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# **External and Internal Exchange Rates and the Dutch Disease: Evidence from a Panel of Oil- Exporting African Countries**

**The author:**

Edouard Mien

School of Economics, University of Clermont Auvergne, CNRS, CERDI.

26 avenue Léon-Blum. F- 63000 Clermont- Ferrand, France.

Tel. +33 4 73 17 74 00

Fax +33 4 73 17 74 28

Email: edouard.mien@uca.fr

**Corresponding author:**

Edouard Mien

Email: edouard.mien@uca.fr

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## **Abstract**

Despite an increasing number of empirical studies on the Dutch disease in developing countries and the evidence that oil revenues tend to appreciate the real exchange rate, there are very few existing discussions about the definition of real exchange rates. This article intends to fill this gap by using different proxies of the real exchange rate and differentiating the internal and external real exchange rates for the agricultural and manufacturing sectors. Using Pooled- Mean- Group and Mean- Group estimates on a panel of nine African net oil- exporting countries, results show a clear appreciation of the exchange rates generated by an increase in oil revenues or international oil prices, except for the internal real exchange rate for manufacturing goods. This could imply that, in these African countries, oil revenues affect the competitiveness of agricultural sectors more clearly than the manufacturing ones. This article also tests potential cross-section dependence by implementing a Cross-sectionally augmented version of the Pooled-Mean-Group, which overall supports the previous results.

**Keywords:** Dutch disease, Oil revenues, Pooled- Mean- Group estimator, Equilibrium real exchange rate, Africa.

## 1. Introduction

There is an ample literature related to the role that natural resources, especially oil, can play in explaining the absence of growth-producing structural transformations in developing countries, particularly in Africa. This question is even more prevalent today, due to the numerous discoveries in the 2010s all around the continent of new reserves of oil (Niger and the Mozambique Channel at the beginning of the 2010 decade, Senegal in the mid-2010s...) and gas (Egypt in the first half of the decade). One of the most common explanation for this phenomenon is the so-called Dutch disease (DD) effect, a widely known phenomenon that has been extensively discussed in the theoretical and empirical literature since the first models developed in the early 1980s. This concept implies that natural resources tend to appreciate the real exchange rate (RER) through several channels which in return reduces the competitiveness of the non-resource tradable sector. Yet, despite the extensive literature on the subject, the question of the definition of RER has often been neglected in empirical analyses. Indeed, one can broadly distinguish between two types of measures: the “internal” RER from the model of Corden and Neary (1982), defined as the ratio of the price of non-tradable to tradable products, and the “external” RER, defined as the ratio of domestic to foreign prices. This distinction is important because those two indicators can be interpreted differently. The “internal” RER is a measure of the profitability differential between sectors, and hence explains structural transformations, whereas the “external” RER measures the external competitiveness of a country’s production, explaining declining export revenues in the non-resource sectors. Thus, both may not show the same patterns over time, especially when a boom occurs, while most empirical studies use only the external definition of the RER, even when they directly refer to the Corden-Neary model as the core theoretical model. There is then a clear and quite surprising gap between the importance of the discussion related to exchange rates in the early theoretical literature, and the empirical literature in which the external definition is predominant and in which the difference between both approaches is hardly ever discussed. This gap can be explained by three reasons. First, the external exchange rate has now become the canonical definition of the exchange rate in the economic literature. Second, even though their definitions differ, there is a direct mathematical relationship between the two RER. Finally, while several institutions (World Bank, IMF, UNCTAD...) provide measures of the external RER, reliable data for internal RER are much more difficult to obtain. This remark is particularly true for developing countries, which have attracted most of the interest in the Dutch disease literature for the last two decades.

This paper intends to fill this gap by determining whether oil revenues have been associated in Africa with an appreciation of the external real exchange rate, with an appreciation of the internal real exchange rate, or both. Using a panel of nine African oil-exporting countries between 1995 and 2017, we investigate the long- and short-run impacts of oil revenues on five different exchange rate indicators. These indicators correspond to the traditional real effective exchange rate and to four additional exchange rates computed as internal and external exchange rates for the main agricultural and the main manufacturing exports. The choice of using two indicators for each RER helps to strengthen the results and contributes to understanding which export sectors are more likely to suffer from Dutch disease consequences. For this analysis, we apply the Pooled-Mean-Group estimator proposed by Pesaran et al. (1999) to the panel dataset and test its robustness by using the Mean-Group estimators. We also use two different explanatory variables: oil rents expressed in % of total GDP and the international price of oil. Finally, we account for potential cross-sectional dependence by applying the Cross-Sectionally Augmented Pooled-Mean-Group estimator.

The panel data estimation reveals a clear and significant appreciation of the external RER caused by oil revenues in the sample. Regarding internal measures of the RER, only the variable for agriculture clearly reveals the presence of a disease while the other variable provides mixed results, implying that oil revenues

could have more “de-agriculturalization” than “de-industrialization” effects in our panel.

The contribution of this article to the existing literature is threefold. First, it is the only attempt to investigate the effects of DD on different RER to account for the difference between internal and external exchange rates and between manufactured and agricultural competitiveness. Second, it focuses on a panel of nine net oil-exporting African countries, while empirical analyses of Dutch disease in Africa have focused on countries or on specific areas (such as Northern Africa or the CFA Franc Zone). Finally, this study exploits brand new indicators of RER. This last point is of special interest in the analysis of internal RER, due to the frequent lack of data in developing countries.

In a first step, we briefly review the theoretical and empirical literature relative to the impact of natural resource revenues on the RER and link the Dutch disease models with the literature relative to the determinants of long-run equilibrium exchange rate (section 2). Then, we detail the two definitions of the RER given in this article and discuss the relationship between them (section 3). Third, we describe the source of the data and justify the variables used in this paper (section 4). Then, we detail the econometric specifications and analyse the results (section 5). The last section concludes and comments on the main limitations of the analysis (section 6).

## **2. A Short Review of Theoretical and Empirical Literature**

This section presents the theoretical and empirical literature relative to the Dutch disease and equilibrium exchange rates. It first describes the theoretical models of Dutch disease and the equilibrium exchange rate approach that will be used in this article. Then, it aims to provide an overview of the empirical evidence that resource revenues can generate an appreciation of the exchange rate through a Dutch disease mechanism in developing countries, with a focus on Africa.

### *2.1 The Models of Dutch Disease*

The term “Dutch disease” was used for the first time by the journal *The Economist* to describe the appreciation of the RER and the subsequent decline in competitiveness of the manufacturing sector in the Netherlands caused by gas exports during the 1960s and 1970s. Following this, a large theoretical literature has emerged in the early 1980s to explain this phenomenon with different assumptions, theoretical foundations and definitions. However, empirical studies almost always refer to the so-called model of Corden-Neary (Corden and Neary, 1982) as the seminal theoretical model of Dutch disease. In that model, a boom in natural resources generates an exchange rate appreciation through two main channels. The first one is the *spending effect*: by increasing public and private expenditures, natural resources revenues lead to an increase in the price of non-tradable goods, while tradable goods prices are assumed exogenous because fixed on international markets. This leads to an appreciation of the real exchange rate, implying a decline in the production of tradable goods and a rise in the production of non-tradable ones. The second channel of Dutch disease is the *resource-movement effect*: due to its higher profitability, the resource sector attracts workers from the non-tradable and non-resource tradable sectors, reducing in these two sectors output. In the tradable sector where wages are assumed exogeneous, this is compensated by a decline in exports or a rise in imports, whereas in the non-tradable sector this situation of underproduction leads to an increase in wages and in prices. The final consequences are an absolute decline in non-resource tradable output, a smaller absolute decline (but a relative increase) in non-tradable output, and an appreciation of the real exchange rate. It must be noticed that even though these two effects have the same implications for

tradable sector and the real exchange rate, they rely on different assumptions, explaining why one can exist without the other. For instance, the resource-movement effect typically requires the assumption of full employment, which is unlikely to hold in many developing countries, whereas the spending effect does not.

In the model of Corden-Neary, the real exchange rate is defined as the ratio of domestic tradable to domestic non-tradable goods (called the internal real exchange rate or IRER in the rest of this paper). However, other definitions of the RER have been proposed in several models. For instance, Buiters and Purvis (1980) define the RER as the ratio of domestic and foreign prices, following the currently most common definition of the exchange rate (called the external real exchange rate or ERER in the rest of this paper), but describe only the Spending effect. In this paper, we specifically target the link between natural resources revenues and the different real exchange rates to compare the predictions of these different models of Dutch disease.

Another major point relative to these models is that they often assume the existence of a perfectly non-tradable and a perfectly non-resource tradable sector, while imperfect tradability could exist in some sectors. On the contrary, Benjamin et al. (1989) assume imperfect substitutability between foreign and domestic goods in the tradable sectors in the Cameroonian case, considering this assumption to be more relevant when studying developing countries. This implies that a disease could have different effects on the different tradable sectors, depending on their level of substitutability on international markets. This question will also be investigated here using different proxies of RER for agricultural and manufacturing products.

In most models, the appreciation of the real exchange rate after a resource boom is considered as an optimal response considering the characteristics of the economy. However, if the boom is only temporary, either because it is due to a temporary price increase or because the resources are exhaustible, this new equilibrium can have a long-run negative impact on the economy, even if it can be considered as an optimal response in the short-run. Indeed, if the non-resource tradable sector is characterized by learning-by-doing effects or benefits from higher productivity gains in the long-run than the resource sector and/or than the non-tradable sector, a temporary decline in this sector will generate a long-run decline in growth and the economy will be worse-off once the resource boom has ended. Another issue comes from potential asymmetry in the Dutch disease effect or from stickiness in the response of economic variables to the resource shocks. In that case, an overvalued real exchange rate caused by a temporary increase in resource revenues can subsist even after the end of the boom, at least in the short- or medium-run. Finally, exporting firms might not be able to quickly adapt their production to real exchange rate variations. This is particularly true when the boom is caused by an international price increase since primary commodity prices tend to be highly volatile and are often unpredictable, generating instability of the real exchange rate and hence of non-resource tradable production and exports. All these issues advocate for a better understanding of the main determinants of real exchange rates to determine if natural resource revenues are one of these determinants.

## *2.2 The Behavioural Equilibrium Exchange Rate*

Since the Purchasing Power Parity theory coming back from the first half of the 20<sup>th</sup> century, there has been a large development of approaches aiming at capturing the concept of “equilibrium exchange rate” and short-run misalignment. Among them, the two most popular approaches are the Fundamental Equilibrium Exchange Rate (FEER) associated with Williamson (1994) and the Behavioural Equilibrium Exchange Rate (BEER) proposed by Clark and MacDonald (1999). The FEER approach considers the equilibrium exchange rate as the exchange rate that simultaneously allows for external balance sustainability (exports equal imports) and internal balance equilibrium (the non-accelerating inflation rate of unemployment). On the contrary, the BEER approach focuses on a list of variables that are supposed to determine the long-run value

of the real exchange rate. As underlined by Égert et al. (2006), this approach does not rely on a theoretical model of exchange rates but use real variables to produce long-run estimates of the real exchange rate and estimate short-run misalignments from this long-run equilibrium. Since the paper from Clark and MacDonald, a large theoretical and empirical literature has emerged, trying to determine the main fundamentals of long-run real exchange rates. These fundamentals traditionally include GDP per capita or any other variable allowing to capture the Balassa-Samuelson effect, terms of trade, trade openness, public expenditures, investment, foreign capital inflows or net foreign assets... Even if most models of Dutch disease do not follow the BEER approach or any specific equilibrium exchange rate approach, there has also been a large variety of empirical studies arguing that natural resources revenues could be included in this set of fundamentals, in line with the Dutch disease models. The BEER literature typically follows two steps. First, estimating the equilibrium exchange rate based on a set of fundamentals. Then, computing the short-run misalignments defined as the difference between the equilibrium exchange rate estimated as the observed exchange rate. We are here primarily interested in assessing the impact of oil revenues on long-run exchange rate. Hence, this study will be restricted to the first step (the determination of the long-run equilibrium exchange rate). Finally, it is noticeable that the equilibrium exchange rate literature (either FEER or BEER approaches) focuses on the external definition of real exchange rates, which differentiates it from the internal exchange rate adopted by Corden and Neary (1982). Therefore, we try here to link these two different approaches by estimating the impact of several fundamentals on five different exchange rates, with three external and two internal exchange rates. Even if the BEER literature is based on an external definition of the RER, we use for the determination of the internal RER equilibrium the same fundamentals as for the external RER (i) for consistency and comparability between regression results and (ii) because there is a direct relationship between external and internal exchange rates (see section 3).

### *2.3 Exchange Rate Fundamentals and the Dutch Disease in Africa*

In Africa, there is an important literature relative to the understanding of exchange rate fundamentals. For instance, Roudet et al. (2007) estimate the impact of five fundamentals (terms of trade, government expenditures, openness, Balassa-Samuelson effect, and investment) on the exchange rate of countries of the West African Economic and Monetary Union (WAEMU). For this, they first apply the Fully Modified Ordinary Least Squares (FMOLS) and the Pooled-Mean-Group (PMG) strategies to estimate the equilibrium RER for the complete panel and find similar results with both methodologies. Then, they apply the Hodrick-Prescott filter to evaluate short-run misalignments and conclude to the presence of an overvaluation of the RER before the devaluation of the CFA Franc in 1994. Finally, they apply the Johansen maximum likelihood procedure and the ARDL approach to each country of the sample, allowing them to account for the heterogeneity in the panel. Similarly, Couharde et al. (2013) estimate the long-run relationship between the RER and a set of five fundamentals (terms of trade, Balassa-Samuelson, openness, public spending and NFA) in a panel of thirteen CFA area country members using Dynamic OLS (DOLS) estimation. In another type of monetary union, Candau et al. (2014) assess the impact of three fundamentals on the real exchange rate in La Reunion Island (which as a French department belongs to the Euro Area). The fundamentals include terms of trade, the rate of growth of GDP per capita (aiming at capturing technological progress and hence the Balassa-Samuelson effect) and public transfers from the metropolis. The coefficient for the Balassa-Samuelson effect appears to be insignificant but the two other variables are positively and significantly correlated with the real exchange rate as expected. Noura and Sekkat (2015) investigate the impact of five fundamentals (trade openness, net capital inflows, terms of trade, country debt service, government expenditures and Balassa-Samuelson effect) on the long-run equilibrium exchange rate using DOLS for a panel of 51 developing countries (among which 26 African countries) over 1980-2010. They also estimate short-run misalignments of this RER using the modified Hodrik-Prescott filter and find results

that are overall consistent with the expectations. Finally, Khan Jaffur et al. (2020) apply an ARDL-bounds testing approach to multiple time-series to investigate the impact of several fundamentals (terms of trade, trade openness, real GDP per capita, investment, government expenditures, inflation, official development assistance, net foreign assets, capital inflows and money supply) in fifteen African countries. They find results that are overall consistent with the expectations (for instance a coefficient for trade openness negative and significant in most countries or a positive coefficient for terms of trade or GDP per capita) but with a large heterogeneity across countries.

