

Competitiveness analysis of the oil industry in the main Latin American oil countries, 1996-2017

*Análisis de competitividad de la industria petrolera
en los principales países petroleros latinoamericanos,
1996-2017*

Mario Gómez¹

Lilibeth K. Marquez

Irma C. Espitia²

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ABSTRACT

The objective of this research is to analyze the main determinants of competitiveness in the oil industry in the main Latin American oil countries during the period 1996-2017. For this purpose, panel data econometric methods are applied in this research, namely, cross-section dependence (Pesaran), second generation unit root, cointegration (Kao and Fisher–Johansen), and heterogeneous causality tests (Hurlin and Dumitrescu). In this way, it is demonstrated that most of the variables are characterized by a cross-section dependence and there is evidence of cointegration relationships between the variables in the long term. Using the estimator Fully Modified OLS (FMOLS), it is determined that there is a positive relationship between competitiveness and oil barrel production, referring to the fact that an increase in oil barrel production creates an increase in competitiveness, while there is a negative relationship between competitiveness with the real exchange rate and the crude oil barrel price, referring to an increase in the real exchange rate and the oil barrel price in each country generate a decrease in the competitiveness of the oil industry.

Keywords: Competitiveness; oil industry; unit root; cointegration; causality.

RESUMEN

El objetivo de esta investigación es analizar los principales determinantes de la competitividad de la industria petrolera en los principales países petroleros latinoamericanos durante el período 1996-2017. Para este propósito, se apli-

1 Economic and Business Research Institute, Universidad Michoacana de San Nicolás de Hidalgo, Avda. Francisco J. Múgica S/N, Edificio ININEE, Ciudad Universitaria, Morelia C.P. 58030, Michoacán, Mexico.

2 School of Accounting and Administrative Sciences, Universidad Michoacana de San Nicolás de Hidalgo, Avda. Francisco J. Múgica S/N, Edificio ININEE, Ciudad Universitaria, Morelia C.P. 58030, Michoacán, Mexico.

can métodos econométricos de datos de panel en esta investigación, a saber, dependencia de sección transversal (Pesaran), raíz unitaria de segunda generación, cointegración (Kao y Fisher-Johansen) y pruebas de causalidad heterogéneas (Hurlin y Dumitrescu). De esta forma, se demuestra que la mayoría de las variables se caracterizan por una dependencia transversal y hay evidencia de relaciones de cointegración entre las variables a largo plazo. Usando el estimador OLS totalmente modificado (FMOLS), se determina que existe una relación positiva entre la competitividad y la producción de barriles de petróleo, refiriéndose al hecho de que un aumento en la producción de barriles de petróleo crea un aumento en la competitividad, mientras que hay una relación negativa entre la competitividad con el tipo de cambio real y el precio del barril de petróleo crudo, en referencia a un aumento en el tipo de cambio real y el precio del barril de petróleo en cada país.

Palabras clave: competitividad, industria petrolera, raíz unitaria, cointegración, causalidad.

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1. INTRODUCTION

Crude oil has been considered the soul of industrialized nations, and it has become the most important energy source in the world since the midfifties (UKOG, 2019). Its products support modern society, mainly by supplying power to the electrical industry, heating homes and providing fuel for vehicles and airplanes to transport goods and people around the world (UKOG, 2019).

The oil industry and its value chain are traditionally known as a strategic sector in countries that have these resources, mainly for Latin American countries such as Mexico, Venezuela, and Brazil, in large part due to their relevance in the productive base of the economy (IEA, 2019). Although its relative participation in the national production of goods and services varies from one country to another, the degree of dependence that any economy has is undeniable, especially when compared to traditional energy sources (IEA, 2019). Although more attention has been paid to the problem of environmental pollution, fossil fuels (i.e. oil, coal, and natural gas) continue to dominate global energy consumption (Gómez et al., 2018). Fossil fuels have had an 81% stake in the last 25 years. From 1989 to 2014, oil use decreased from 37% to 31%; during that same period, the use of natural gas increased from 19% to 21% and coal increased from 25% to 28% (IEA, 2016).

Mexico has based part of its economic growth on the use of oil and gas produced as the basis of primary energy generation since, in 2013 alone, these fuels contributed with 85.6% of the gross domestic supply of energy (Romo, 2016). All this in a context in which Pemex has shown a set of problems that

have caused the loss of capabilities, competitiveness, and skills to boost its growth and promote actions that could trigger a better performance of the oil industry as a whole (Romo, 2016). Although the conditions of the oil sector in Mexico have not always been favorable, Pemex is a main axis for the growth and economic development of Mexico; it is the most valuable brand in the country, with a value that amounts to US \$ 8,477 million (Brand Finance México, 2017). Today, the Mexican oil sector has to become more competitive since, after the Energy Reform, 75 years of state monopoly in the oil sector ended, and the doors were opened to market conditions that forced Pemex to have a performance more comparable with that of other similar brands around the world (Brand Finance México, 2017). Pemex is one of the few oil companies in the world that has developed the entire production chain of the industry, from exploration to the distribution and marketing of the final oil products, including petrochemicals (Álvarez, 2006).

