Is the boost in oil prices affecting the appreciation of real exchange rate?: Empirical evidence of "Dutch disease" in Colombia

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ABSTRACT

The term *Dutch disease* appears in relation to The Netherlands' discovery of large gas deposits in the North Sea and its harmful effects on the country's industrial sector. The sudden increase in the country's wealth created an inflow of capital never seen before, which led to an appreciation of its currency and, therefore, a loss of competiveness of the non-energy exporting sector. The purpose of this article is to provide empirical evidence of *Dutch disease* in Colombia as a consequence of the high oil prices and the increasing share in total exports of this product. A Vector Error Correction Model is estimated to determine whether oil prices are related to the real exchange rate, the Gross Domestic Product and the relative manufacturing output. Estimations show that, as expected for the Colombian economy, oil prices are weakly exogenous and positively related to the real exchange rate in the long term. Thus, increases in oil prices have a negative effect on the country's competitiveness.

Key words: Dutch disease, oil prices, cointegration analysis.

JEL classification: C22, F14, P27

1. Introduction

In recent years, Latin-American economies have suffered a common phenomenon: the appreciation of their currencies. The worldwide economic crisis, as well as the constant increase in the prices of raw materials, which frequently represent a main export product, have attracted large capital inflows into the countries of the region. Colombia, whose currency's appreciation reached 19% in 2010, is no exception.

The rise in oil prices has generated an unprecedented boom of mining activity. Of the total foreign direct investment in 2010, around 85% was related to this sector. Although the influx of currency in this area can be seen as positive in many aspects, the appreciation of the real exchange rate may cause a loss of competitiveness for the Colombian industrial sector. Because of this, there is now an open discussion on possible *Dutch disease* symptoms in Colombia. *Dutch disease* is frequently understood as the de-industrialization process of an economy, which is associated to the real exchange rate appreciation produced as a consequence of an increase in capital inflows related to a surge in natural resource production.

The purpose of this study is to explore whether there is empirical evidence of *Dutch disease* in Colombia. This is an important issue for several reasons. First, there is no methodological consensus, internationally-speaking, on how to research this phenomenon. Usually, articles are divided into two types. On the one hand, those that work with a large collection of cross-section data and use static or dynamic panel models; see Coudert, Couharde and Mignon (2011), Lartey (2007, 2011), Acosta and Mandelman (2009), and Kang and Lee (2011), and on the other, authors who use time series to find the relation between real exchange rate and several macroeconomic and financial variables; Beine, Bos and Coulombe (2011), Algieri (2011), Egert (2008) and Shirinbakhsh, and Azahra (2011); among others. It is worth emphasizing that the country's specific details related to *Dutch disease* are unexplored in cross-section studies. Furthermore, data and types of techniques of time series differ according to the country of study.

Secondly, very few studies on the subject have been carried out in Colombia: Puyana (2000) and Meisel (2010) have produced articles on the subject, and Suescún (1997) creates a theoretical model of *Dutch disease*. Hence, there is no recent research on *Dutch disease* in this country that contains strong empirical evidence. Another

important issue related to *Dutch disease* is its impact on Colombian economic development. At the moment, the relation between the abundance of natural resources and the country's growth is a subject for debate. According to authors such as Sachs and Warner (1995), Neary and vanWijnbergen (1986) and Gelb (1988), the constant fluctuation in the raw material prices causes greater macroeconomic volatility in these countries, which results in lower economic growth. The observation that countries with natural resource abundance tend to grow slowly is known in the literature as the "natural resource curse". Nevertheless, more recent studies, e.g. Kronenberg (2004), Papyrakis and Gerlagh (2004) and Stijns (2005), cast doubts on this view. They suggest that the countries that are rich in natural resources do not necessarily suffer from de-industrialization or slower growth in the long term. In a recent article by Crutzen and Holton (2011), data of 93 developed and developing countries are used to find the determining factors of economic growth in countries that are rich in natural resources. According to the authors, there are four factors that determine the path of economic growth in these countries: 1) institutions; 2) ethno-linguistic characteristics and the division of population; 3) nature and types of resources and; 4) distribution and concentration of these resources. Our article addresses the relation between natural resources and long-run economic growth for Colombia.

Finally, although this paper makes no in depth study of the policy implications, if the symptoms of *Dutch disease* were confirmed, these should be oriented toward preventing the industry's disintegration and a better use of the energy resources. How to spend the revenues from the oil boom is crucial not only to avoid *Dutch disease* effects, but also to take better advantage of the benefits associated with the positive income shock.

We estimate a Vector Error Correction Model (VECM) to explore the evidence of *Dutch disease* in Colombia, which enables us to find equilibrium relations among variables in the long term, based on the cointegration evidence among them. The cointegration concept, introduced by Engle and Granger (1987) and extended by Johansen (1991), consists of determining whether two or more variables come together in the long term, and how deviations may affect the short term.