In line with the DD model, an important strand of the literature tries to estimate the impact of resource revenues on exchange rates, either by considering resource revenues as a fundamental like trade openness or productivity per capita or by focusing on short-run variations caused by natural resources discoveries or international price variations. For example, by focusing on international oil price variations in a panel of 32 developing oil-producing countries and by implementing both a first-difference and a System Generalised Method of Moments (GMM) methodology, Arezki and Ismail (2013) observe that oil prices are positively correlated with government spending which in return has an appreciation effect on the RER. This supports the evidence of a Spending effect in their panel of oil-exporting countries. Coudert et al. (2015) also investigate the impact of international commodity prices for a panel of 68 commodity exporters (including 26 developing, 37 intermediate and 5 advanced countries). Using Dynamic OLS, and accounting for cross-sectional dependence, they estimate the impact of three variables on long-run equilibrium exchange rates and short-run RER variations: workers productivity (the Balassa-Samuelson effect), Net Foreign Assets, and what they call commodity Terms of Trade which aim to capture the variations of commodity prices. They finally conclude to an appreciation effect caused by commodities exports, with a much stronger coefficient in low-income countries. In a country-case perspective, Essien and Akipan investigate the impact of a set of key fundamentals on the Nigerian equilibrium exchange rate (Essien and Akipan, 2016). They include the Balassa-Samuelson effect, the size of M2 in the total economy, government expenditures, net foreign assets, trade openness and the international price of oil. In line with the DD, they conclude to a positive impact of oil prices on RER, with an average coefficient even higher than NFA, public expenditures and money supply. Finally, it has also been argued in the literature that the Dutch disease can have other drivers than natural resources, such as international aid or migrant remittances, but we will restrict here only to Dutch disease effects caused by natural resources.

This article follows this empirical literature by assessing the impact of oil revenues on exchange rates in a panel of nine oil-exporting African countries. However, the aim here is only to determine the relationship between oil revenues and ER in oil-exporting countries. Then, the methodology implemented allows to evaluate short-run and long-run impacts of oil revenues variations on the RER but does not aim to estimate short-run misalignments from the equilibrium RER.

### **3. External and Internal Exchange Rates**

The first question is the definition of the RER. Indeed, one can broadly define two different exchange rates. The “external” real exchange rate is the most popular interpretation of the exchange rate and corresponds to the ratio of domestic to foreign prices. On the contrary, some studies sometimes use what will be called here an “internal” exchange rate, defined as the ratio of domestic non-tradable to domestic tradable prices. It is noticeable that the seminal Corden-Neary model of Dutch disease never uses foreign prices but focuses only on the internal RER (Corden and Neary, 1982), contrary to Buiter and Purvis (1980) who prefer the external approach of the RER. However, surprisingly, most empirical studies of Dutch disease adopt the external



RER, even when they directly refer to the model of Corden-Neary.

Here, we follow Candau et al. (2014) and define the internal and the bilateral external RER (respectively IRER and ERER)<sup>1</sup> as:

$$IRER_i = \frac{P_{i;N}}{P_{i;T}} \quad (1)$$

With  $P_{i;N}$  and  $P_{i;T}$  the price indexes in non-tradable and tradable sectors respectively.

$$ERER_{i;j} = E_{i;j} \cdot \left( \frac{P_i}{P_j} \right) \quad (2)$$

With  $E_{i;j}$  the nominal bilateral exchange rate between the two currencies, and  $P_i$  and  $P_j$  the price indexes in the countries  $i$  and  $j$  respectively. From equation 2, the external real effective exchange rate is given by:

$$EREER_i = \prod_{j \neq i} \left( E_{i;j} \cdot \frac{P_i}{P_j} \right)^{\gamma_j} \quad (3)$$

With  $\gamma_j$  a weight given to each partner country  $j$ . Let us now define  $\lambda_j$  as the share of tradables in the total production of  $j$  with  $0 < \lambda_j < 1$ . It follows that  $P_j = P_{j;T}^{\lambda_j} * P_{j;N}^{1-\lambda_j}$ , and equation 3 becomes:

$$\begin{aligned} EREER_i &= \prod_{j \neq i} \left( E_{i;j} \cdot \frac{P_{i;T}^{\lambda_i} * P_{i;N}^{1-\lambda_i}}{P_{j;T}^{\lambda_j} * P_{j;N}^{1-\lambda_j}} \right)^{\gamma_j} = \prod_{j \neq i} \left( E_{i;j} \cdot \frac{P_{i;T}}{P_{j;T}} \right)^{\gamma_j} * \prod_{j \neq i} \left( E_{i;j} \cdot \frac{P_{i;T}^{\lambda_i-1} * P_{i;N}^{1-\lambda_i}}{P_{j;T}^{\lambda_j-1} * P_{j;N}^{1-\lambda_j}} \right)^{\gamma_j} \\ &= \prod_{j \neq i} \left( E_{i;j} \cdot \frac{P_{i;T}}{P_{j;T}} \right)^{\gamma_j} * \prod_{j \neq i} \left( E_{i;j} \cdot \frac{\left( \frac{P_{i;N}}{P_{i;T}} \right)^{1-\lambda_i}}{\left( \frac{P_{j;N}}{P_{j;T}} \right)^{1-\lambda_j}} \right)^{\gamma_j} \end{aligned}$$

We finally get:

$$EREER_i = \prod_{j \neq i} \left( E_{i;j} \cdot \frac{P_{i;T}}{P_{j;T}} \right)^{\gamma_j} * \prod_{j \neq i} \left( E_{i;j} \cdot \frac{IRER_i^{1-\lambda_i}}{IRER_j^{1-\lambda_j}} \right)^{\gamma_j} \quad (4)$$

Under the Law of One Price and assuming that the IRER of foreign countries are exogenous, a rise in the domestic IRER implies a similar rise in the EREER. However, if these assumptions are not met, the two RER can have different patterns over time. The rest of this paper therefore aims to estimate the impact of oil revenues on the internal and external RER given by equations 1 and 3.

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<sup>1</sup> By convention, we chose here to express both internal and external RER such that an increase in the index means an appreciation of the exchange rate.

## 4. Data

We use annual data from several sources (FERDI-OCD, World Economic Outlook, World development Indicators and the UNCTAD) for nine main African oil exporting countries between 1995 and 2017 to investigate the long-run relationship between the external and internal exchange rates and the set of fundamentals. The choice of this period corresponds to the availability of data for the different measures of exchange rates. It also presents the advantage of including periods of booms and busts in oil prices and does not include the devaluation that occurred in the CFA Franc Area in 1994 (which concerns four countries of the sample: Cameroon, the Republic of Congo, Equatorial Guinea and Gabon). We selected the countries among the main oil-producers in Africa according to the World Development Indicators. Since the empirical methodology applied here requires a variation in oil rents across time within each country, we included only countries which were net oil-exporters during the whole 1995-2017 period. Due to a lack of data availability and to the political instability that could have led to poor quality of data, we excluded Libya and Sudan from the sample, keeping nine net oil-exporting countries: Algeria, Angola, Cameroon, the Republic of Congo, Egypt, Equatorial Guinea, Gabon, Nigeria, and Tunisia. Data sources and descriptive statistics are provided in table 1. Graphs representing the evolution of the dependent and explanatory variables for each country are also provided in figures 1 to 9. All variables (including price indexes used to construct ER) are annual period-average variables. We detail in the following subsections the justification and definition of the variables used.

### 4.1 The Dependent Variables

Five different variables are used to capture the effects of oil revenues in net oil-exporting countries, all of them coming from the Sustainable Competitiveness Observatory (OCD) of the Foundation for Studies and Research on International Development (FERDI). The first one is the traditional real effective exchange rate as defined in equation (3) and where the weights  $\gamma_j$  attributed to each partner country correspond to the share of non-oil trade between  $i$  and  $j$  in the total trade of the country  $i$ . This variable comes from the OCD for comparison purposes and because of a lack of data for some countries (particularly Angola, the Republic of Egypt and the Republic of Congo) in standard databases (such as World Development Indicators, International Financial Statistics or the UNCTAD). The four remaining dependent variables are two internal and two external RER, computed for agricultural and manufacturing goods separately<sup>2</sup>.

Now we present the way these four proxies have been computed<sup>3</sup>. Regarding the IREER, both indicators are defined as:

$$IREER_{OCD} = \frac{P}{P_X} \quad (5)$$

With  $P$  the consumer price index and  $P_X = \sum_{k=1}^5 p_k s_k$  with  $p_k$  the country-specific export prices of the five

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<sup>2</sup> Agricultural products include food products either transformed or not (such as cereals, vegetables, fish, meat or dairy) as well as primary goods produced for exports (such as coffee, rubber, tobacco or wood). Manufacturing products include transformed non-agricultural goods. For Angola and the Republic of Congo which exports diamonds, the exchange rate variables have been computed by the author with the four other products using the reweighted average of the index of these products so that none of the exchange rate variables include oil or mineral products. For simplicity purpose, we will call them “agricultural” and “manufacturing” goods from now. The goods included in each exchange rate for each product are detailed in table 2.

<sup>3</sup> All variables used are described in OCD (2017) and can be found at <https://competitivite.ferdi.fr/>. The indexes are constructed by the FERDI based on data from the *Centre d'études prospectives et d'informations internationales* (CEPII) and *International Financial Statistics* (IFS).

main agricultural and five main manufactured products  $k$  exported by the country and  $s_k$  the share of each good  $k$  among these five exports. To avoid variations in the index that would not be caused by changes in prices but by changes in the share of each good among total exports, the weights  $s_k$  attributed to each good  $k$  are constant over time and based on the average composition of exports for the period 2008-2012.

The internal real exchange rates of the OCD are thus defined as the ratio of the consumer price index to respectively agricultural exports prices and manufactured exports prices. This definition differs slightly from the IRER as defined in Corden-Neary's model (noted  $IRER_{CN}$ ), but it is easily proved that they are linked. Indeed, if we note  $\alpha$  the share of the five main (agricultural and manufactured) exports in total domestic tradables such that  $0 < \alpha < 1$  and note  $P_H$  the price index for the tradable goods that are not among the five main exports<sup>4</sup> such that  $P_T = P_X^\alpha * P_H^{1-\alpha}$ , then:

$$IRER_{CN} = \frac{P_N}{P_T} = \frac{P_N}{P_X^\alpha \cdot P_H^{1-\alpha}} = \left(\frac{P_N}{P_X}\right)^\alpha \cdot \left(\frac{P_N}{P_H}\right)^{1-\alpha}$$

While

$$\begin{aligned} IRER_{OCD} &= \frac{P}{P_X} = \frac{P_T^\lambda \cdot P_N^{1-\lambda}}{P_X} = \frac{P_X^{\alpha\lambda} \cdot P_H^{(1-\alpha)\lambda} \cdot P_N^{\alpha(1-\lambda)} \cdot P_N^{(1-\alpha)(1-\lambda)}}{P_X^{\alpha\lambda} \cdot P_X^{(1-\alpha)\lambda} \cdot P_X^{\alpha(1-\lambda)} \cdot P_X^{(1-\alpha)(1-\lambda)}} \\ &= \left(\frac{P_H^{1-\alpha}}{P_X^{(1-\alpha)(1-\lambda)}}\right) \cdot \frac{1}{P_X^{1-\alpha}} \cdot \left(\frac{P_N}{P_X}\right)^{\alpha(1-\lambda)} \cdot P_N^{(1-\alpha)(1-\lambda)} \\ &= \left(\frac{P_H}{P_X}\right)^{1-\alpha} \cdot \left(\frac{P_N}{P_X}\right)^{\alpha(1-\lambda)} \cdot \left(\frac{P_N}{P_H}\right)^{(1-\alpha)(1-\lambda)} \end{aligned}$$

Thus:

$$IRER_{OCD} = \left(\frac{P_H}{P_X}\right)^{1-\alpha} \cdot IRER_{CN}^{1-\lambda}$$

Since  $P_T = P_X^\alpha * P_H^{1-\alpha}$ , we finally obtain:

$$IRER_{OCD} = \frac{P_T}{P_X} IRER_{CN}^{1-\lambda} \quad (6)$$

It must be noted that the value in level for the exchange rates does not mean much, the only condition required here is that changes in our proxy follow the same patterns as changes in the Corden-Neary internal real exchange rate. The choice of using average prices (estimated by the Consumer Price Index) instead of the price of non-tradables only is justified by the difficulty to differentiate perfectly non-tradable from other products. Indeed, while theoretical models tend to distinguish perfectly non-tradable from perfectly tradable goods, most goods are imperfectly tradable and differ in their level of tradability. In that case, it can be quite challenging to identify a representative basket of perfectly non-tradable goods or services. This issue is more easily dealt with for the basket of tradable goods since it is based on export prices, the most exported goods being here assumed to be representative of the main tradable goods.

We now move to the definitions of the external real exchange rates. Like the IRER, two indexes are

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<sup>4</sup>  $P_H$  includes both goods that are exported but not among the main exports and tradable but non exported goods.

constructed, both following the same equation:

$$ERER_{OCD} = \sum_{k=1}^5 \left( \sum_{j=1}^{10} \left( E_{i,j} \cdot \frac{P_{k,i}}{P_{k,j}} \right)^{\gamma_j} \right)^{s_k} \quad (7)$$

with  $P_{k,j}$  the price of the good  $k$  in the country  $j$  and  $E_{i,j}$  the bilateral nominal exchange rate between  $i$  and  $j$ . Here, and contrary to the common definitions of the REER used by the World Bank or the IMF, the weights attributed to each foreign country  $\gamma_j$  correspond to the share of each country  $j$  among total exports of good  $k$  in the world for the ten main exporting countries of good  $k$ . Therefore, the weights are not based on the partner shares of each country, but on competition between  $i$  and  $j$ . It is an important distinction from traditional empirical studies, which often use an index based on partner shares, especially for countries that are specialized in primary products and that do not export products to or import them from the countries that are specialized in the same production. Since the aim is to analyse the impact of resource revenues on external competitiveness, it seems more relevant to focus on competitors rather than trade partners. Due to the difficulty to aggregate price data from a large sample of countries, and the high imprecision that may result from the lack of data availability in many African countries, the index is restricted to the ten leading exporters for each good  $k$ . Finally, the two indexes are computed as the weighted average for the five main agricultural and the five main manufactured goods separately, with  $s_k$  the shares of each good  $k$  in exports of country  $i$ . Similarly to the IREER, the weights are constant over time and based on the shares calculated for the period 2008-2012. A major advantage of these variables is that, by focusing only on the five main agricultural and manufacturing exports, they do not include oil, contrary to traditional measures of the real effective exchange rate. Graphs showing the evolution of the five exchange rates are provided in the appendix (figures 1 to 9). As expected, they tend to have similar evolutions over time in each country, even though there is some heterogeneity across countries. Indeed, while the five exchange rates follow very close patterns in Angola, Egypt and Nigeria, there is a much greater variability between them in Congo or Tunisia. We can also notice that the internal exchange rate for manufactured products is always the index which differs the most from the four others.