In the same context, in 2010, Brazil produced 2.7 million barrels of oil per day, becoming the second largest oil producer in Latin America, only behind Mexico, when a decade ago, it was only the third regional, producing less than half of the daily barrels produced by Mexico or Venezuela. China and India have given life to Brazilian exports in exchange for loans, as they have been doing with Venezuela (Serrani, 2013). Asia has bet on the Brazilian market with such magnitude that, in 2016, China granted Latin America credit for 21.2 billion dollars, of which, more than 70% went to Brazil (specifically Petrobras, the state firm), according to the Center of Studies Inter-American Dialogue (Granados, 2017).

Petrobras is on the list of the 500 largest companies in the world, and it is also recognized for its work in very deep waters, being a pioneer in the development of robots for the exploration and construction of oil wells that are 400 meters below sea level (PETROBRAS, 2019). It is considered an integrated company, since it carries out activities ranging from oil and gas exploration, production, transportation, and refining to the commercialization of the distribution of oil, gas, and its derivatives to the generation, transport, and distribution of electric energy (PETROBRAS, 2019).

On the other hand, Venezuela is the second largest oil producer and the first exporter in the region, having the largest hydrocarbon reserves, currently, it proven reserves of 78 billion barrels of oil and 148 billion cubic feet of gas (Monaldi, 2010). Venezuela is also the only founding member of the Organization of Petroleum Exporting Countries (OPEC) in Latin America, and oil is its main source of fiscal revenue, representing about 50% of revenues in the budget and about 90% of the exports (Monaldi, 2010). This places it as the country with the largest hydrocarbon reserves in the Western Hemisphere and positions it as the fifth country in the world in proven reserves (PDVSA, 2019). With the Orinoco Belt reserves, the country has the largest accumulation of liquid fuel on the planet (PDVSA, 2019). PDVSA's international

activities have had an unprecedented expansion in recent years, which contributes to the projection of the Company in the world, with recognition of a high operational level, technological mastery, and management excellence (PDVSA, 2019).

The main contribution of this research is twofold. Firstly, there are no previous studies that analyze the competitiveness of the oil industry among the main oil-producing Latin American countries. Secondly, within this paper, unlike the literature reviewed, the following econometric techniques were applied: a) Pesaran test for cross-sectional dependence; b) second-generation unit root test (PESCADF); c) Estimation of long-term coefficients (FMOLS); and d) heterogeneous causality test (Hurlin-Dumitrescu).

From the aforementioned, the general research question emerges: *What were the main factors that determined the competitiveness of the main Latin American oil countries in the period 1996-2017?* The general objective is established, which is to identify the main factors that determined the competitiveness of the oil industry of the main Latin American oil countries in the period 1996-2017. Therefore, the present article is structured as follows. After the introduction, Section 2 briefly describes the literature on the subject. Then, the econometric models are presented in Section 3. In Section 4, the results are presented and analyzed, and finally, the conclusions are presented.

2. LITERATURE REVIEW

This section develops the theoretical and empirical basis that will support the research. Some definitions of the variables are addressed, and some of the most outstanding works on the oil industry are mentioned. In its beginnings, and since the author Adam Smith published in 1776 the book entitled *The Wealth of Nations*, the theme of competitiveness has been the center of business analysis (Monaldi, 2010). Since then, the term has evolved constantly, and different concepts have emerged around *competitiveness* (López and Marín, 2011). Leading authors, such as Schumpeter, Engels, and Marx, and some more recent authors have been involved in addressing the construct from a broader and more complex perspective, with technical, sociopolitical, and cultural support (López and Marín, 2011). In the same sense, Porter (1990) mentions that there is no definition of competitiveness nor a single theory to explain that it is generally accepted and recognizes that its meaning may be different according to the context in which it is used.

The concept of competitiveness is ambiguous, since a wide range of interpretations has been found (Siggel, 2007). Due to the superficiality of the word owing to the various connotations it encompasses and with the aim of specifying the meaning of competitiveness, for this research the interpretation of Reinert (1995) is adopted, which mentions that a standard definition could be that the term competitiveness refers to the ability of a firm to compete,

grow and be profitable in the market. A company is considered to be competitive if it is capable of developing and applying strategies that take it to a sustained or expanded market position in the industrial segment in which it operates. For this, the strategies, capacities and performance of a company must have a relationship with the prevailing patterns of competition in the activity it carries out (Ferraz, Kupfer and Loopty, 2004).