We consider annual series between 1980 and 2010 to determine whether oil prices are related to the real exchange rate, the Gross Domestic Product and the ratio between manufacturing to services output in Colombia in the long term. We also take into

account variables such as productivity, government expenditure and international reserves.

The rest of this article is organized as follows. Section two focuses on the description and definition of *Dutch disease* symptoms and a descriptive analysis of some of the key variables related to *Dutch disease* in Colombia. The econometric model is developed in section three. The last section offers conclusions and recommendations of economic policy.

2. Dutch disease and its symptoms in Colombia

The phenomenon known as *Dutch disease* refers to the negative effects on the manufacturing sector due to a large increase in a country's income. The term was first used in an article in The Economist in 1977 to describe The Netherlands' experience of discovering large gas deposits in the North Sea and their harmful effects on the industrial sector of the country.

The sudden increase of that country's wealth created an unprecedented inflow of capital which produced an appreciation of its currency and, therefore, a loss of competiveness of the non-gas exporting sectors.

The discoveries of natural resource deposits and increases in the prices of these resources in the producing countries create great advantages, such as the increase of the country's wealth, greater fiscal income for social investment and an improvement in the balance of payments. However, the de-industrialization resulting from the loss of competiveness may produce a high level of specialization in the production of the resource and in non-tradable sectors, which may leave the rest of the economy in a more vulnerable situation to external shocks with regard to international prices.

Corden and Neary's (1982) paper is the first to analyze the de-industrialization phenomenon produced by the boom of a sector which had been traditionally extractive from a theoretical viewpoint. The authors divide the economy into three sectors, two of which produce internationally tradable goods. The first is the booming extractive sector; like gas in The Netherlands, oil in Venezuela and minerals in Australia. The second exporting sector is traditional manufacturing, and the third is a non-tradable sector such as services and construction. According to Corden and Neary (1982) the capital inflow

caused by the booming sector will generate real appreciation of the local currency, which will end up in a loss in manufacturing competiveness. Likewise, the increase in the countries' income pushes up internal demand and generates a surge in the non-tradable production. Corden and Neary (1982) call this phenomenon relative de-industrialization.

Other authors, e.g. Egert (2008), consider that the boom in an extractive sector can also encourage both national and international investment in that sector. The capital inflow to the country's energy sector, as a form of foreign direct investment, can accentuate the real exchange rate appreciation. Lartey (2008) finds that the relative de-industrialization can be produced by the capital inflow to the country, even if not necessarily related to the extractive sector. In other words, there is empirical evidence of the relation between real exchange rate appreciation and variables such as, foreign direct investment, the level of financial liberalization and remittances; see Lartey (2011) and Acosta and Mandelman (2009). In this way, *Dutch disease* may be triggered by deposits discovered in the energy sector, as a result of variations of international prices of extractive products or commodities, or as a result of capital inflows such as foreign direct investment and remittances.

Regarding other possible symptoms of *Dutch disease*, Algieri (2011) suggests an improvement of the Gross Domestic Product in the short and the medium term, due to the increase in the country's income through the discovery of energy resources or the rise in commodity prices. The economic performance in the long term will depend on the policies and reforms carried out by countries to reverse the negative effects of *Dutch disease* and guarantee economic stability.

The importance and effectiveness of these policies will determine a country's economic long term growth. As we mentioned before, the relation between the abundance of natural resources and a country's wealth is a matter for debate. The policies implemented by the governments determine the differences between successful cases of the use of natural resources, such as Canada and Norway; and those in which natural resources have represented a burden for growth, among them Venezuela and Kenya.

Correct policies tend to avoid the transmission of price shocks which are external to the economy, and what is termed in the literature as the "voracity effect"; see Meda and Zakharova (2009). This effect consists of an excessive increase in spending by

governments, as a result of an increase in tax income[1]. In fact, there is empirical evidence of the direct correlation between oil benefits and public expenditure in those countries. It seems that there is a certain proclivity to waste and corruption in the management of the government resources; see Meda and Zakharova (2009).

To summarize, *Dutch disease* symptoms are: real appreciation of local currency; zero or even the decrease of the manufacturing sector related to that of non-tradable goods or services (relative de-industrialization); a drop in manufacturing exports and an increase of investment in the extractive sector.

In the case of Colombia, since 2010, newspapers and journals, encouraged by the industrial sector, have been warning about the possible contagion of the *Dutch disease* symptoms in this country. Many economic analysts and even the president have written columns and made statements on this subject. President Juan Manuel Santos declared, during a keynote speech at the headquarters of the Economic Commission for Latin America and the Caribbean (CEPAL) in Chile:

"I am trying to attract investors in sectors other than oil and mining, because we are now facing a prelude to the *Dutch disease*, since investment is becoming focused on these sectors". *Dinero* Magazine, August 18th, 2011.