#### 4.2 The Explanatory Variables

In the Dutch disease literature, three different types of explanatory variables are used. The most straightforward variable is the share of resources (here oil) in total GDP or total exports. This variable presents the advantage of directly capturing the impact of resource revenues on the economy. However, it also suffers from obvious endogeneity issues. First, for a given value of oil revenues, a poorer country will have a higher share of oil revenues in total GDP than a richer one. Reciprocally, one can assume that a more developed country will have more opportunities to develop a resource sector, or fewer incentives to do so, than a developing country. In both cases, the level of economic development affects the variable used for oil revenues. Another difficulty arising from the use of this variable is the fact that the shares of all sectors among total GDP adds up to 100%, i.e. a sudden drop or boom in one sector generates a symmetric rise or fall in the share of resource revenues in GDP even without any change in the resource sector, creating obvious reverse causality issues in empirical studies. However, this issue is particularly challenging when estimating the impact of resources on sectoral value-added, and not so much for exchange rate analysis.

The other most common strategy corresponds to the use of international prices (mainly oil prices such as

the Brent or WTI crude oil price). The clear advantage of this variable relies on its supposed exogeneity<sup>5</sup>. However, this proxy is also subject to some key limitations. First, resource revenues do not depend only on prices but also on other variables such as reserves discoveries or the political will to exploit natural resources. In that case, resource revenues can be weakly correlated with prices, making it more challenging to detect Dutch disease effects. Second, the exogeneity assumption requires that domestic resource production does not react to international price variations. However, a country or a firm can reduce its production when prices are low and increase it when they are high. In that case, oil revenues tend to overreact to oil prices movements.

A final strand of the literature relies on the timing of resource discoveries to estimate the impact of booms in production on the RER (for instance Arezki and Ismail, 2013). This methodology allows the implementation of different econometric strategies, such as difference-in-difference or synthetic control methods. We will not detail this literature here since, while it is helpful to estimate the impact of large booms, it is less useful when investigating the long-run relationships between resource revenues and exchange rates. This methodology also tends to require larger datasets than other strategies.

We use here both oil revenues and international crude oil prices. The first one is the variable “Oil rents” provided by the World Development Indicators and expressed in percentage of total GDP. Regarding international oil prices, we use the Brent and the West Texas Intermediate spot oil prices, which are the two main crude oil prices on international markets and the more likely to affect African oil prices to export. The changes in these variables are presented in figures 1 to 9 in the appendix. Unsurprisingly, there is a clear positive correlation between oil rents and international oil prices, even if oil rents tend to be more volatile (which is expected since this variable is mainly determined by both international price shocks and domestic production shocks). We can also notice heterogeneity across countries: while the changes in oil rents follow closely the evolution of oil prices in the three northern African countries, there are more pronounced short-run shocks of oil rents in the beginning of the period in Angola, Cameroon, Congo, Gabon and Nigeria (these could be caused by exogenous production shocks or overreaction to price variations). Finally, we can notice that in Equatorial Guinea oil rents started to decline not long before the peak in international prices (due to the progressive decline in oil production).

The control variables are the traditional fundamentals of the real effective exchange rate used in the literature on exchange rate misalignments, following the Behavioural Exchange Rate (BEER) approach. We select here four fundamentals among the most frequent in the literature. The first fundamental is the degree of trade openness computed as the sum of total exports and total imports expressed in % of total GDP (from the UNCTAD). According to the theoretical and empirical literature, this index is expected to be negatively associated with exchange rates. Indeed, higher trade barriers usually result in both lower trade openness and higher prices, implying a negative correlation between trade openness and real exchange rates (Égert et al., 2006). This argument is supported by several empirical studies for the external RER (Couharde et al., 2013; Diop et al., 2018...) Regarding our proxies for the internal RER, trade openness is expected to reduce domestic prices (the numerator) and thus the IRER.

We also include a proxy for the Balassa-Samuelson effect constructed by the FERDI-OCD as a ratio of non-oil GDP per capita against foreign countries non-oil GDP per capita. The use of non-oil GDP is important because (i) it captures more precisely productivity gains than total GDP and (ii) it does not include oil resource booms (which would lead to underestimating the impact of our oil revenues variable).

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<sup>5</sup> It is possible for some large oil exporters, such as Saudi Arabia, that the hypothesis of small economy is not verified. However, this assumption holds for most countries, and particularly for African countries that are mainly small producers at the world level.

Theoretically, the expected sign of this proxy should be positive: an increase in total productivity is associated with an appreciation of the exchange rate. The empirical evidence in the literature is quite mixed but suggests overall to expect a positive sign for this variable. For instance, Coudert et al. (2015) find for a large panel of countries that an increase in productivity is associated with an appreciation in low-income countries but not in wealthier countries.

Then, we use a variable for Net Foreign Assets expressed in % GDP (from the UNCTAD). The theoretical literature suggests a positive relationship between NFA and exchange rates. However, empirical evidence remains mixed. Égert et al. (2006) argue that NFA may be negatively correlated with capital inflows in the medium-run but positively in the long-run (if foreign capital inflows are invested in the export sector, they will increase competitiveness and boost exports in the long-run). If capital inflows tend to generate an appreciation effect, one will observe a negative correlation between NFA and RER in the medium-run and a positive one in the long-run. In that case, the heterogeneity in results depends mainly on the number of periods in the sample (the size of  $T$ ). In this case, the expected sign of NFA can also depend on the nature of foreign capital inflows and on the type of sector they are invested in, which depend themselves on the level of economic development. For instance, using a panel of countries with different levels of economic development, Coudert et al. (2015) observe a positive impact of NFA for developing countries (and to a lesser extent for advanced countries) but a negative coefficient for intermediate ones.

The final explanatory variable is the value of total investment (public and private) expressed in % of GDP. There is no consensus neither in the theoretical nor in the empirical literature on the expected sign for this variable. For instance, Diop et al. (2018) find a positive impact of investment on the RER in Senegal based on a Johansen and an ARDL model while Saxegaard (2007) finds a negative impact for the same country. One could expect that, in the short-run, investment plays a role in appreciating the exchange rate (like consumption) by increasing domestic prices. However, in the long-run, investment can help firms to become more productive and reduce prices, generating depreciation effects. This effect however depends on the nature of investment (public or private, foreign or domestic...) and can differ across sectors.

Except for Net Foreign Assets and Oil Rents, all variables (including dependent and explanatory variables) are in logarithms. We do not include the terms of trade (which are also a common fundamental for the exchange rate in the empirical literature) since they could partly capture the appreciation effect of the Dutch disease. Similarly, we do not include public expenditures. Indeed, it is often considered that Dutch disease effects are partly driven by public spending (i.e. the *spending effect*): natural resources are assumed to increase public expenditures which in return leads to an appreciation of the real exchange rate. Assessing if Dutch disease effects are really driven by public spending (they could also be caused by private consumption) could be of interest for future research but this lies beyond the scope of this study.

## **5. Methodology and Results**

Based on the variables described in section 4, we want to investigate the impact of oil revenues and oil prices on different exchange rates. This section presents and discusses these empirical results.

### *5.1 Integration and Co-Integration Tests*

We begin by testing for the presence of unit-roots in the selected variables. For this, we apply the Panel-data unit-root test proposed by Im, Pesaran and Shin (2003) which has proved to provide consistent estimates

even in small samples (Hurlin and Mignon, 2005). To account for potential cross-section dependence between countries in the variables of interest, we also use the test proposed by Pesaran (2003) which has been specifically designed to deal with this issue. Since the Brent and the WTI oil prices are repeated time-series, we use the simple time-series Augmented-Dickey-Fuller and Phillips-Perron unit-root tests for these two variables. Results are reported in table 3. Both integration test results clearly indicate that all (dependent and explanatory) variables are I(1).

We then test for the presence of a co-integrating relationship among the variables. For this, we apply the tests proposed by Kao (1999) and Pedroni (2004). Indeed, the Kao co-integration test has more power in small samples than other tests (Hurlin and Mignon, 2007). It provides five statistics based on the Dickey-Fuller and Augmented Dickey-Fuller statistics. However, the Pedroni co-integration test has more power in samples with a fixed N and an increasing T. This test provides seven different statistics, relying on different assumptions, and grouped into four Panel-Cointegration Statistics based on within-dimension and three Group-Mean Cointegration Statistics based on between-dimension. Results are reported in tables 4, 5 and 6. Overall, the results show a strong rejection of the null hypothesis of the absence of co-integration for the REER, for the two EREER and for the IREER for manufacture. Regarding the IREER for agricultural products, only four out of seven Pedroni statistics support the rejection of the null hypothesis when the main explanatory variable is oil rents and three for oil prices. Nevertheless, almost all statistics from Kao strongly suggest rejecting the null hypothesis of no co-integration, which seems more than enough to accept the hypothesis of co-integration among variables in the regressions.

## 5.2 Pooled-Mean-Group Estimation Results

Now, the aim is to estimate both the sign and the magnitude of the long-run relationships between each fundamental and the outcomes. The traditional empirical literature relative to the long-run determinants of real exchange rates in panel data has identified several econometric specifications to estimate such long-run relationships. These methods can be divided into two groups. On one side, pooling methods consist in using all data in the same regressions and therefore require the assumption of homogeneity of effects across countries. On the contrary, “group-mean” specifications consist of (i) estimating the coefficients separately for each country and (ii) averaging them. These methods do not require the homogeneity assumption but have very low power due to the high number of coefficients to estimate. Therefore, we choose here to implement the intermediate strategy of the Pooled Mean Group (PMG) Estimator developed by Pesaran et al. (1999), which presents a higher power than averaging methods but requires weaker assumption than pooling ones. Indeed, the PMG relies on the assumption that long-run coefficients are homogeneous but not short-run coefficients. It consists of estimating the following equation:

$$\Delta y_{i,t} = \phi y_{i,t-1} + \beta_i x_{i,t} + \sum_{j=1}^{p-1} \lambda_{i,j} \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \delta_{i,j} \Delta x_{i,t-j} + \mu_i + \epsilon_{i,t} \quad (8)$$

where  $y_{i,t}$  is for each country  $i$  at time  $t$  computed as the logarithm of the standard RER, of the external RER for agricultural and manufacturing goods, and of the internal RER for agricultural and manufacturing goods.  $x_{i,t}$  is a set of fundamentals that include our main explanatory variable and the four other control variables presented in section 4<sup>6</sup>. The model also estimates the error-correction term, which indicates the speed of adjustment toward the long-run equilibrium and is expected to be comprised between -1 and 0.

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<sup>6</sup> For simplicity purposes, all variables expressed in logarithms will be written in lower-case letters.

Regressions are run first with Oil Rents and second with the two international oil prices as the main explanatory variable. The number of lags of the short-run coefficients ( $p$  and  $q$ ) is selected using the Bayesian Information Criteria, as recommended by Pesaran et al. (1999), with a maximum lag length of 1. Both the AIC and the BIC indicate to prefer an ARDL with one lag for the six variables in difference (one lag for the dependent variable and for each of the five explanatory variables), except for the IRER for manufacture with the Brent oil price (where a model without lag for NFA is preferred) and with the WTI oil price (model without lag neither for NFA nor for investment). The coefficients are then obtained through maximum likelihood estimation.

The PMG presents some major advantages compared to other panel data estimators. First, and contrary to a GMM estimator, it is adapted to panel with a small  $N$  and a medium-sized  $T$ . Then, the use of lags for the explanatory and explained variables helps to overcome potential reverse causality issues that are likely to arise when estimating exchange rates fundamentals. Finally, this methodology allows to distinguish short-from long-run effects. The PMG is also preferred to the Mean-Group (MG) estimator for two reasons. First, due to the higher number of coefficients estimated in the MG specification, this strategy is very likely to provide imprecise and insignificant results, especially in a limited size sample like ours. Second, according to Pesaran et al. (1999), PMG estimates also tend to be less sensitive to outliers than MG ones. They recommend comparing the long-run coefficients provided by MG and PMG specifications to ensure the validity of the second methodology. Since the Hausman test tests the null hypothesis that the long-run coefficients are not systematically different, and under the assumption that MG estimates are unbiased, it results in testing the hypothesis that the long-run PMG coefficients are unbiased. If the coefficients are observed to be significantly different from each other at 5% (if the  $p$ -value  $< 0.05$ ), the PMG estimators might be biased and Mean-Group procedures are more likely to provide consistent estimates. Otherwise, we are inclined to prefer the PMG to the MG estimators. It must be underlined that this test is not a formal econometric proof that the PMG is or is not unbiased but only a piece of evidence to support the idea that the PMG results can be interpreted, since we are primarily interested in the average long-run effect of oil revenues on the exchange rates. It can also be noted that it tests the joint difference in coefficients and not the difference for each explanatory variable used separately.

First, we discuss the results for the classical REER that are displayed in the first column of table 7 and the two first columns of table 8. The results are as expected, with a positive coefficient for oil rents and oil prices. This suggests the presence of Dutch disease effects generated by oil revenue in the sample. Regarding the other fundamentals, the results are also as expected for the Balassa-Samuelson effect (positive coefficient) and for trade openness (negative), confirming the validity of our model. The only relatively surprising result is that Net Foreign Assets are indicated to generate depreciating effects while we were expecting an appreciation. Nevertheless, it is not in total contradiction with the literature since the evidence that NFA accumulation appreciates the ER is mixed in empirical analyses (see section 4). Finally, the coefficient associated with investment is never significant, making it difficult to interpret. Now, we turn to the four other exchange rates.

We observe positive and highly significant correlation between oil rents and all four other exchange rates in the long-run, supporting the Dutch disease hypothesis, both for the external and the internal approaches (table 7). Regarding the IRER for manufacturing goods, the coefficient appears to be smaller than the three others, probably due to a lower impact of oil rents on the manufacturing sector. However, due to the limits of the proxy used, one must remain careful about such interpretations, and more analyses are required. In addition, this is the only outcome for which the Hausman test suggests to reject the result. The results overall indicate that oil revenues are an important driver of RER fluctuations, even if the coefficient is lower than



trade openness or the Balassa-Samuelson effect. For international oil prices, the results are very similar to the previous ones, with a positive and significant impact of the international Brent and the WTI oil prices on the two ERE and the first IRE (table 8). However, the coefficient for manufacturing IRE, which was previously positive and significant at 5%, becomes here negative and significant at 1% in both cases. Two plausible explanations can be provided for this negative coefficient. First, one can assume that manufacture products are not perfectly tradable goods in our sample of countries, or that their degree of tradability is lower than the one of agricultural goods. Since the consumer price index used as the numerator in the construction of this variable includes tradable-goods, a negative coefficient for the internal exchange rate (i.e. a decrease in the ratio of aggregate prices to manufacturing goods prices) could reveal a low level of tradability in the manufacturing sector. Indeed, if most manufacturing goods are produced for the domestic market and/or protected from international competition (through tariffs or subsidies for instance), they may counterintuitively be more non-tradable than tradable goods and escape Dutch disease effects. Hence, the price increase of the tradable goods that are included in the consumer price index leads to a higher increase in the total consumer price index than the increase in manufacturing goods only. Even if this result is in contradiction with traditional assumptions of DD (the tradable sector being often associated with manufacturing industries), this might apply for countries where agricultural products represent a large share of domestic output and exports. In that case, the Dutch disease would be a concern for the agricultural sector rather than for the manufacturing one. This is in line with the model developed by Benjamin et al. (1989) for Cameroon which assumes that different levels of tradability can exist across the different export sectors. Second, oil can be used as an input for the domestic production of manufacturing goods, meaning that an exogenous price increase in international markets raises the production costs and the prices of these goods (even if the country is an oil-exporter since oil-producing firms sell their production at the international market price even on domestic markets), counterbalancing the Dutch disease effects. However, the approximation used to construct the internal exchange rates is obviously imperfect and may also partly explain this surprising result.

