right-hand-side variables included in the two separate regressions that we used to model the spending and the resource movement effects, intuition as well as theory warrants the use of a simultaneous-equation framework to model these two interrelated effects. A second avenue of research is to attempt to understand the Algerian economy's deindustrialization puzzle by analyzing it in a more systematic way.

[17] For a recent study of the impact of Algeria's international trade structure on this country's oil real purchasing power, see Gasmi and Laourari (2015).

The Dutch disease is a possible explanation, but it is far from being the only one. Political economy as well as institutional quality, human capital, and wealth distribution considerations are among promising lines of thought.

Appendix

Variables used to test the spending effect and theoretical predictions

Real effective exchange rate (*reer*): This paper uses the real effective exchange rate of the Algerian Dinar against a basket of 41 trade partners' currencies adjusted for inflation using consumer price index series with a base year 2007 = 100. It is treated as a dependent variable and, provided the spending effect exists in the data, is expected to have a long run positive relationship with real oil prices. Data on this variable were extracted from the Darvas (2014) online database.

Real oil prices *(rop)*: This variable represents nominal oil price deflated by the US consumer price index (with 2014 as a base year). The data were obtained from the BP Statistical Workbook 2015. As to the effect of oil price booms on the real effective exchange rate, it is expected to be positive in the long run. In other words, it is expected that the real exchange rate appreciate following oil price increases.

Productivity differential (*prod*): Following Habib and Kalamova (2007), we proxy the productivity differential with a variable defined as the trade weighted relative productivity differential of Algeria against its trading partners' productivity where the productivity is taken to be PPP GDP per capita, i.e., GDP per capita based on purchasing power parity (PPP). This proxy is used to capture the so-called Balassa-Samuelson effect (Balassa, 1964) according to which countries with higher productivity growth in the tradable sector experience higher relative prices of non-tradables, and hence an exchange rate appreciation without a loss of competitiveness. Thus, it is expected that an increase in this variable leads to an appreciation of the real effective exchange rate. This *prod* series is computed using data from the IMF, the World Bank, and the UN Comtrade databases.

Net foreign assets (*nfa*): This variable corresponds to the ratio of total net foreign assets to GDP. It is meant to capture the impact of the foreign reserves on the real effective exchange rate. Note that it also provides an idea of the extent of government intervention in the capital of the economy. The series for this variable was computed using data obtained from the Office National des Statistiques (ONS), the National Currency and Credit, Rétrospective 1960–2011, and the IMF.

Terms of trade (*tot*): This variable represents the % value of Algeria's exports relative to that of its imports. If it is less than 1, there is obviously more capital going out than there is coming in while if it is greater than 1 it means that the country is accumulating capital, i.e., more money is coming in from exports. Note that this variable also informs on any changes in the international economic environment, in particular, in the foreign prices a country face. The sign of its relationship with the real effective exchange rate depends on the relative weights of the income and substitution effects and hence cannot unambiguously be predicted without ambiguity. The series are computed using data from The World Bank's Africa Development Indicators 2013 dataset.

Government expenditure (*gex*): This variable represents government expenditure as a ratio of GDP and is meant to capture the effect of fiscal policy on various aspects of an economy. No real consensus exists in the literature as to the impact of government spending on the real effective exchange rate. Indeed, it depends on where extra funds are channeled toward tradable or non-tradable goods and exchange rate tends to appreciate if non-tradables are receiving more and depreciate if tradables receive the extra funds (Iossifov and Loukoianova, 2007). The series are computed using data recovered from The IMF and The World Bank databases.

Variables used to test the resource movement effect and theoretical predictions

Manufacturing value added (*manu*): This variable aggregates the value added of the industries belonging to the International Standard Industrial Classification (ISIC) codes 15 through 37. The value added corresponds to the net output of a sector after adding up the value of all outputs and subtracting those of all the intermediate inputs. The origin of value added is determined by the ISIC revision 3. This variable is used as a proxy for the level of development of Algeria's manufacturing sector, hence for its level of industrialization. It is the dependent variable of equation (7) in the text. The figures for this variable have been collected from The World Bank databases.

Inflation rate (*inf*): This variable corresponds to the annual growth rate of the GDP implicit deflator, which is the ratio of GDP in current local currency to GDP in constant local currency. This variable is used in our regression to control for the general increase in price levels. The inflation rate is intended to capture the net short run impact on profitability resulted from changes in the cost of imported inputs associated to exchange rate movements together with the ability of firms to pass these costs on in the form of higher prices. The increase in the relative inflation rate should increase the profitability of each industry and therefore the expected sign of the coefficient associated with this variable should be positive. This series was downloaded from The World Bank databases.