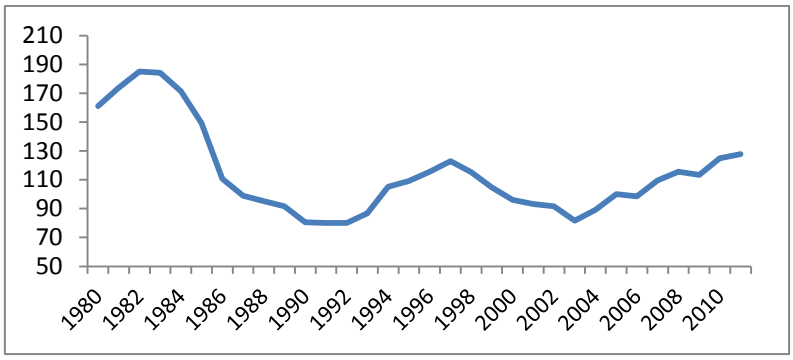
This is actually a valid concern, considering that the Colombian peso is one of the most revalued currencies in the world. The Colombian peso has appreciated 6.86% against the dollar in the first twenty days of January, 2012 alone; while the Brazilian real and the Mexican peso have appreciated 5.72% and 5.67%, respectively. Likewise, the Colombian peso is placed above the Indian rupee, the Hungarian forint or the new Turkish Lira, among others.

When evaluating the real exchange rate from a historical perspective, it can be determined that there is no clear trend; see Graph 1. While there was a pronounced real devaluation of the Colombian peso during the eighties, it was followed by different

[1]Economic policy decisions related with the negative effect of *Dutch Disease* symptoms are: protecting the most vulnerable sector, increasing the productivity of the non-tradable sector and diversifying exports to reduce the dependency of the booming sector. Regarding the policies that seek to avoid the "voracity effect", the most important of these have to do with fiscal rules that tend to restrict public deficit or spend better the resources coming from the extractive sector. For an analysis of these policies, see Medas and Zakharova, (2009).

episodes of appreciation/devaluation. Therefore, the concern of the Colombian non-traditional exporting sectors is due to real exchange rate growth since 2003[2], its possible upward trend and the loss of share of the country's industrial exports.

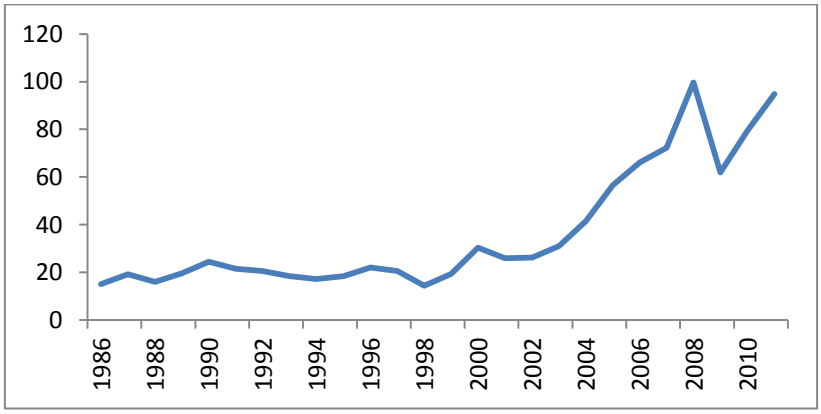
Graph 1. Real Effective Exchange Rate (2005 = 100)



Source: Worldwide Development Indicators. World Bank.

One fundamental variable in the analysis of Dutch disease is oil price. Its evolution in recent years has set off one of the greatest booms in the history of oil producing countries; see Graph 2. In addition, in the case of Colombia, it has attracted national and international investment towards the mining-energy sector. In 2011, the country received US$15.000 million, and 80% was invested in this sector. Therefore, on the one hand, the country has received currency from oil prices, and on the other, foreign direct investment. The inflow of dollars to the country has created an enormous currency supply which has led to the appreciation of the peso.

Graph 2.Annual Average Value of crude oil, Worldwide Development Indicators WTI (prices in dollars per barrel).

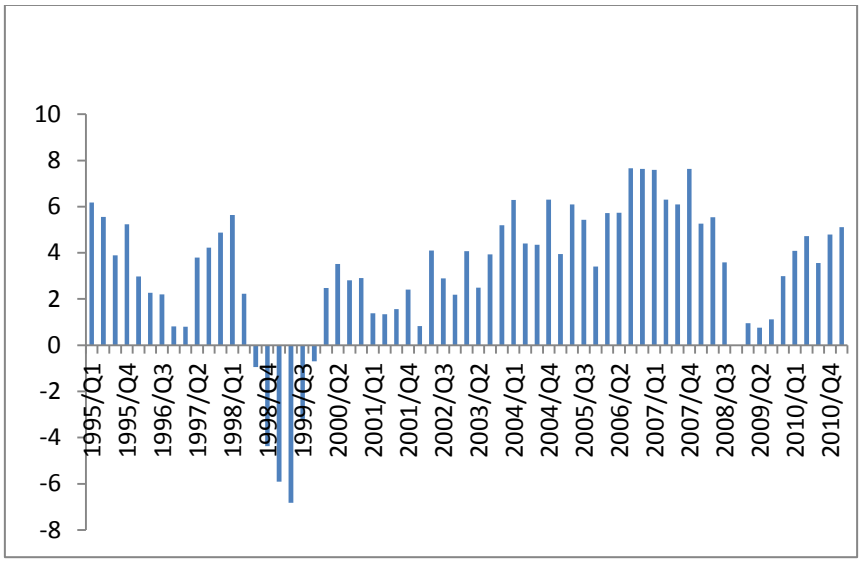


Source: Energy Information Administrator

[2]From 2003 to 2011 the real exchange rate in Colombia has grown by 53%.