Regarding the other fundamentals, the coefficients are mainly as expected. The variable for trade openness is always negative and significant, in line with both theoretical and empirical literature. In contrast, the Balassa-Samuelson proxy is always positive except for the external exchange rate for manufacturing products, reinforcing the idea that agriculture and manufacture should be analysed differently when estimating equilibrium exchange rates. Even if the coefficient for trade openness seems to be quite large when comparing it with other main determinants such as the Balassa-Samuelson effect or investment, its size remains reasonable. Net Foreign Assets are associated with negative and strongly significant coefficients, confirming the results obtained with the traditional RER. However, the variable for total investment becomes positive and strongly significant for the regressions based on oil rents. Finally, the error-correction term (noted *ec* in the tables) has the expected negative sign and is most of the time significant.

The results for the Mean-Group estimators are displayed in tables 9 and 10, even when the Hausman test suggests accepting the PMG. As expected, the results are mostly insignificant even if the coefficients remain of the same sign that with the PMG. The few significant coefficients (*irer<sub>agriculture</sub>* with oil rents, *erer<sub>manufacture</sub>* with WTI and *irer<sub>agriculture</sub>* with both Brent and WTI prices) also tend to support the evidence of a DD effect related to oil revenues.

### 5.3 Testing for Cross-Section Dependence

One common issue when dealing with panel data is the potential presence of cross-section dependence. This

can occur when there is interdependence across countries such that a shock in each country can affect other countries, or when omitted shocks affect error terms in all countries. In that case, Pesaran et al. (1999) noted that the econometric model is likely to be misspecified. To test for the presence of cross-section dependence in the results, we implement the Breusch-Pagan Lagrange-Multiplier test (Breusch and Pagan, 1980). Results are available in table 11 and strongly suggest the presence of cross-section dependence in the model with Oil Rents as the main explanatory outcome. To deal with cross-section dependence, we follow the recommendation made by Pesaran et al. (1999) by implementing the Cross-Sectionally Augmented Pooled-Mean-Group (CPMG) approach used in several empirical papers such as Cavalcanti et al. (2012) or Grekou (2018). This strategy consists in including the cross-sectional average over all countries at time  $t$  for the variables of interest (written  $\bar{x}_t = (1/N) \sum_{i=1}^N x_{i,t}$ ) in the Pooled-Mean-Group estimation. The main drawback of this empirical strategy is that it increases the number of parameters to estimate. Due to the small size of our sample, it is unfortunately not possible to include all cross-section averages for all (dependent and explanatory) variables. It is noticeable that the RER and the proxy for the Balassa-Samuelson effect are defined as a base 100 index (equals to 100 in 2010 for all countries), hence the cross-section average (and the divergence for a given country from this average) does not make much sense here. Therefore, we restrict the regressions to include only the cross-section averages of three main explanatory variables, oil rents, trade openness and net foreign assets, which are the more likely to suffer from cross-section dependence because they are very likely to be affected by global shocks in international commodity prices. Since the international price of oil is a repeated time-series and is the same for each country, we could not apply cross-sectionally augmented empirical strategies to this variable and restrict this procedure to the equation where oil rents is the main explanatory variable. The results are displayed in table 12.

The results tend to confirm the previous analyses since the coefficients associated with oil rents are positive and strongly significant in the second and third regressions and positive but less significant for the two internal exchange rates and for the traditional REER. These results overall support the Dutch disease hypothesis, particularly for the agricultural sector since both external and internal exchange rate coefficients are positive and of sizes that have economic sense.

## 6. Conclusion

Based on brand-new data, we investigated in this paper the long-run relationship between oil revenues and different variables for the real exchange rate in nine African net oil-exporting countries. The results clearly indicate that both the external interpretation of the Dutch disease (resource revenues weaken external competitiveness of other sectors and reduce non-resource exports) and the internal interpretation (resource revenues boost the development of non-tradable sectors at the expense of tradable ones and encourage structural transformations) are empirically confirmed in our panel of countries, supporting the seminal theoretical models of Dutch disease. From the external perspective, these findings imply that oil revenues tend to appreciate the exchange rate apart from its “classical” long-run fundamentals (such as trade openness or productivity per worker) and to make non-resource products less competitive on international markets. From an internal point of view, they generally confirm the model of Corden-Neary at least for agricultural products, implying that oil revenues can lead to “de-agriculturalization”. The evidence of a disease on both external and internal exchange rates for agricultural goods is of special interest for policy deciders by highlighting the importance for well-targeted public policies aiming at dealing with Dutch disease consequences not to neglect the agricultural sector. This is particularly relevant for African countries where agriculture often represents a higher share of the economy than manufacture, while empirical studies of Dutch disease focus more often on de-industrialization consequences. Another policy implication directly

arises from the observation of differences between internal and external definitions of the RER. Indeed, the choice of the indicator selected to assess Dutch disease affects the results and the conclusions that can be drawn from these results. As mentioned earlier, there has been for the last decades a shift in empirical analyses toward the use of external definitions of exchange rates as the expense of internal ones. Nevertheless, the two approaches differ in their interpretation and policymakers could benefit from using both types of indexes, depending on the issues they investigate.

However, these results should be carefully interpreted, due to major data limitations. In fact, the use of proxies for the internal exchange rates that do not perfectly correspond to the Corden-Neary definition of the RER, as well as the fact these proxies are based on a few products rather than on all exports by sectors, could have resulted in noise in the results. Therefore, more analyses are required to investigate the impact of natural resources on internal exchange rates, and to determine the differential impacts of Dutch disease effects on different tradable sectors. Finally, the empirical strategy implemented here does not allow to observe potential heterogeneity across countries. This is a major issue for external approaches since all countries of the database do not share the same exchange rate and monetary targets (with four among the nine countries belonging to the common Central African CFA Franc Zone while the five others have adopted flexible nominal exchange rate policies). Further analyses relying on time-series could solve this issue and help to understand which countries in Africa are the most prone to Dutch disease.

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## Appendix

Table 1: Descriptive Statistics

Variable	Observations	Units	Mean	Std. Dev.	Min	Max	Source
<i>REER</i>	207	Base 100=2005	107.83	30.79	43	289	FERDI
<i>ERER<sub>agriculture</sub></i>	207	Base 100=2005	107.79	30.77	41	326	FERDI
<i>ERER<sub>manufacture</sub></i>	207	Base 100=2005	106.27	32.39	42	303	FERDI
<i>IRER<sub>agriculture</sub></i>	207	Base 100=2005	100.15	32.73	31	309	FERDI
<i>IRER<sub>manufacture</sub></i>	207	Base 100=2005	125.20	37.63	36	270	FERDI
Oil Rents	207	% GDP	20.25	15.92	1.08	55.46	WDI
Brent	23	USD per barrel	54.14	33.60	12.72	111.96	IMF
WTI	23	USD per barrel	52.54	29.48	14.42	99.61	IMF
Openness	207	% GDP	86.70	41.62	21.10	268.24	UNCTAD
Balassa	207	Base 100=2010	96.72	31.27	6.46	219.86	FERDI
NFA	207	% GDP	16.25	21.46	-44.77	107.93	IFS and WEO
Investment	207	% GDP	28.80	15.34	8.25	115.10	WEO

Note: The exchange rate variables use period-average consumer price indexes and products prices to exports (from the WDI) translated into USD using the nominal bilateral exchange rate (from the IFS). The weights for trade partners for the variable “REER” are constructed with on non-oil exports and non-oil imports for all countries except for Algeria where only non-oil exports are used due to data limitations. Six observations are missing for “Oil Rents” for Equatorial Guinea between 2000 and 2005. These data were reconstructed using country’s oil production (BEAC Central Bank) before 2000 and after 2005 and assuming similar trends. Three observations are missing for “Trade Openness” for Equatorial Guinea in 2017 and Gabon in 2016 and 2017. The data are reconstructed based on data for trade openness from the WDI and assuming similar trends. It is in base 100 for the year 2010. Four observations are missing for “Balassa” for Egypt between 1995 and 1998. They are reconstructed using FERDI-OCD data for the Balassa-Samuelson effect based on imports only and assuming similar trends.

Figure 1: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Algeria

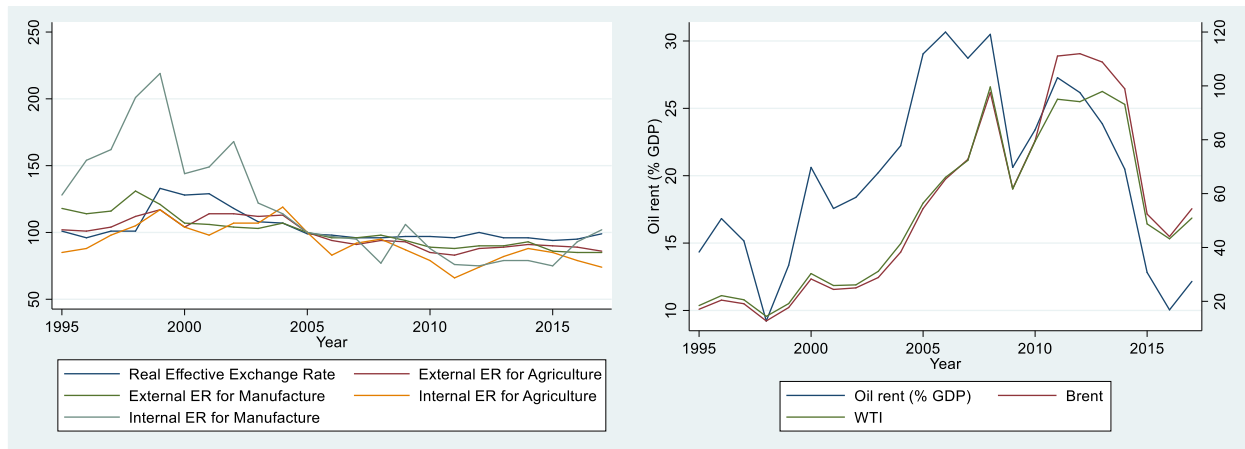


Figure 2: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Angola

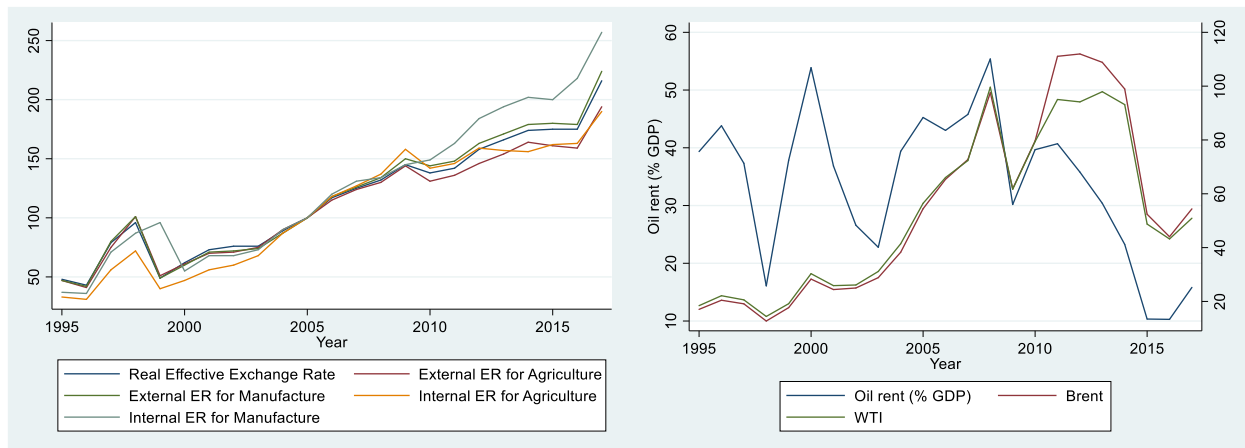


Figure 3: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Cameroon

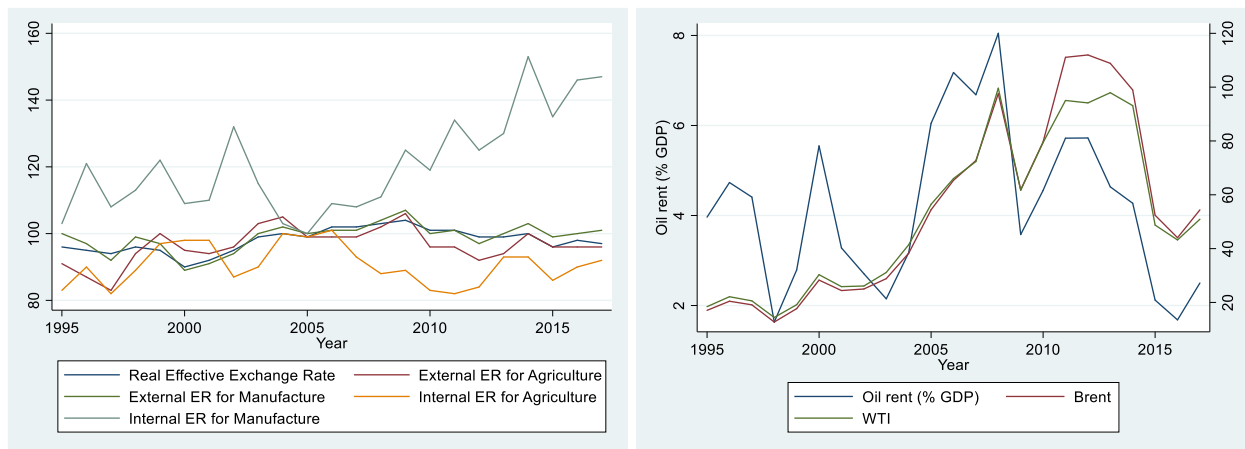


Figure 4: Evolution of Exchange Rates (left side) and Oil Rents (right side) for the Republic of Congo