Real GDP per capita (*rgdp*): This variable is the gross domestic product divided by midyear population and expressed in constant US dollars. It is included in our regression to control for the changes in Algeria's level of economic development. A per capita rather than a total measure is used in order to control for the relative size per economy. As the country develops and devotes more attention to the manufacturing sector, per capita GDP should increase. As such, this variable also controls for the industrialization process, and thus, is expected to have a positive effect on manufacturing. The series for this variable was obtained from the IMF and the World Bank databases and the ONS.

Real effective exchange rate (*reer*): This is the same variable used to investigate the spending effect. According to the Dutch disease theory, the sign of the coefficient attached to this variable in our regression (equation [7]) is negative since an appreciation of the real exchange rate is expected to harm the manufacturing competitiveness.

Real oil prices (*rop*): This is the same variable used to investigate the spending effect. The sign of the coefficient associated with this variable in our regression is negative since an increase in oil prices should to lead to an appreciation of the real exchange rate and thus to a manufacturing output contraction.

Degree of openness (*open*): This variable is defined as the ratio of the sum of imports and exports of goods and services to GDP. This indicator measures the country's openness or integration in the world economy. It is included in the regression to capture the effect of Algeria's international commerce policy. This criterion of openness has been used in multiple empirical papers to capture the degree to which an economy is exposed to trade (Kang *et al*., 2012). In the classical Dutch disease setting, this variable can have a significant effect on the manufacturing sector because an increase in this index means that the manufacturing sector exports more. One should then expect a positive sign of the coefficient attached to this variable in the regression. The series is computed with data recovered from The World Bank's Africa Development Indicators 2013.

The bounds test procedure

Following Pesaran *et al*. (2001), as summarized in Choong *et al*. (2005), we applied the bounds testing procedure by specifying a general vector autoregressive (VAR) model of order p in the $(k+1)$-variate random process z_t :

$$z_t = c_0 + \beta . t + \sum_{i=1}^{p} \emptyset_i z_{t-i} + \varepsilon_t , t = 1,2, \dots , T \quad \text{(A.1)}$$

where c_0, β, and the $\emptyset$'s are $(k + 1)$-dimensional vectors of respectively intercept, trend, and lagged-variable-associated unknown coefficients. Pesaran *et al*. (2001) derive the following vector equilibrium correction model (VECM):

$$\Delta z_t = c_0 + \beta . t + \prod . z_{t-1} + \sum_{i=1}^{p} \Gamma_i . \Delta z_{t-i} + \varepsilon_t , t = 1,2, \dots , T \tag{A.2}$$

where Δ is the first difference operator and the square $(k + 1) \times (k + 1)$ matrices $\prod = I_{k+1} + \sum_{i=1}^{p} \Psi_i$ and $\Gamma_i = - \sum_{j=i+1}^{p} \Psi_j$, $i = 1,2, \dots , p - 1$, I_{k+1} being the $(k + 1)$-dimensional unit matrix, contain the long-run multipliers and short-run dynamic coefficients of the VECM.

In our analysis, we take

$$z_t = (y_t, X_t) = (reer_t, rop_t, prod_t, tot_t, open_t, nfa_t, gex_t) \tag{A.3}$$

where $y_t = reer$ is the I(1) dependent variable and

$$X_t = (rop_t, prod_t, tot_t, open_t, nfa_t, gex_t) \tag{A.4}$$

is the matrix of I(0) and I(1) regressors with a multivariate identically and independently distributed zero mean error vector. Assuming that a unique long-run relationship exists among the variables, the conditional VECM given in equation (A.2) above rewrites as:

$$\Delta y_t = c_0 + \beta . t + \theta_{xx} x_{t-1} + \sum_{i=1}^{p-1} \delta_i \Delta y_{t-i} + \sum_{i=0}^{p-1} \phi_i \Delta x_{t-i} + \varepsilon_{yt}, t = 1,2, \dots , T \tag{A.5}$$

Correlation coefficients between the dependent variable and the independent variables in equation (7)

Table A1: Correlation coefficients

Variable *x*	Corr(*manu*, *x*)
reer	0.73
rop	-0.45
inf	0.42
open	-0.47
rgdp	-0.47

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