It is interesting to mention that in recent years Colombia has had a strong macroeconomic performance, marked by prolonged GDP growth. Between 2002 and 2008 it benefited enormously from the recent greater increase in oil prices. During this period the annual rates of GDP growth were consistently around 5%. As documented in Graphs 2 and 3, after 2000 Colombia had relatively high growth rates while oil prices remained at record levels. However, the collapse of commodity prices in mid-2008 exposed the country to the global financial crisis and, as a result, the country's economic activity declined. From 2009, again, the surge of economic growth coincides with high oil prices.

Graph 3. Colombian growth rate of GDP volume. Percent change over the same period of the previous year.



Source: International Monetary Fund (IMF).

Table 1 shows a decrease in the share of the total amount of exports of the industrial sectors in the country, as well as an increase of the oil sector. In 2010, oil exports and its derivatives represented 41% of the total exports, exceeding, for the first time ever the share of the industrial sector. It is important to highlight the fact that traditional or commodities exports represent almost 64% of the total.

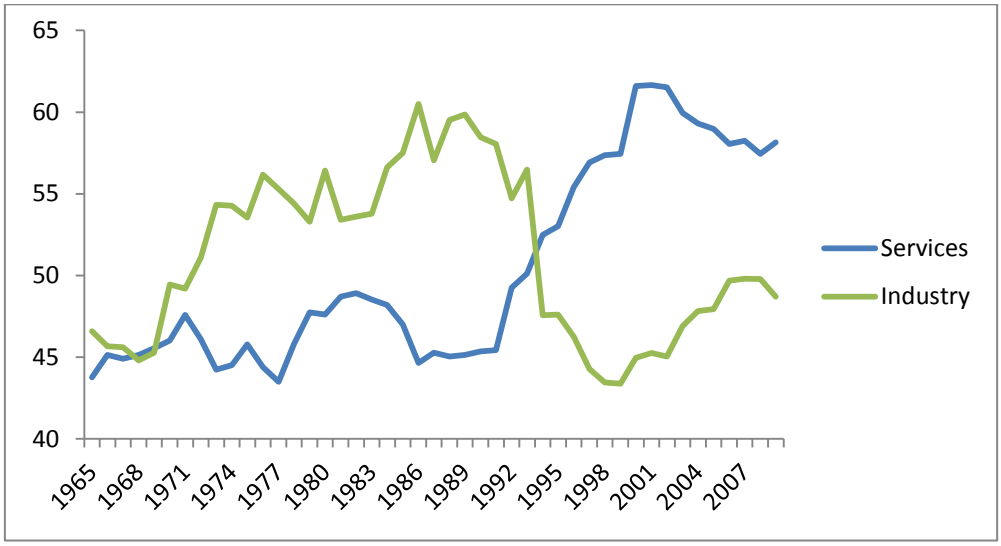
Table 1. Share of the different economic sectors on total exports. Colombia: 2005-2010.

Sector	2005	2006	2007	2008	2009	2010
Traditional exports	48.92	48.42	47.37	53.16	54.64	63.67
Petroleum and derivatives	26.23	25.95	24.40	32.46	31.25	41.40
Coffee	6.94	5.99	5.72	5.01	4.70	4.73
Coal	12.26	11.94	11.65	13.40	16.49	15.11
Ferronickel	3.48	4.54	5.60	2.30	2.21	2.43
Non-traditional exports	51.08	51.58	52.63	46.84	45.36	36.33
Industrial sector	41.93	43.06	45.01	40.43	38.07	30.61
Others	9.15	8.52	7.62	6.41	7.29	5.72

Source: National Statistics Office of Colombia, DANE.

Graph 4 shows the contribution of the services and industry sectors to the Gross Domestic Product. It shows the de-industrialization process that has been taking place since the early nineties. Since 1994, the contribution of the service sector has been greater than that of the industrial sector, though the difference seems to have stabilized since 2000.

Graph 4. Contribution of the Sectors to the Gross Domestic Product (share).



Source: Data Service & Information. World Bank Statistics.

3. Econometric modeling and empirical evidence of Dutch disease in Colombia

To assess the empirical relation between oil prices and the Dutch Disease symptoms in Colombia, we formulate a Vector Error Correction Model (VECM).