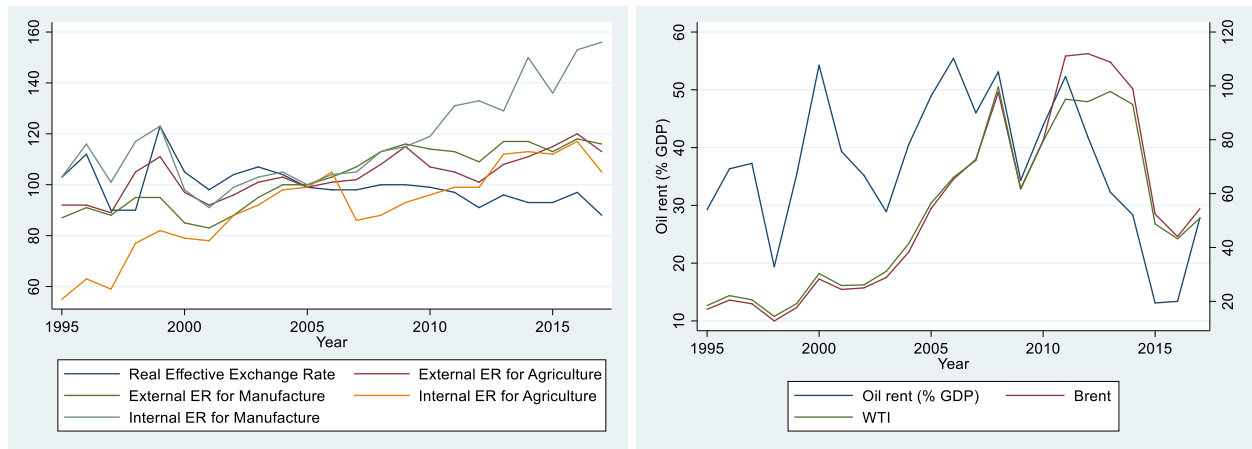


Figure 5: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Egypt

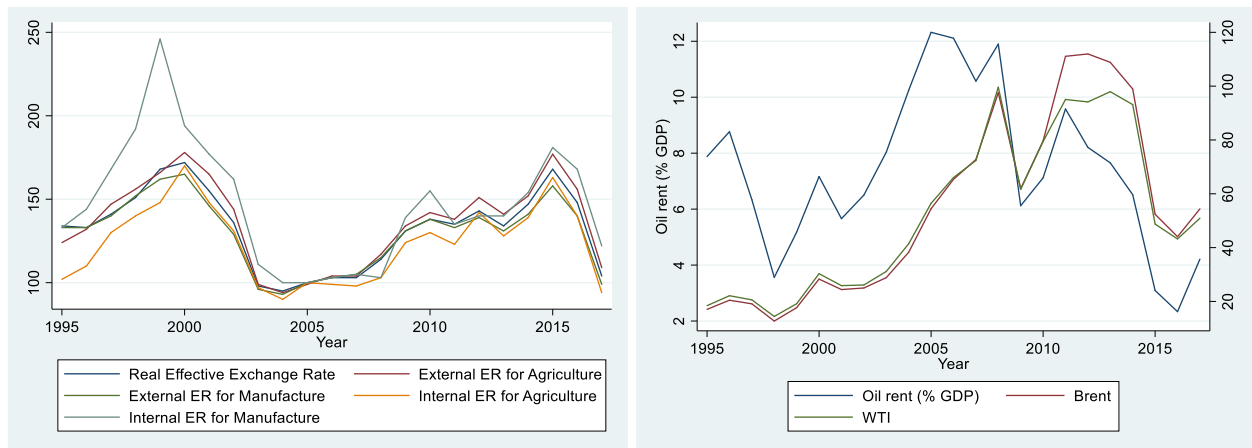


Figure 6: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Equatorial Guinea

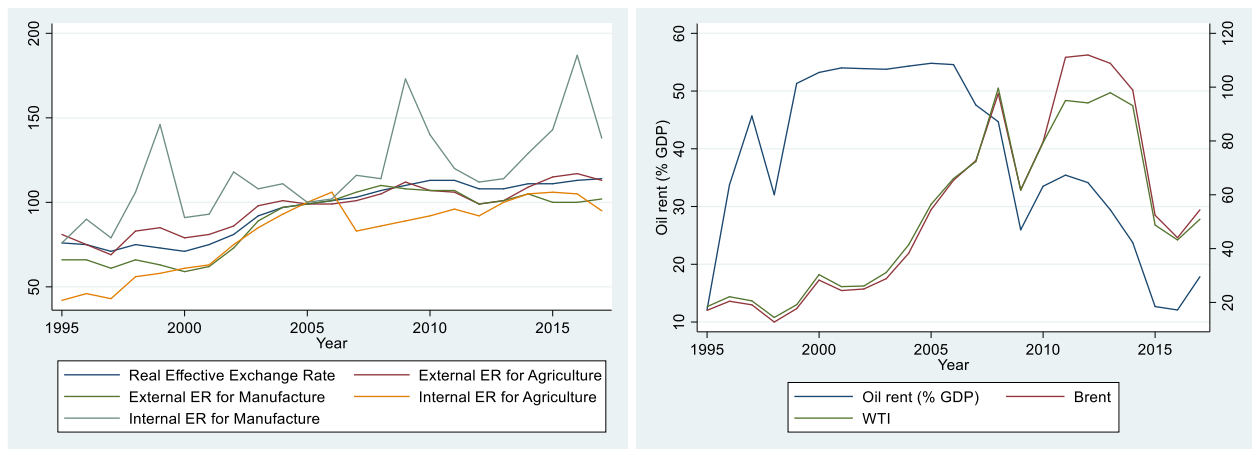


Figure 7: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Gabon

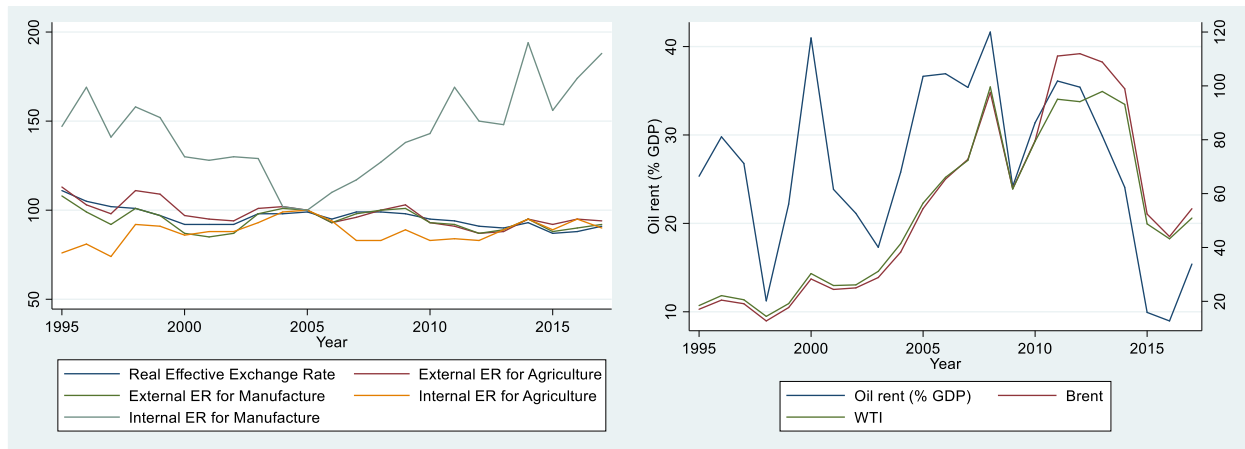


Figure 8: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Nigeria

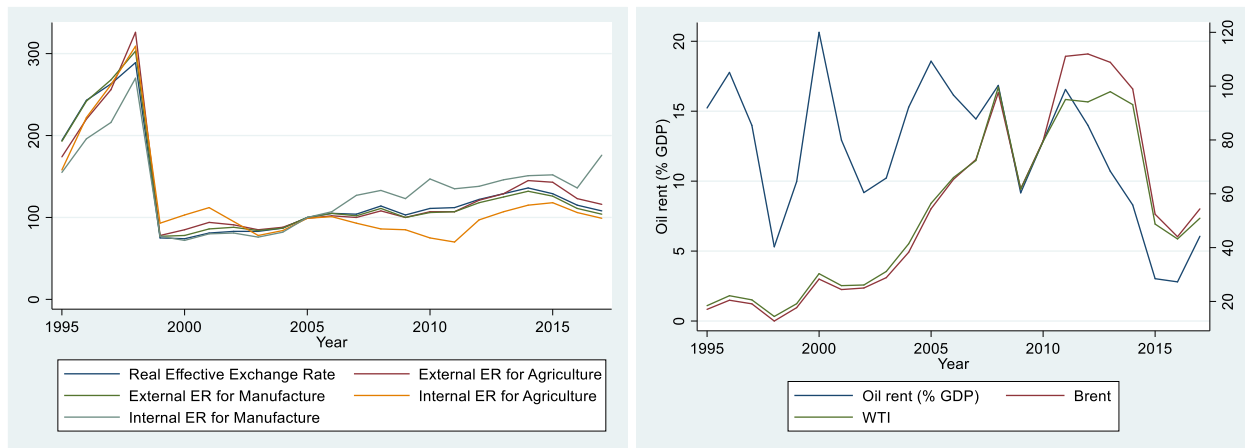


Figure 9: Evolution of Exchange Rates (left side) and Oil Rents (right side) for Tunisia

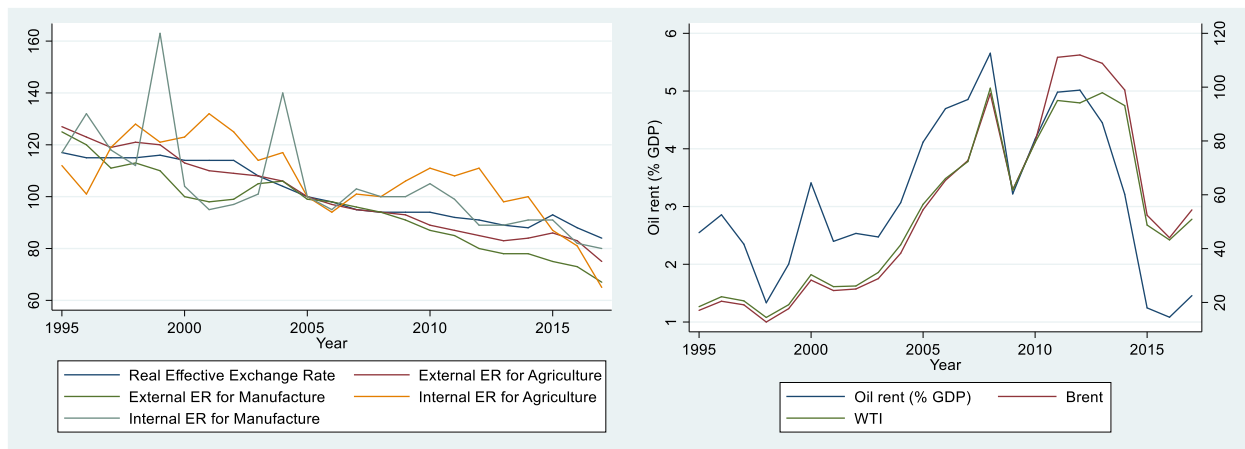




Table 2: Products included in External and Internal Exchange Rates

Country	Agriculture	Manufacture
Angola	Fish, frozen Shellfish Coffee Animal flour Wood in the rough	Paper and Paperboard Structures of Cast-iron, Iron and Steel Interchangeable tools for hand tools Electric generating sets and rotary converters
Cameroon	Bananas Cocoa beans Natural Rubber Wood in the rough Wood sawn	Soap Sheets for veneering Boxes, Sacks and Bags of paper Bottles, flasks, jars, pots, phials, and other containers Bars and rods of iron or steel, hot-rolled
Congo Rep.	Coffee Natural Rubber Fuel wood in logs Wood in the rough Wood sawn	Sheets for veneering Tubes and Pipes seamless, of iron or steel Other Articles of Iron or Steel Tools for hydrography, oceanography, hydrology, meteorology, or geophysics
Algeria	Other vegetables Dates, Figs, Pineapple, Avocado, Guava and Mango Wheat and meslin Sugar Water	Hydrogen and rare gases Ammonium Acyclic alcohols Motor cars and other motor vehicles
Egypt Rep.	Cheese Potatoes Citruses Rice Sugar	Nitrogen fertilizer Men's suits, coats, jackets, trousers, and the like Women's suits, coats, jackets, dresses, skirts, trousers, and the like Flat-rolled products of iron or steel, not further worked than hot-rolled Insulated wire, cable, and other insulated electric conductors
Gabon	Other tobacco Rubber Wood in the rough Railway or tramway sleepers of wood Wood sawn	Sheets for veneering Plywood Hand-crafted garments Ferroalloy Tools for hydrography, oceanography, hydrology, meteorology, or geophysics
Equatorial Guinea	Frozen fish Cocoa beans Raw wood Railway or tramway sleepers of wood Wood sawn	Acyclic hydrocarbons Acyclic alcohols Sheets for veneering Tubes and Pipes seamless, of iron or steel
Nigeria	Milk Coconut, Cashew and Brazil nut Other nuts and Oleaginous fruits Cocoa beans Rubber	Ammonium Tanned or crust hides and skins of bovine Other leather, without hair on, and skins of other animals Leather further prepared after tanning or crusting of bovine Other Footwear of Rubber or Plastic
Tunisia	Shellfish Mollusks Dates, Figs, Pineapple, Avocado, Guava and Mango Olive oil Other vegetable oil	Men's suits, coats, jackets, trousers, and the like Women's suits, coats, jackets, dresses, skirts, trousers, and the like Footwear with outer soles Insulated wire, cable, and other insulated electric conductors Electrical apparatus for switching or connecting electrical circuits

Note: To keep only non-mineral manufacturing products in the exchange rates for manufactured goods, we withdrew diamonds which were initially included in these two indexes for Angola and the Republic of Congo and compute the re-weighted indexes with the four remaining products.