The model will seek the estimation of three equations related to the main symptoms: 1) deterioration of international competitiveness in Colombia, 2) the GDP growth and 3) the relative de-industrialization related to oil price. We shall also take account of productivity, and fiscal and monetary policies.

The first equation considers the real exchange rate, RER, as a measure of competiveness in international markets. An increase in RER or a real appreciation of the peso implies that the prices of local goods are more expensive than those from the rest of the world. In this sense, the competiveness of Colombian products, compared with those of its competitors, would be reduced.

From an empirical point of view, the real exchange rate is related to productivity, oil prices, fiscal policy and international reserves. The productivity in the model is linked to the Balassa-Samuelson effect[3] and it is included in the model through the variable *PRODUCT* constructed as an index of the gross manufacturing output divided by the employment in the sector (2005=100). Oil price, *P_PET*, is fundamental when analyzing the *Dutch disease* symptoms in Colombia and can also be considered as a proxy variable of the terms of trade[4]. The increase in the international oil prices produces a surge of income through exports and an improvement in the terms of trade in oil exporting countries like Colombia. In addition, the coefficient which accompanies this variable is expected to have a positive sign or a direct relation with the real exchange rate, since an increase in oil price would cause a real appreciation of the peso against the dollar.

The fiscal policy is represented by the variable *GOB_INDEX* which accounts for the ratio between government expenditure to total income and it is expected to affect the country`s competitiveness positively as the government tends to consume more in non-

[3]The Balassa-Samuelson effect describes the distortion in purchasing power parity (PPP) as the result of international differences in relative productivity. The boom of the extractive sectors or those of raw materials produces an increase in productivity, as well as in salaries. If we assume that there is free labor movement within the sectors, salaries would even themselves out in the non-tradable sector, leading to a rise in domestic prices, compared with international prices, i,e. a real appreciation of the domestic currency.

[4] This variable is included in the recently paper by Coudert, Couharde and Mignon (2011), who analyse the long term relation between the real effective exchange rate and the commodity terms of trade for 52 commodity exporters and 12 oil exporters.

tradable goods[5]. The monetary policy is included by the variable international reserves, R_I, as it measures the central bank's intervention in the foreign exchange market and it is expected to have a negative sign. These relations will be considered in equation (1), detail data descriptions are reported in Appendix 1 and the graphs of the data in Appendix 2.

$$RER = f\,(PRODUCT, P\_PET, GOB\_INDEX, R\_I) \qquad (1)$$

With the second equation we evaluate whether the economic expansion of recent years in Colombia has been mainly triggered by high oil prices.

We include Colombia's Gross Domestic Product at a constant price of 2005, *GDP*, as a function of oil price, *P_PET*, and the real exchange rate, *RER*. With the former we try to test if a natural resource boom could negatively affect long-term economic performance, as suggested by Sachs and Warner (1995) Neary and vanWijnbergen (1986), and Gelb (1988). With the latter we seek to confirm if an overvalued exchange rate hinders the real Gross Domestic Product as suggested in the literature of natural resource and growth, see Magud y Sosa (2010). Economic activity in the long run is also affected by productivity and policy variables, which is why we include in the second equation the variables *PRODUCT*, *GOB_INDEX* and *R_I*. Following classical economic theory, the sign for the productivity variable is expected to be positive, because when productivity grows the production possibility frontier increases as well as the real output. The expected sign for government variable is negative, since excess fiscal expending only affects prices in the long run, given potential real output and employment[6].

$$GDP = F\,(P\_PET, RER, PRODUCT, GOB\_INDEX) \qquad (2)$$

The third equation is expected to prove the relative de-industrialization due to a surge in oil prices.

We include, as a dependent variable, the ratio between Colombia's manufacturing production to services production (*MAN_SERV*). Hereinafter, this relation will be referred to as relative manufacturing output. If there is indeed, evidence of *Dutch disease* in the country, it is expected that oil prices, *P_PET*, will have a negative effect

[5]The extent of the effect will depend on the marginal propensity to consume non-tradable goods. The greater this propensity, the greater the odds would be of a fiscal expansionary policy creating an increase in the real exchange rate; see Lartey (2007).

[6]See Kukk (2007) for a review of the effects of expansionary fiscal policies and budget balance in economic growth in the long term.

on relative manufacturing output. In equation 3, relative manufacturing output is also related to productivity, real exchange rate and Colombia´s Gross Domestic Product. The variable productivity reflects the outsourcing process of the developing economies. The constant increases in productivity in these countries will eventually result in the strengthening of the service sector in relation to the manufacturing sector. In this way, it can be assumed that productivity has a negative sign. One of the explanations of this relation is based on the greater exposure of economies to international trade[7]. The real exchange rate, *RER*, is included in the third equation as it measures industrial competitiveness in international markets. We expect that increases in real exchange rate, that is real appreciation, will cause a loss in the countries competitiveness that leads to a contraction of manufacturing exports and a contraction of manufacturing output. Colombia´s Gross Domestic Product, *GDP*, is a proxy for national demand on manufacturing; therefore, we expect a positive sign in the parameter.

$$MAN\_SERV = F\ (P\_PET, PRODUCT, RER, GDP) \qquad (3)$$

Order of integration

Before estimating the model, we perform the augmented Dickey-Fuller (ADF) and Phillips-Peron (PP) unit root tests to check the number of unit roots in each time series. The variables were log-transformed (from now on we represent with capital letters the original variables and with lower case letters the log-transformed ones).The number of lags in the Augmented Dickey-Fuller test is based on Schwartz's information criterion, and the results are shown in Table 2.

[7]As long as the countries grow, and trade with more competitive countries in terms of manufacturing, the prices of these products will drop on the national market. Domestic producers will be forced to improve their productivity or withdraw from the market. For its part, the service market is not exposed to international trade, and so benefits to the extent that the country grows and opens its doors to international trade; see Kang and Lee (2011).

Table 2. Unit root tests

	Augmented Dickey-Fuller test statistic				Phillip-Perron test statistic			
	ADF in levels		ADF in first differences		PP in levels		PP in first differences	
	t-Statistics	Prob.	t-Statistics	Prob.	t-Statistics	Prob.	t-Statistics	Prob.
Gdp	-2.355	0.393	-3.209	0.102	-1.963	0.596	-3.186	0.106
gob_index	-1.539	0.792	-4.829	0.002	-1.782	0.688	-4.829	0.002
man_serv	-3.131	0.119	-6.295	0.000	-1.659	0.743	-6.205	0.000
p_pet	-1.760	0.698	-4.963	0.002	-1.587	0.773	-9.039	0.000
Product	0.208	0.996	-5.100	0.002	-0.221	0.989	-3.309	0.084
r_i	-2.809	0.205	-3.342	0.080	-2.769	0.218	-3.573	0.050
Rer	-3.684	0.091	-3.306	0.085	-1.332	0.859	-3.234	0.097

Null Hypothesis: There is a unit root.

The analysis of the graphs in Appendix 2, as well as the tests in the previous table, suggests the need for at least one unit root for the majority of the series. The t-statistic and the p-values of the ADF and PP tests indicate that the unit root null hypothesis cannot be rejected for the following series: real Gross Domestic Products (gdp), government index (gob_index), relative manufacturing output (man_serv), oil prices (p_pet), productivity (product) and international reserves (r_i). Considering the first differences, the null hypothesis is rejected for the usual significance levels. Therefore, it is concluded that these series are integrated of order one, I(1).

Regarding the real exchange rate (rer) there is mixed evidence as ADF and PP tests lead to different conclusions. However, we have decided to consider it is integrated of order one at 5% significance level, as this option allows us to use cointegration analysis as more recent literature does, see, for instance, Beine et al. (2012) and Coudert et al. (2011).

The absence of stationarity in all the series implies that a co-integration analysis must be carried out, to analyze if the series are related in the long term. In this sense, we apply Johansen´s (1991) methodology, we estimate a Vector Autoregressive model and test for cointegration. Table 3 shows the results of both trace and maximum eigenvalue cointegration test statistics. It includes the summarized results of the test for the five assumptions or models of the deterministic elements in the data. Although the leading option that seems to adjust best to data is a linear trend, the results for each case are presented to corroborate robustness. Only one lag in the VAR is included, as it is enough to allow for white noise multivariate residuals.

Table 3. Johansen Cointegration Test. Sample period: 1980-2010

Selected (0.05 level*) Number of Cointegration Relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	4	5	4	4	4
Max-Eig	2	2	2	3	4

*Critical values based on MacKinnon-Haug-Michelis (1999).

In most of the options, the trace statistic (Trace, in Table 3) shows the presence of four co-integrating relations with a significance level of 5%. The maximum eigenvalue statistic (*Max-Eig*, in Table 3) is located between two and four co-integrating equations. However we have finally considered three cointegration relations as this option would be adopted at 1% significance level and allows equations (1), (2) and (3) to be estimated.

We also impose restrictions to identify the cointegration relation in equations (1), (2) and (3). Therefore, the dependent variable for each co-integrating equation is imposed, giving the value of zero to the variables that are not included in each of the equations.

Results suggest that oil price (p_pet) is co-integrated with the real exchange rate (rer) and the Gross Domestic Product (gdp), but not with the relative manufacturing output (man_serv). The co-integrating relations can be formalized in the following equations, in which the standard errors are in brackets:

$$rer_t = \underset{}{6.03} + \underset{(0.060)}{0.42} * p\_pet_t + \underset{(0.402)}{2.61} * gob\_index_t + \underset{(0.031)}{0.29} * product_t - \underset{(0.077)}{1.11}{,}* r\_i_t \quad (4)$$

$$gdp_t = \underset{}{0.56} + \underset{(0.034)}{0.53} * rer_t - \underset{(0.011)}{0.08} * p\_petr_t + \underset{(0.0036)}{0.18} * product_t - \underset{(0.083)}{0{,}97} * Gob\_index_t \quad (5)$$

$$man\_serv = \underset{}{0.76} - \underset{(0.0202)}{0.0006} * p\_petr_t - \underset{(0.0243)}{0.63} * product - \underset{(0.0576)}{1.57} * rer_t + \underset{(0.126)}{2.13} * gdp_t \quad (6)$$

Equations (4), (5) and (6) are the estimated version of equations (1), (2) and (3). In this sense, equation (4) can be identified as a long run competitiveness equation, equation (5) as a long run growth equation and equation (6) as a long run relative de-industrialization equation.