Table 3: Unit-Root Tests Results

Variables	Variables in Level		Variables in Difference	
	IPS ( $W_{tbar}$ )	Pesaran ( $Z_{tbar}$ )	IPS ( $W_{tbar}$ )	Pesaran ( $Z_{tbar}$ )
<i>reer</i>	0.048 (0.519)	1.554 (0.940)	-9.599*** (0.000)	-2.550*** (0.005)
<i>erer<sub>agriculture</sub></i>	-0.602 (0.273)	0.581 (0.719)	-11.322*** (0.000)	-5.079*** (0.000)
<i>erer<sub>manufacture</sub></i>	0.120 (0.548)	2.036 (0.979)	-11.334*** (0.000)	-6.158*** (0.000)
<i>irer<sub>agriculture</sub></i>	-0.596 (0.275)	0.566 (0.714)	-9.346*** (0.000)	-4.468*** (0.000)
<i>irer<sub>manufacture</sub></i>	-0.384 (0.350)	2.149 (0.984)	-8.433*** (0.000)	-4.745*** (0.000)
<i>Oil Rents</i>	0.663 (0.746)	1.356 (0.913)	-9.560*** (0.000)	-5.290*** (0.000)
<i>openness</i>	0.969 (0.834)	0.155 (0.562)	-7.725*** (0.000)	-4.489*** (0.000)
<i>balassa</i>	-0.084 (0.467)	2.735 (0.997)	-8.039*** (0.000)	-2.376*** (0.009)
<i>NFA</i>	-0.489 (0.312)	0.178 (0.571)	-3.897*** (0.000)	-3.603*** (0.000)
<i>investment</i>	0.441 (0.670)	0.823 (0.795)	-8.891*** (0.000)	-3.849*** (0.000)
	Augmented Dickey-Fuller	Phillips-Perron	Augmented Dickey-Fuller	Phillips-Perron
<i>brent</i>	-1.449 (0.5587)	-1.447 (0.5593)	-3.974*** (0.0016)	-3.944*** (0.0017)
<i>wti</i>	-1.514 (0.5266)	-1.501 (0.5333)	-4.299*** (0.0004)	-4.291*** (0.0005)

Note: The table reports the results for the Im-Pesaran-Shin (2003) and the Pesaran (2003) panel unit-root tests with two lags for the main dependent and explanatory variables, but the Z-statistic for the Augmented-Dickey-Fuller and the Phillips-Perron time-series unit-root tests for the logarithms of the Brent and WTI oil prices. P-values are in parentheses.

Table 4: Kao and Pedroni Co-Integration Tests Results for Oil Rents

		<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
Kao Co-Integration Test	Modified DF	-0.8800 (0.1894)	-0.2813 (0.3892)	0.0746 (0.4703)	-0.3357 (0.3686)	-2.1455** (0.0160)
	DF	-2.6146*** (0.0045)	-1.8768** (0.0303)	-1.4485* (0.0737)	-1.4164* (0.0783)	-3.3001*** (0.0005)
	Augmented DF	-2.8386*** (0.0023)	-2.0120** (0.0221)	-1.6629** (0.0482)	-1.9425** (0.0260)	-0.4079 (0.3417)
	Unadjusted Modified DF	-4.1108*** (0.0000)	-4.1805*** (0.0000)	-3.2985*** (0.0005)	-2.3623*** (0.0091)	-4.7102*** (0.0000)
	Unadjusted DF	-4.2679*** (0.0000)	-4.0961*** (0.0000)	-3.5447*** (0.0002)	-2.6005*** (0.0047)	-4.3357*** (0.0000)
Pedroni Co-Integration Test	Panel v-statistic	-2.7509*** (0.0030)	-2.5196*** (0.0059)	-2.4835*** (0.0065)	-2.6270*** (0.0043)	-3.1377*** (0.0009)
	Panel ρ-statistic	1.7402** (0.0409)	2.3529** (0.0093)	2.1765** (0.0148)	2.6157*** (0.0045)	1.3567* (0.0874)
	Panel PP-statistic	-2.0792** (0.0188)	-1.4582* (0.0724)	-2.1528** (0.0157)	-0.4301 (0.3336)	-4.1730*** (0.0000)
	Panel ADF-statistic	-3.0145*** (0.0013)	-3.2950*** (0.0005)	-3.0213*** (0.0013)	-0.9046 (0.1828)	-4.7042*** (0.0000)
	Group ρ-statistic	2.9338*** (0.0017)	3.4211*** (0.0003)	3.3993*** (0.0003)	3.6808*** (0.0001)	2.6627*** (0.0039)
	Group PP-statistic	-1.3031* (0.0963)	-0.9804 (0.1634)	-1.5785* (0.0572)	-0.0872 (0.4653)	-3.7517*** (0.0001)
	Group ADF-statistic	-2.4743*** (0.0067)	-3.2032*** (0.0007)	-2.7414*** (0.0031)	-0.5233 (0.3004)	-4.0278*** (0.0000)

Note: The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table 5: Kao and Pedroni Co-Integration Tests Results for the Brent Oil Price

		<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
Kao Co-Integration Test	Modified DF	-3.5569*** (0.0002)	-4.0486*** (0.0000)	-2.9315*** (0.0017)	-2.3663*** (0.0090)	-4.1679*** (0.0000)
	DF	-4.1934*** (0.0000)	-4.3309*** (0.0000)	-3.5911*** (0.0002)	-2.8296*** (0.0023)	-4.3784*** (0.0000)
	Augmented DF	-4.4071*** (0.0000)	-4.4094*** (0.0000)	-3.7855*** (0.0001)	-3.2548*** (0.0006)	-3.3704*** (0.0004)
	Unadjusted Modified DF	-4.1805*** (0.0000)	-4.4784*** (0.0000)	-3.4707*** (0.0003)	-2.5866*** (0.0048)	-4.8835*** (0.0000)
	Unadjusted DF	-4.3802*** (0.0000)	-4.4490*** (0.0000)	-3.7732*** (0.0001)	-2.9136*** (0.0018)	-4.5749*** (0.0000)
Pedroni Co-Integration Test	Panel v-statistic	-2.7517*** (0.0030)	-2.5284*** (0.0057)	-2.4701*** (0.0068)	-2.5099*** (0.0060)	-3.0350*** (0.0012)
	Panel $\rho$ -statistic	1.4798* (0.0695)	2.3156** (0.0103)	1.9807** (0.0238)	2.7236*** (0.0032)	1.5457* (0.0611)
	Panel PP-statistic	-2.6249*** (0.0043)	-1.6462** (0.0499)	-2.8720*** (0.0020)	0.0514 (0.4795)	-3.5787*** (0.0002)
	Panel ADF-statistic	-3.6972*** (0.0001)	-3.5833*** (0.0002)	-4.9085*** (0.0000)	-0.6076 (0.2717)	-4.1849*** (0.0000)
	Group $\rho$ -statistic	2.6426*** (0.0041)	3.4133*** (0.0003)	3.2851*** (0.0005)	3.8250*** (0.0001)	2.7793*** (0.0027)
	Group PP-statistic	-1.8650** (0.0311)	-1.1583 (0.1234)	-2.2172** (0.0133)	0.4734 (0.3180)	-3.8424*** (0.0001)
	Group ADF-statistic	-2.9463*** (0.0016)	-3.5266*** (0.0002)	-4.1981*** (0.0000)	-0.2719 (0.3928)	-3.8734*** (0.0001)

Note: The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table 6: Kao and Pedroni Co-Integration Tests Results for the WTI Oil Price

		<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
Kao Co-Integration Test	Modified DF	-3.5533*** (0.0002)	-4.0576*** (0.0000)	-2.9304*** (0.0017)	-2.3678*** (0.0089)	-4.1736*** (0.0000)
	DF	-4.1934*** (0.0000)	-4.3292*** (0.0000)	-3.5902*** (0.0002)	-2.8296*** (0.0023)	-4.3770*** (0.0000)
	Augmented DF	-4.4068*** (0.0000)	-4.4062*** (0.0000)	-3.7887*** (0.0001)	-3.2561*** (0.0006)	-3.3625*** (0.0004)
	Unadjusted Modified DF	-4.1817*** (0.0000)	-4.4811*** (0.0000)	-3.4669*** (0.0003)	-2.5845*** (0.0049)	-4.8734*** (0.0000)
	Unadjusted DF	-4.3818*** (0.0000)	-4.4454*** (0.0000)	-3.7714*** (0.0001)	-2.9122*** (0.0018)	-4.5689*** (0.0000)
Pedroni Co-Integration Test	Panel v-statistic	-2.7125*** (0.0033)	-2.4958*** (0.0063)	-2.4634*** (0.0069)	-2.5234*** (0.0058)	-3.0371*** (0.0012)
	Panel ρ-statistic	1.5065* (0.0660)	2.3364** (0.0090)	2.0319** (0.0211)	2.7144*** (0.0033)	1.5518* (0.0604)
	Panel PP-statistic	-2.5424*** (0.0055)	-1.4810* (0.0693)	-2.9708*** (0.0015)	-0.0059 (0.4977)	-3.7058*** (0.0001)
	Panel ADF-statistic	-3.6573*** (0.0001)	-3.5403*** (0.0002)	-5.3150*** (0.0000)	-0.7302 (0.2326)	-4.2918*** (0.0000)
	Group ρ-statistic	2.6707*** (0.0038)	3.4585*** (0.0003)	3.3104*** (0.0005)	3.8056*** (0.0001)	2.8155*** (0.0024)
	Group PP-statistic	-1.7941** (0.0364)	-0.9714 (0.1657)	-2.4230*** (0.0077)	0.4705 (0.3190)	-4.5122*** (0.0000)
	Group ADF-statistic	-2.9634*** (0.0015)	-3.4994*** (0.0002)	-4.6273*** (0.0000)	-0.3651 (0.3575)	-3.9575*** (0.0000)

Note: The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table 7: Pooled-Mean-Group Results for Oil Rents

Variables	<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
<b>Long-Run:</b>					
<i>Oil Rents</i>	0.0180*** (0.0021)	0.0182*** (0.0026)	0.0203*** (0.0024)	0.0256*** (0.0033)	0.0055** (0.0022)
<i>openness</i>	-0.8106*** (0.0834)	-0.7986*** (0.1060)	-0.8710*** (0.1018)	-0.7592*** (0.1046)	-0.6505*** (0.1278)
<i>balassa</i>	0.7120*** (0.0653)	0.6288*** (0.0874)	0.7813*** (0.0750)	0.9297*** (0.1147)	0.0691 (0.0609)
<i>NFA</i>	-0.0022* (0.0012)	-0.0030*** (0.0010)	-0.0022*** (0.0006)	-0.0038*** (0.0010)	-0.0098*** (0.0013)
<i>investment</i>	0.0911 (0.0686)	0.0911 (0.0845)	0.1599** (0.0795)	0.0872 (0.0699)	0.2091*** (0.0748)
<b>Short-Run:</b>					
$\Delta$ <i>Oil Rents</i>	-0.0006 (0.0048)	-0.0026 (0.0044)	0.0012 (0.0038)	-0.0061 (0.0063)	0.0098 (0.0109)
$\Delta$ <i>openness</i>	-0.0837 (0.1074)	-0.1675*** (0.0622)	-0.1955*** (0.0741)	-0.0147 (0.1738)	-0.0791 (0.1162)
$\Delta$ <i>balassa</i>	0.2981 (0.2877)	0.3374 (0.2546)	0.3896* (0.2221)	0.5060*** (0.1708)	0.8168** (0.4089)
$\Delta$ <i>NFA</i>	-0.0048 (0.0031)	-0.0044 (0.0031)	-0.0037 (0.0034)	-0.0032** (0.0015)	-0.0052* (0.0027)
$\Delta$ <i>investment</i>	-0.0681 (0.1688)	-0.0935 (0.1825)	-0.1197 (0.1741)	0.0229 (0.1901)	-0.0127 (0.1221)
<i>ec</i>	-0.2183** (0.1073)	-0.1945* (0.1011)	-0.2056** (0.0984)	-0.2181** (0.1020)	-0.4723*** (0.1181)
<i>Constant</i>	0.9551** (0.4820)	0.9078* (0.4876)	0.8215** (0.4059)	0.6137* (0.3188)	3.1867*** (0.8021)
Hausman	0.7288	0.8853	0.8971	0.5352	0.0000
Observations	207	207	207	207	207

Note: *ec* is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Hausman test reports the p-value for the Hausman test of PMG against MG. We prefer the Mean-Group to the Pooled-Mean-Group Estimator if  $P < 0.05$ . The number of lags of the model is selected using the Bayesian Information Criterion. The BIC indicates to prefer an ARDL(111111) in each case. Standard errors are in parentheses. \* Significant at 10%. \*\* Significant at 5%. \*\*\* Significant at 1%.

Table 8: Pooled-Mean-Group Results for Oil Prices

Variables	<i>reer</i>		<i>erer<sub>agriculture</sub></i>		<i>erer<sub>manufacture</sub></i>		<i>irer<sub>agriculture</sub></i>		<i>irer<sub>manufacture</sub></i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
<b>Long-Run:</b>										
<i>oilprice</i>	0.0595*** (0.0188)	0.2141*** (0.0331)	0.0572*** (0.0219)	0.1569*** (0.0358)	0.4877*** (0.0531)	0.5257*** (0.0548)	0.0694*** (0.0250)	0.0770*** (0.0290)	-0.2273*** (0.0399)	-0.2387*** (0.0466)
<i>openness</i>	-0.8245*** (0.0873)	-0.4705*** (0.0927)	-0.6383*** (0.0912)	-0.3568*** (0.1039)	-0.9941*** (0.0870)	-0.9866*** (0.0847)	-0.6580*** (0.0968)	-0.6543*** (0.1000)	-0.1926* (0.1002)	-0.2140** (0.1016)
<i>balassa</i>	0.2433*** (0.0803)	0.4870*** (0.0587)	0.3034*** (0.0825)	0.4532*** (0.0706)	-0.0135 (0.0926)	-0.0116 (0.0868)	0.3819** (0.1730)	0.3875** (0.1739)	0.2795*** (0.0412)	0.2728*** (0.0423)
<i>NFA</i>	-0.0011 (0.0010)	-0.0042*** (0.0015)	-0.0024** (0.0011)	-0.0041*** (0.0011)	0.0005 (0.0033)	0.0012 (0.0035)	-0.0032** (0.0013)	-0.0029** (0.0012)	-0.0047*** (0.0011)	-0.0047*** (0.0012)
<i>investment</i>	0.1035 (0.0949)	0.0067 (0.0765)	-0.0633 (0.0966)	-0.0728 (0.0665)	0.8786*** (0.1144)	0.8026*** (0.1071)	-0.0363 (0.0684)	-0.0388 (0.0670)	0.0261 (0.0696)	0.0410 (0.0606)
<b>Short-Run:</b>										
$\Delta oilprice$	0.1038*** (0.0384)	0.0461* (0.0275)	0.0316 (0.0451)	0.0054 (0.0371)	0.1029*** (0.0315)	0.1118*** (0.0218)	0.0408 (0.0604)	0.0525 (0.0628)	0.0792 (0.0565)	0.0791 (0.0526)
$\Delta openness$	-0.1266 (0.0873)	-0.1117 (0.1067)	-0.2061*** (0.0665)	-0.2178** (0.0884)	-0.2922*** (0.1005)	-0.2867*** (0.1033)	-0.1186 (0.1420)	-0.1215 (0.1428)	-0.1903* (0.0998)	-0.1655* (0.0868)
$\Delta balassa$	0.4004* (0.2317)	0.2529 (0.1811)	0.4757** (0.2304)	0.3666** (0.1701)	0.4431*** (0.1389)	0.4625*** (0.1298)	0.6565*** (0.1881)	0.6942*** (0.1860)	0.8316*** (0.2825)	0.7847*** (0.2821)
$\Delta NFA$	-0.0051 (0.0040)	-0.0049 (0.0039)	-0.0046 (0.0037)	-0.0044 (0.0036)	-0.0062 (0.0046)	-0.0062 (0.0045)	-0.0024 (0.0019)	-0.0026 (0.0019)		
$\Delta investment$	-0.0449 (0.1507)	-0.0336 (0.1488)	-0.0384 (0.1610)	-0.0302 (0.1556)	-0.0946 (0.1646)	-0.0993 (0.1622)	0.0835 (0.1714)	0.0750 (0.1749)	-0.0381 (0.1073)	
<i>ec</i>	-0.2269** (0.1021)	-0.2384** (0.1026)	-0.2524*** (0.0876)	-0.2807*** (0.0894)	-0.0632 (0.0821)	-0.0668 (0.0869)	-0.2282** (0.0993)	-0.2277** (0.0992)	-0.3823*** (0.1443)	-0.3885*** (0.1413)
<i>Constant</i>	1.4908** (0.6680)	0.9087** (0.4040)	1.5272*** (0.5373)	1.0728*** (0.3500)	0.2732 (0.3646)	0.2943 (0.3921)	1.2467** (0.5551)	1.2281** (0.5487)	2.0394*** (0.7779)	2.1179*** (0.7803)
Hausman	0.3095	0.3493	0.8254	0.8674	0.1989	0.3699	0.9906	0.9952	0.1658	0.0756
Observations	207	207	207	207	207	207	207	207	207	207

Note: Column (1) shows the results for the logarithm of the Brent oil price and column (2) for the logarithm of the WTI oil price. *ec* is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Hausman test reports the p-value for the Hausman test of PMG against MG. We prefer the Mean-Group to the Pooled-Mean-Group Estimator if  $P < 0.05$ . The number of lags of the model is selected using the Bayesian Information Criterion. The BIC indicates to prefer an ARDL(111111) in each case except for the internal ER for manufacture where an ARDL(111101) is preferred with the Brent oil price and an ARDL(111100) with the WTI oil price. Standard errors are in parentheses. \* Significant at 10%. \*\* Significant at 5%. \*\*\* Significant at 1%.