The results that refer to the speed of adjustment are shown in Table 4.

Table 4. Speed of adjustment

Error Correction:	Δ(rer)	Δ(gdp)	Δ(man_serv)	Δ (product)	Δ(gob_index)	Δ (r_i)	Δ(p_petr)
Long-run competiveness equation	0.091 (0.049)	0.0375 (0.018)	0.428 (0.095)	---	-----	----	0.000 (0.000)
Long-run growth equation	----	----	1.203 (0.471)	-1.463 (0.360)	1.145 (0.172)	4.286 (1.498)	0.000 (0.000)
Long-run relative manufacturing equation	1.367 (0.232)	----	1.161 (0.392)	-1.490 (0.299)	0.631 (0.092)	-1.203 (0.683)	0.000 (0.000)

Δ=1-L is the difference operator where L is the lag operator such that $Lx_t = x_{t-1}$.
Standard errors are in brackets and the p-value for the LR-test on the restrictions is 0.26.
'---`denotes that the corresponding parameter was not significant and excluded from the estimation.

As seen in table 4, the first cointegration relation is affecting the short-run movements of Δ(man_serv), Δ(r_i) and Δ(gdp), while it is not significative for the rest. In this sense, deviations from the long-term equilibrium of the real exchange rate impact on the short run movements of relative manufacturing output and economic performance in general. This result shows that real exchange rate misalignment can affect growth, as suggested in the literature of natural resource and growth, see Magud y Sosa (2010). The estimated error correction term in the second cointegration relation is significant for Δ (man_serv), Δ (product), Δ (gob_index) and Δ (r_i). Therefore, deviations from the real gdp long run path affects the short term of these variables. Finally, variables responsible for returning the system to its long-run equilibrium in the third cointegration relation are: Δ(rer), Δ(product), Δ(man_serv) and Δ(gob_index).

Results analysis

Perhaps the first important result is related to the fact that there is evidence that oil prices positively affect the real exchange rate, as the *Dutch disease* hypothesis predicts. In fact, an increase oil price of 10% produces real appreciation of the peso of approximately 4%, "ceteris paribus", see equation (4) that relates to the long-run competiveness. The real appreciation of the Colombian peso creates a loss of competiveness in international markets, since local prices are higher than their international competitors. Likewise, internal consumers replace the demand of expensive national goods with cheaper imports.

Regarding equation (4), or long run competiveness equation, all the signs are those expected in the theory and all the variables are significant. It is important to emphasize the *gob_index* variable, which represents the ratio between expenditure and total income of the national government. A 1% increase in this relation (*gob_index*) produces a real appreciation of 2.61%, "ceteris paribus". According to the theory, the expenditure effect boosted by the government generates an increase in prices, which causes a relative price rise of local goods compared to international products (real currency appreciation). With regard to the other policy variable, international reserves showed a negative relation with the real exchange rate. A 1 % increase of the reserves is associated to a real devaluation of approximately 1.11% in the long term, "ceteris paribus".

Productivity is positively related to the real exchange rate. The model estimates that an increase of the country's productivity of 10% causes a real appreciation of the currency of approximately 3%; "ceteris paribus". As a consequence of the increase in productivity, the salaries and the prices of local goods rise compared to those from abroad, thus creating real appreciation of the currency.

With respect to the equation (5), or long run growth equation, the parameter of the variable *rer* does not have the expected sign according to the literature, even though the variable is significant. Thus, the results suggest that an increase of the real exchange rate of 1% produces an increase of the real Gross Domestic Product in the long term of 0.5%. As a result, in the long term the devaluations of the real exchange rate in Colombia have had a negative effect on economic growth, while in contrast the real appreciations have favored it. A satisfactory explanation of this fact may come from the relation between capital flows, economic growth and the evolution of the nominal

exchange rate. It is common that capital worldwide is allocated in countries with potentially positive economic growth. The capital inflow in periods of economic expansion causes an appreciation of the nominal exchange rate. Likewise, in periods of economic uncertainty and recession, capitals migrate from the country producing exchange rate devaluations.