Table 9: Mean-Group Results for Oil Rents

Variables	<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
<b><u>Long-Run:</u></b>					
<i>Oil Rents</i>	0.1274 (0.1241)	0.0986 (0.0933)	0.1479 (0.1413)	0.0366** (0.0178)	0.0174 (0.0355)
<i>openness</i>	-2.0074 (1.6449)	-1.5141 (1.2587)	-2.4172 (1.8689)	-0.7439*** (0.2433)	-0.6932 (0.5856)
<i>balassa</i>	-2.8537 (2.9321)	-2.0839 (2.2985)	-3.2506 (3.4109)	-0.2342 (0.5385)	-1.0715 (0.8580)
<i>NFA</i>	-0.0802 (0.0801)	-0.0615 (0.0624)	-0.0899 (0.0916)	-0.0206 (0.0127)	-0.0178 (0.0210)
<i>investment</i>	0.2886 (0.3120)	-0.0651 (0.1292)	0.3248 (0.2695)	-0.0993 (0.4513)	-0.3419 (0.3400)
<b><u>Short-Run:</u></b>					
$\Delta$ <i>Oil Rents</i>	0.0024 (0.0059)	0.0004 (0.0066)	0.0026 (0.0056)	-0.0063 (0.0069)	0.0157* (0.0083)
$\Delta$ <i>openness</i>	0.0244 (0.1184)	-0.0976 (0.1043)	-0.0006 (0.1048)	0.0792 (0.1773)	-0.0411 (0.1316)
$\Delta$ <i>balassa</i>	0.7049* (0.4177)	0.6298 (0.4513)	0.6782 (0.4346)	0.5124* (0.3083)	0.8590** (0.4155)
$\Delta$ <i>NFA</i>	-0.0031* (0.0018)	-0.0031* (0.0018)	-0.0024 (0.0020)	-0.0004 (0.0018)	-0.0062** (0.0024)
$\Delta$ <i>investment</i>	-0.0667 (0.1284)	-0.0167 (0.1360)	-0.0772 (0.1301)	0.0410 (0.1097)	0.1183 (0.0927)
<i>ec</i>	-0.7133*** (0.1040)	-0.5731*** (0.0869)	-0.6511*** (0.1152)	-0.5058*** (0.0516)	-0.8524*** (0.1221)
<i>Constant</i>	5.1591*** (1.1938)	4.0536*** (1.3196)	4.9786*** (1.1768)	3.4268*** (1.2783)	8.4159*** (2.5267)
Observations	207	207	207	207	207

Note: *ec* is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses. \* Significant at 10%. \*\* Significant at 5%. \*\*\* Significant at 1%.



Table 10: Mean-Group Results for Oil Prices

Variables	<i>reer</i>		<i>erer<sub>agriculture</sub></i>		<i>erer<sub>manufacture</sub></i>		<i>irer<sub>agriculture</sub></i>		<i>irer<sub>manufacture</sub></i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
<b>Long-Run:</b>										
<i>oilprice</i>	-0.0062 (0.0671)	0.0122 (0.0697)	0.0726 (0.0744)	0.0793 (0.0716)	0.1440 (0.1018)	0.1581* (0.0901)	0.1642* (0.0946)	0.1844* (0.1004)	-0.0886 (0.1221)	-0.1336 (0.1301)
<i>openness</i>	-0.4787** (0.1993)	-0.4245** (0.1674)	-0.1931 (0.1773)	-0.2044 (0.1601)	-0.2809 (0.1927)	-0.3023* (0.1654)	-0.5375*** (0.2077)	-0.5971*** (0.2051)	-0.5026** (0.2013)	-0.4677** (0.2158)
<i>balassa</i>	-0.0568 (0.2534)	-0.0174 (0.2289)	0.2267 (0.2003)	0.2405 (0.2113)	0.3090 (0.2779)	0.2932 (0.2580)	0.4154 (0.4042)	0.4861 (0.4339)	-0.0709 (0.5578)	-0.0177 (0.5415)
<i>NFA</i>	0.0047** (0.0023)	0.0036** (0.0017)	0.0018 (0.0019)	0.0017 (0.0016)	0.0046* (0.0026)	0.0038* (0.0020)	-0.0059 (0.0055)	-0.0064 (0.0057)	0.0067 (0.0065)	0.0087 (0.0072)
<i>investment</i>	-0.5943 (0.7215)	-0.5774 (0.6730)	-0.4213 (0.5903)	-0.4393 (0.5699)	-0.6396 (0.7108)	-0.6122 (0.6614)	-0.2572 (0.5964)	-0.2962 (0.6054)	-0.4944 (0.6780)	-0.4580 (0.6460)
<b>Short-Run:</b>										
$\Delta oilprice$	0.1600*** (0.0425)	0.1320*** (0.0357)	0.0775 (0.0503)	0.0641 (0.0461)	0.1109** (0.0461)	0.0877** (0.0417)	0.0345 (0.0487)	0.0202 (0.0451)	0.1745 (0.1085)	0.1076 (0.1224)
$\Delta openness$	-0.0612 (0.1092)	-0.0519 (0.1140)	-0.2050** (0.0959)	-0.1960* (0.1009)	-0.1384 (0.0957)	-0.1238 (0.1018)	-0.0863 (0.1611)	-0.0710 (0.1538)	0.1206 (0.1741)	0.0666 (0.1765)
$\Delta balassa$	0.4317* (0.2578)	0.3465 (0.2244)	0.4032 (0.2547)	0.3639 (0.2253)	0.3400 (0.2768)	0.3052 (0.2430)	0.4166** (0.2061)	0.4471** (0.1740)	0.9738* (0.5244)	0.6475* (0.3644)
$\Delta NFA$	-0.0068 (0.0050)	-0.0063 (0.0047)	-0.0064 (0.0047)	-0.0062 (0.0045)	-0.0071 (0.0049)	-0.0067 (0.0047)	-0.0022 (0.0028)	-0.0021 (0.0028)	-0.0109* (0.0057)	-0.0104* (0.0060)
$\Delta investment$	0.0408 (0.0581)	0.0488 (0.0577)	0.0954 (0.0718)	0.0952 (0.0701)	0.0735 (0.0658)	0.0733 (0.0660)	0.1336 (0.1262)	0.1266 (0.1112)	0.0215 (0.0789)	0.0337 (0.0912)
<i>ec</i>	-0.7308*** (0.1220)	-0.7311*** (0.1130)	-0.6387*** (0.1071)	-0.6323*** (0.0893)	-0.7126*** (0.1503)	-0.7160*** (0.1462)	-0.4935*** (0.0679)	-0.4737*** (0.0606)	-0.8537*** (0.1265)	-0.8268*** (0.1088)
<i>Constant</i>	4.3778*** (0.9907)	4.3343*** (0.9096)	3.0732*** (0.9734)	3.0004*** (0.9513)	3.0347*** (1.0482)	3.0754*** (0.9200)	2.4045** (1.1329)	2.2858** (1.1034)	8.7363*** (2.9894)	7.9304*** (2.3717)
Observations	207	207	207	207	207	207	207	207	207	207

Note: Column (1) shows the results for the logarithm of the Brent oil price and column (2) for the logarithm of the WTI oil price. *ec* is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses. \* Significant at 10%. \*\* Significant at 5%. \*\*\* Significant at 1%.

Table 11: Breusch-Pagan Test for Cross-Section Dependence

		<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
Oil Rents	Without trend	86.48*** (0.00)	91.71*** (0.00)	105.20*** (0.00)	98.10*** (0.00)	84.78*** (0.00)
	With trend	94.53*** (0.00)	102.90*** (0.00)	112.80*** (0.00)	89.98*** (0.00)	80.19*** (0.00)

Note: The table presents the results for the Breusch-Pagan (1980) test of Cross-sectional dependence based on Lagrange-Multiplier. A p-value lower than 0.05 indicates to reject the hypothesis of error cross-section independence. P-values are in parentheses.

Table 12: Cross-Sectionally Augmented Pooled-Mean-Group Results for Oil Rents

Variables	<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
<b><u>Long-Run:</u></b>					
<i>Oil Rents</i>	0.0025 (0.0019)	0.0035*** (0.0011)	0.0024 (0.0018)	0.0934*** (0.0076)	0.0063* (0.0033)
<i>openness</i>	-0.3176*** (0.0786)	-0.2626*** (0.0752)	-0.2453*** (0.0295)	-0.9288*** (0.0881)	-0.7958*** (0.1765)
<i>balassa</i>	0.1185*** (0.0215)	0.0927*** (0.0176)	0.2853*** (0.0540)	-0.5604*** (0.1419)	-0.0946 (0.0777)
<i>NFA</i>	-0.0026** (0.0010)	-0.0022*** (0.0009)	-0.0053*** (0.0012)	-0.0203*** (0.0016)	-0.0093*** (0.0017)
<i>investment</i>	-0.0292 (0.0361)	-0.0352 (0.0364)	-0.0242*** (0.0083)	1.4123*** (0.0720)	0.0281 (0.1186)
<i>Oil Rents</i>	-0.0129*** (0.0041)	-0.0143*** (0.0031)	-0.0046*** (0.0010)	-0.0157*** (0.0019)	-0.0373*** (0.0074)
<i>openness</i>	0.5486*** (0.1192)	0.4778*** (0.1096)	0.1279*** (0.0376)	-0.7811*** (0.0836)	1.8616*** (0.2601)
<i>NFA</i>	0.0074*** (0.0017)	0.0031** (0.0014)	0.0033*** (0.0008)	0.0032** (0.0016)	0.0197*** (0.0035)
<b><u>Short-Run:</u></b>					
$\Delta$ <i>Oil Rents</i>	-0.0064 (0.0057)	-0.0014 (0.0059)	0.0087 (0.0082)	-0.0047 (0.0167)	-0.0142 (0.0113)
$\Delta$ <i>openness</i>	-0.2831 (0.2428)	-0.4518* (0.2544)	-0.4712** (0.2342)	-0.2279 (0.2800)	-0.1776 (0.3251)
$\Delta$ <i>balassa</i>	0.0251 (0.1453)	0.0226 (0.1022)	0.2969* (0.1551)	0.2225 (0.3350)	0.1788 (0.1570)
$\Delta$ <i>NFA</i>	-0.0079 (0.0064)	-0.0078 (0.0065)	-0.0084 (0.0066)	-0.0023 (0.0069)	-0.0110* (0.0063)
$\Delta$ <i>investment</i>	-0.0554 (0.1808)	-0.0619 (0.1886)	-0.1059 (0.1860)	-0.3759 (0.2824)	0.0092 (0.1427)
$\Delta$ <i>Oil Rents</i>	0.0053 (0.0036)	-0.0004 (0.0045)	-0.0006 (0.0041)	0.0073 (0.0060)	0.0047 (0.0072)
$\Delta$ <i>openness</i>	0.5739 (0.5860)	0.6589 (0.7195)	0.7802 (0.6062)	0.0737 (0.6361)	0.2779 (0.9265)
$\Delta$ <i>NFA</i>	0.0019 (0.0020)	0.0014 (0.0016)	0.0012 (0.0022)	-0.0024 (0.0046)	0.0019 (0.0046)
<i>ec</i>	-0.3996*** (0.1216)	-0.3716*** (0.1240)	-0.4286* (0.2224)	-0.3010 (0.2035)	-0.4421*** (0.1274)
Constant	1.3400*** (0.4103)	1.3389*** (0.4480)	1.6182* (0.8293)	-0.5811** (0.2929)	0.4525*** (0.1284)
Observations	207	207	207	207	207

Note: ec is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses. \* Significant at 10% \*\* Significant at 5% \*\*\* Significant at 1%.

## Supplementary Results

Table A1: Unit-Root Tests Results

Variables	Variables in Level		Variables in Difference	
	Augmented Dickey-Fuller	Phillips-Perron	Augmented Dickey-Fuller	Phillips-Perron
<i>deflated brent</i>	-1.486 (0.5404)	-1.495 (0.5360)	-3.988*** (0.0015)	-3.958*** (0.0016)
<i>deflated wti</i>	-1.551 (0.5079)	-1.540 (0.5137)	-4.327*** (0.0004)	-4.320*** (0.0004)

Note: The table reports the Z-statistic for the Augmented-Dickey-Fuller and the Phillips-Perron time-series unit-root tests for the logarithms of the deflated Brent and WTI oil prices. The deflated brent oil price and the deflated wti oil price are computed as the logarithm of the ratio of the Brent and WTI oil price to the US Consumer Price Index. P-values are in parentheses.

Table A2: Kao and Pedroni Co-Integration Tests Results for the deflated Brent Oil Price

		<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
Kao Co-Integration Test	Modified DF	-3.5517*** (0.0002)	-4.0245*** (0.0000)	-2.9294*** (0.0017)	-2.3710*** (0.0089)	-4.1697*** (0.0000)
	DF	-4.1945*** (0.0000)	-4.2998*** (0.0000)	-3.5938*** (0.0002)	-2.8404*** (0.0023)	-4.3839*** (0.0000)
	Augmented DF	-4.4161*** (0.0000)	-4.3788*** (0.0000)	-3.8002*** (0.0001)	-3.2638*** (0.0005)	-3.3744*** (0.0004)
	Unadjusted Modified DF	-4.1764*** (0.0000)	-4.4558*** (0.0000)	-3.4708*** (0.0003)	-2.5921*** (0.0048)	-4.8889*** (0.0000)
	Unadjusted DF	-4.3817*** (0.0000)	-4.4190*** (0.0000)	-3.7766*** (0.0001)	-2.9246*** (0.0017)	-4.5813*** (0.0000)
Pedroni Co-Integration Test	Panel v-statistic	-2.7570*** (0.0029)	-2.5242*** (0.0058)	-2.4742*** (0.0067)	-2.5074*** (0.0061)	-3.0340*** (0.0012)
	Panel p-statistic	1.4781* (0.0697)	2.3122** (0.0104)	1.9766** (0.0240)	2.7300*** (0.0032)	1.5572* (0.0597)
	Panel PP-statistic	-2.6290*** (0.0043)	-1.6522** (0.0493)	-2.8848*** (0.0020)	0.0747 (0.4702)	-3.5478*** (0.0002)
	Panel ADF-statistic	-3.6868*** (0.0001)	-3.5732*** (0.0002)	-4.9007*** (0.0000)	-0.5730 (0.2833)	-4.1571*** (0.0000)
	Group p-statistic	2.6427*** (0.0041)	3.4095*** (0.0003)	3.2855*** (0.0005)	3.8306*** (0.0001)	2.7892*** (0.0026)
	Group PP-statistic	-1.8656** (0.0310)	-1.1684 (0.1213)	-2.2296** (0.0129)	0.4920 (0.3114)	-3.8249*** (0.0001)
	Group ADF-statistic	-2.9222*** (0.0017)	-3.5083*** (0.0002)	-4.1732*** (0.0000)	-0.2329 (0.4079)	-3.8439*** (0.0001)

Note: The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table A3: Kao and Pedroni Co-Integration Tests Results for the deflated WTI Oil Price

		<i>reer</i>	<i>erer<sub>agriculture</sub></i>	<i>erer<sub>manufacture</sub></i>	<i>irer<sub>agriculture</sub></i>	<i>irer<sub>manufacture</sub></i>
Kao Co-Integration Test	Modified DF	-3.5473*** (0.0002)	-4.0315*** (0.0000)	-2.9302*** (0.0017)	-2.3743*** (0.0088)	-4.1695*** (0.0000)
	DF	-4.1959*** (0.0000)	-4.2949*** (0.0000)	-3.5996*** (0.0002)	-2.8430*** (0.0022)	-4.3771*** (0.0000)
	Augmented DF	-4.4194*** (0.0000)	-4.3731*** (0.0000)	-3.8149*** (0.0001)	-3.2674*** (0.0005)	-3.3592*** (0.0004)
	Unadjusted Modified DF	-4.1766*** (0.0000)	-4.4562*** (0.0000)	-3.4690*** (0.0003)	-2.5916*** (0.0048)	-4.8715*** (0.0000)
	Unadjusted DF	-4.3846*** (0.0000)	-4.4121*** (0.0000)	-3.7815*** (0.0001)	-2.9257*** (0.0018)	-4.5696*** (0.0000)
Pedroni Co-Integration Test	Panel v-statistic	-2.7188** (0.0033)	-2.4920** (0.0064)	-2.4684*** (0.0068)	-2.5214*** (0.0058)	-3.0367*** (0.0012)
	Panel $\rho$ -statistic	1.5075* (0.0658)	2.3614*** (0.0091)	2.0282** (0.0213)	2.7186*** (0.0033)	1.5595* (0.0594)
	Panel PP-statistic	-2.5384*** (0.0056)	-1.4828* (0.0691)	-2.9876*** (0.0014)	0.0091 (0.4964)	-3.6805*** (0.0001)
	Panel ADF-statistic	-3.6457*** (0.0001)	-3.5276*** (0.0002)	-5.3209*** (0.0000)	-0.7049 (0.2404)	-4.2710*** (0.0000)
	Group $\rho$ -statistic	2.6751*** (0.0037)	3.4557*** (0.0003)	3.3128*** (0.0005)	3.8093*** (0.0001)	2.8208*** (0.0024)
	Group PP-statistic	-1.7820** (0.0374)	-0.9739 (0.1651)	-2.4392*** (0.0074)	0.4817 (0.3150)	-4.4596*** (0.0000)
	Group ADF-statistic	-2.9348*** (0.0017)	-3.4727*** (0.0003)	-4.6088*** (0.0000)	-0.3318 (0.3700)	-3.9356*** (0.0000)

Note: The table presents the four statistics provided by the Kao co-integration test and the seven provided by the Pedroni co-integration test. The number of lags is chosen using the Bayesian Information Criterion. P-values are in parentheses.

Table A4: Pooled-Mean-Group Results for deflated Oil Prices

Variables	<i>reer</i>		<i>erer<sub>agriculture</sub></i>		<i>erer<sub>manufacture</sub></i>		<i>irer<sub>agriculture</sub></i>		<i>irer<sub>manufacture</sub></i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
<b>Long-Run:</b>										
<i>oilprice</i>	0.2343*** (0.0376)	0.2854*** (0.0376)	0.0801*** (0.0287)	0.3125*** (0.0533)	0.3536*** (0.0498)	0.3757*** (0.0422)	0.0893*** (0.0316)	0.1000*** (0.0372)	-0.0854** (0.0418)	-0.2626*** (0.0552)
<i>openness</i>	-0.6105*** (0.1003)	-0.5480*** (0.0847)	-0.6344*** (0.0919)	-0.4607*** (0.1023)	-0.6482*** (0.1125)	-0.5567*** (0.0883)	-0.6660*** (0.0974)	-0.6652*** (0.1009)	-0.7138*** (0.1199)	-0.2595** (0.1122)
<i>balassa</i>	0.4509*** (0.0606)	0.4796*** (0.0513)	0.3107*** (0.0773)	0.5272*** (0.0671)	0.5066*** (0.0726)	0.5329*** (0.0543)	0.3816** (0.1706)	0.3866** (0.1719)	0.8287*** (0.2106)	0.2624*** (0.0467)
<i>NFA</i>	-0.0041*** (0.0015)	-0.0044*** (0.0015)	-0.0026** (0.0011)	-0.0074*** (0.0019)	-0.0082*** (0.0019)	-0.0070*** (0.0013)	-0.0033** (0.0013)	-0.0029** (0.0012)	-0.0034** (0.0015)	-0.0051*** (0.0019)
<i>investment</i>	0.1197 (0.1040)	0.0656 (0.0827)	-0.0575 (0.0943)	0.1904 (0.1167)	0.3388** (0.1428)	0.11667* (0.1008)	-0.0322 (0.0675)	-0.0339 (0.0662)	-0.2421* (0.1414)	0.0945 (0.0680)
<b>Short-Run:</b>										
<i>Δoilprice</i>	0.0692*** (0.0254)	0.0390 (0.0262)	0.0236 (0.0444)	0.0078 (0.0400)	0.0787*** (0.0233)	0.0541** (0.0226)	0.0367 (0.0609)	0.0476 (0.0630)	0.0669 (0.0825)	0.1291** (0.0521)
<i>Δopenness</i>	-0.1147 (0.0979)	-0.0948 (0.1079)	-0.1965*** (0.0673)	-0.2274** (0.0948)	-0.2143* (0.1119)	-0.1722 (0.1198)	-0.1132 (0.1406)	-0.1156 (0.1412)	-0.1184 (0.1185)	-0.1670* (0.0988)
<i>Δbalassa</i>	0.3177* (0.1786)	0.2549 (0.1793)	0.4634** (0.2275)	0.3732** (0.1687)	0.4298*** (0.1515)	0.4178*** (0.1512)	0.6510*** (0.1890)	0.6874*** (0.1856)	1.0172*** (0.3504)	0.6936*** (0.2664)
<i>ΔNFA</i>	-0.0052 (0.0039)	-0.0051 (0.0039)	-0.0046 (0.0036)	-0.0049 (0.0039)	-0.0048 (0.0043)	-0.0045 (0.0041)	-0.0024 (0.0019)	-0.0026 (0.0019)		-0.0056* (0.0034)
<i>Δinvestment</i>	-0.0451 (0.1542)	-0.0430 (0.1510)	-0.0386 (0.1623)	-0.0705 (0.1671)	-0.1077 (0.1613)	-0.1105 (0.1560)	0.0837 (0.1724)	0.0744 (0.1762)	0.0813 (0.1068)	
<i>ec</i>	-0.2097** (0.0912)	-0.2298** (0.0991)	-0.2569*** (0.0881)	-0.1898** (0.0892)	-0.1576* (0.0847)	-0.2117** (0.1033)	-0.2289** (0.0989)	-0.2282** (0.0990)	-0.3151*** (0.1054)	-0.4051*** (0.1378)
<i>Constant</i>	0.8622** (0.3892)	0.8504** (0.3818)	1.5143*** (0.5276)	0.4891** (0.2344)	0.4471* (0.2572)	0.5866 (0.3007)	1.2380** (0.5480)	1.2182** (0.5423)	1.6673*** (0.5480)	2.2849*** (0.7871)
Hausman	0.2139	0.1206	0.8185	0.1266	0.0779	0.0226	0.9996	0.9986	0.1154	0.0363
Observations	207	207	207	207	207	207	207	207	207	207

Note: Column (1) shows the results for the logarithm of the Brent oil price and column (2) for the logarithm of the WTI oil price. *ec* is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Hausman test reports the p-value for the Hausman test of PMG against MG. We prefer the Mean-Group to the Pooled-Mean-Group Estimator if  $P < 0.05$ . The number of lags is selected using the Bayesian Information Criterion. Standard errors are in parentheses. \* Significant at 10%. \*\* Significant at 5%. \*\*\* Significant at 1%.

Table A5: Mean-Group Results for deflated Oil Prices

Variables	<i>reer</i>		<i>erer<sub>agriculture</sub></i>		<i>erer<sub>manufacture</sub></i>		<i>irer<sub>agriculture</sub></i>		<i>irer<sub>manufacture</sub></i>	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
<b>Long-Run:</b>										
<i>oilprice</i>	0.0194 (0.0670)	0.0515 (0.0735)	0.0752 (0.0724)	0.1002 (0.0698)	0.3175 (0.2386)	0.2837* (0.1659)	0.1188 (0.1110)	0.1068 (0.1575)	-0.1365 (0.1104)	-0.1968 (0.1278)
<i>openness</i>	-0.4776** (0.1972)	-0.4149** (0.1668)	-0.1970 (0.1874)	-0.2164 (0.1708)	-0.1186 (0.3638)	-0.2347 (0.2488)	-0.6963** (0.2781)	-0.7822*** (0.2911)	-0.4958** (0.2214)	-0.4400* (0.2507)
<i>balassa</i>	-0.0630 (0.2149)	-0.0496 (0.1993)	0.1512 (0.1861)	0.1574 (0.2139)	0.3698 (0.3815)	0.2302 (0.3022)	0.4592 (0.5068)	0.5452 (0.5962)	-0.0945 (0.5017)	-0.0277 (0.4784)
<i>NFA</i>	0.0036** (0.0016)	0.0019 (0.0013)	0.0016 (0.0016)	0.0005 (0.0016)	0.0016 (0.0042)	0.0010 (0.0028)	-0.0049 (0.0075)	-0.0049 (0.0088)	0.0093 (0.0069)	0.0116 (0.0079)
<i>investment</i>	-0.6244 (0.7178)	-0.5963 (0.6570)	-0.4183 (0.5905)	-0.4294 (0.5629)	-0.6262 (0.7105)	-0.5807 (0.6505)	-0.3148 (0.6068)	-0.3687 (0.6231)	-0.5149 (0.7030)	-0.5026 (0.6664)
<b>Short-Run:</b>										
$\Delta oilprice$	0.1621*** (0.0458)	0.1243*** (0.0399)	0.0786 (0.0489)	0.0595 (0.0457)	0.1057** (0.0461)	0.0780* (0.0427)	0.0323 (0.0488)	0.0182 (0.0479)	0.2050* (0.1107)	0.1263 (0.1216)
$\Delta openness$	-0.0522 (0.1085)	-0.0284 (0.1158)	-0.2009** (0.0944)	-0.1870* (0.1022)	-0.1268 (0.1010)	-0.1058 (0.1109)	-0.0697 (0.1617)	-0.0484 (0.1543)	0.1056 (0.1644)	0.0370 (0.1739)
$\Delta balassa$	0.4278* (0.2603)	0.3393 (0.2315)	0.4138 (0.2569)	0.3751 (0.2309)	0.3646 (0.2731)	0.3408 (0.2413)	0.4246** (0.2069)	0.4612*** (0.1786)	0.9490* (0.4862)	0.6049* (0.3425)
$\Delta NFA$	-0.0066 (0.0047)	-0.0060 (0.0043)	-0.0063 (0.0044)	-0.0058 (0.0041)	-0.0070 (0.0047)	-0.0064 (0.0043)	-0.0021 (0.0026)	-0.0017 (0.0026)	-0.0110** (0.0056)	-0.0107* (0.0057)
$\Delta investment$	0.0445 (0.0586)	0.0503 (0.0582)	0.0952 (0.0707)	0.0915 (0.0701)	0.0712 (0.0659)	0.0664 (0.0670)	0.1301 (0.1243)	0.1176 (0.1096)	0.0379 (0.0773)	0.0539 (0.0939)
<i>ec</i>	-0.7567*** (0.1235)	-0.7912*** (0.1095)	-0.6228*** (0.1043)	-0.6040*** (0.0797)	-0.6900*** (0.1533)	-0.6913*** (0.1470)	-0.4746*** (0.0699)	-0.4575*** (0.0639)	-0.8595*** (0.1301)	-0.8275*** (0.1084)
<i>Constant</i>	4.5590*** (0.9043)	4.5989*** (0.8010)	3.1551*** (0.9338)	3.0211*** (0.9472)	3.2658*** (1.0592)	3.3759*** (0.9670)	2.4701** (1.0723)	2.4636** (1.0699)	8.8074*** (2.6573)	7.8453*** (1.9918)
Observations	207	207	207	207	207	207	207	207	207	207

Note: Column (1) shows the results for the logarithm of the Brent oil price and column (2) for the logarithm of the WTI oil price. *ec* is the error-correction term and represents the speed of adjustment toward long-run equilibrium. Standard errors are in parentheses. \* Significant at 10%. \*\* Significant at 5%. \*\*\*Significant at 1%.