Regarding equation (5), it shows that an increase of oil prices in the long term causes a reduction of the Gross Domestic Product. Nevertheless, to determine the final effect on the gross national product, it is necessary to bear in mind the effect of oil prices in the real exchange rate in equation (4). An increase in oil prices of 1% can have two effects: a reduction of the real Gross Domestic Product of 0.08%, equation (5) and a real appreciation of 0.42%, equation (4). Considering that there are two opposite effects, the relation between oil prices and economic growth in the long term can be defined as uncertain and will doubtless depend on the political responses for the management of resources. On the other hand, the estimated coefficients of productivity and government index show that these variables affect the real Gross Domestic Product as suggested by classical economic theory.

With respect to the relative de-industrialization equation, see equation (6), no supporting evidence can be found that oil prices directly affect the relative manufacturing output in the long term. The parameter associated to *p_pet* is not significant. However, the estimated coefficient of the variable *rer* carries the expected sign and is statistically significant and different from zero. An increase of the real exchange rate by 1% produces a reduction of the relative manufacturing output of 1.57%. This means that real appreciation of the national currency causes a loss in the manufacturing competitiveness that leads to a contraction in its relative production. The productivity variable has a significant parameter that is in line with the *Dutch disease* theory. A productivity increase of 1% produces a decrease of the relative manufacturing output of 0.63%. This result shows that this reduction is mainly due to the economy's outsourcing process and not to the effects of increases in oil prices. The *gdp* variable shows a significant and positive relation with *man_serv* variable. That is, a 1% *gdp* growth triggers the relative manufacturing output by 2.13%. These results stress the importance of the national demand in this market.

4. Conclusions and policy recommendations

The aim of this work was to find empirical evidence of the *Dutch disease* symptoms in Colombia. Since the variables in the analysis are not stationary, Johansen's (1995) cointegration approach was used, to establish the equilibrium relations between them in the long term. A Vector Error Correction Model, VECM, has been estimated to determine whether oil prices are related to the real exchange rate, the real Gross Domestic Product and the relative manufacturing output in time. Other variables suggested by the theory and included in the model are productivity, the ratio between the national government's expenditure to total income, and international reserves.

The VECM estimates show that there is co-integration evidence between the oil prices, the real exchange rate and the Gross Domestic Product. In this way, increases in oil price produce a negative effect on the country's competiveness, since national goods become more expensive, compared with those of the rest of world, or they appreciate in real peso terms.

Although, our results do not suggest that oil prices significantly affect the relative manufacturing output in particular, there is a negative relation between the real exchange rate and the relative manufacturing production. This means that the channel through which oil prices could cause relative de-industrialization is the overvaluation of the national currency caused by a booming oil sector.

The relation between oil price and the country's real output is uncertain and therefore depends on the policies which may be adopted to manage the resources produced by oil dividends.

The recent media interest in *Dutch disease* in the country is a result of the real exchange rate growth since 2003. Though in the whole sample since 1980 there are increasing and decreasing periods, it seems that there are convincing reasons to believe that the upward trend observed since 2003 will not change in the short or medium term. Hence, the exchange rate may not correct its trend. Additionally, oil prices continue to rise and the recent political events surrounding the Arab spring and Iran's trade blocks indicate that the upward trend will be persistent. Finally, foreign direct investment in the mining-energetic sector surpasses historical limitations. All these arguments create a current account surplus in the country, which produces a considerable appreciation of the

nominal exchange rate that is a fundamental component of the real exchange rate equation.

Although we found no evidence of relative de-industrialization, it is important to mention that the industrial sector's exports have greatly decreased since 2007 and its contribution to the Gross Domestic Product has now been surpassed by the service sector.

In this context, in a scenario in which the exchange rate appreciates and industrial sectors' competiveness has experienced a loss, it is essential to introduce suitable policy measures to prevent the income boom from oil exports and foreign direct investment becoming a curse.

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Appendix 1: Data sources

Real Effective Exchange Rate *RER* (2005 = 100). Source: World Development Indicators WDI.

Productivity *Product*: It is constructed as an index of the gross manufacturing output divided by the employment in the sector (2005=100). Source: Departamento Administrativo Nacional de Estadística DANE Colombia, Evolución de las Principales Variables Industriales.

Oil prices *P_pet:* Cushing, OK WTI Spot Price (Dollares per Barril). Source: Energy Information Administrator (2010), (http://tonto.eia.doe.gov/dnav/pet/hist/rbrteM.htm).

Government index *Gob_index*: General government revenue /National currency /Billions /Cnt: Colombia /IMF, Washington. General government total expenditure /National currency /Billions /Cnt: Colombia /IMF, Washington. (2005=100).

International reserves R_i: Total reserves (includes gold, current MN US$) /Cnt: Colombia. Source: Global Economic Statistics (2005=100)

Real Gross Domestic Product *GDP* Vol. (2005=100): /Index Number /Base year: 2005 /averages /constant prices (una. /Cnt: Colombia /Source: IMF, Wash.

Relative Manufacturing output *Man_Serv*: Manufacturing, value added (current MN LCU) /Cnt: Colombia. Services, etc., value added (current MN LCU) /Cnt: Colombia. Source: Data Service & Information. World Bank Statistics (2005=100).

Appendix 2: Graphs