There are many advances in the measurement of competitiveness from a commercial perspective. Some authors suggest that the competitiveness of nations can be calculated as revealed in their trade parameters. The Balassa (1979) and Vollrath (1991) indexes quantify the competitiveness of a product or industry on a global or continental basis of comparison. It is worth mentioning that it was Balassa (1965) who introduced the term *comparative advantage revealed* with the purpose of pointing out that comparative advantages between nations can be revealed by the flow of merchandise trade, since the real exchange of goods reflects relative costs and differences that exist between countries, due to factors that are not necessarily market factors (García and Maldonado, 2013).

Among the main variables that determine competitiveness in any industry is productivity, which is a concept that has gained a lot of importance, but it has existed for such a long time that, over the years, its definition has been modified, and currently, there are a large number of definitions of that term (Bannock and Baxter, 2007). A basic conception of productivity is understood as the measure of the rate at which production flows from the use of certain amounts of production factors. If the factors are used without efficiency, it is possible to make productivity improvements because, by definition, it is possible to obtain greater production from the determined amounts of inputs (Bannock and Baxter, 2007). It is considered basic in the sense that does not specify what are the factors of production involved in the production process, or how it is possible to achieve higher levels of efficiency, productivity and production.

The real exchange rate has a fundamental role in the analysis of competitiveness at the international level. In an open economy, the exchange rate is crucial in the transfer of external shocks to the national economy and in the transmission of the shares of monetary policy (Gregorio, 2009). Its significance lies in the fact that a significant variation in the real exchange rate has been associated with many of the crises that have emerged in emerging economies, so it is a variable that must be taken into account to conduct a competitiveness study (Gregorio, 2009). An index widely used to measure the competitiveness of a country's tradable goods sector is the Real Exchange Rate Index (United Nations, 2004). An accepted definition of the RER, based on the purchasing power parity criterion, establishes that the real exchange rate is equal to the nominal exchange rate multiplied by the relationship between the level of external prices and the level of internal prices (United Nations, 2004). Exchange

rates play an important role in international trade because they allow for a comparison of the prices of goods and services produced in different countries (Noel and Viga, 2011). By converting the prices expressed in foreign currency into the respective national prices, or vice versa, the relative prices that affect international trade flows can be obtained (Noel and Viga, 2011).

There are several investigations of the oil sector on the relationship of different factors at the macroeconomic level and internal level of the oil companies. One of these variables is the behaviour of the price of crude oil and the influence it has on the profitability of the oil sector, which, by applying a data regression panel method, studies explain that oil prices have a significant impact on the profitability of the oil sector (Wattanatorn and Kanchanapoom, 2012). For Govea et al. (2018), the oil industry in Mexico has been subject to different ups and downs in the last decade, which are directly reflected in its profitability. In the article they carried out together, they show the results of the factors that influence the performance of Pemex's oil profitability and perform an analysis of how they maintain a direct relationship with the total budget collection. They use an econometric model of multiple linear regression with data from 2005 to 2016. The results show that oil profits are affected by the price of a barrel of crude oil and the total assets and net exports made by the company, and they conclude by contrasting how many of these variables were considered in the energy reform of 2013.

Lanteri (2012) studies the main macroeconomic determinants of real oil prices (world growth, monetary policy, dollar exchange rate). He empirically evaluates the impact of changes in oil prices on economic activity, employment and domestic prices in some net importing countries (United States and Spain), exporters (Norway) and countries self-sufficient in oil (Argentina). Its analysis uses SVAR models, with short-term restrictions, for a period that covers the last four decades. The results show that, for importing countries, the effects of price increases on real GDP growth and employment differ from the effects generated by declines in crude oil prices.

Meanwhile, Antoniadis (2012) investigates the impact that the oil and gas industry has on the global competitiveness of the economies of the countries of the Black Sea Region, as measured by the Global Competitiveness Index, using the data method of unbalanced panel for the period from 2006 to 2015. He used independent factors related to the oil and gas sector, such as fuel exports, oil and gas prices, oil revenues, and governance.

For Santillán, Calderón, and Venegas (2017), the analysis of the different channels through which oil prices impact the economy suggests that an upward impact affects economic activity, raising production costs and reducing the profits of those companies. They use oil as an input. As a result, and given the widespread use of oil in many industrial processes and transportation services, an increase in oil prices is expected to affect the valuation of stocks down. The rise in oil prices will also positively affect interest rates, as

they are often a precursor to cost inflation in the economy.

The authors Alqudah, Elsound, and Badawi (2016) study the impact of the oil sector on the global competitiveness of the Gulf Cooperation Council (GCC), based on the econometric model of panel data in the period from 2006 to 2014. The variables that the authors use are the following: the global competitiveness index (dependent variable), oil revenues, fuel exports as a percentage of merchandise exports, the mining sector production, and oil prices. They used panel data techniques to measure the effect of independent variables on the global competitiveness of GCC countries. The results obtained from the regression show that there was a relationship between income and negative and highly significant competitiveness, while oil prices had a positive relationship with the Global Competitiveness Index (GCI) at a significance level of 90%. Finally, fuel exports as the percentage of merchandise exports have an insignificant relationship with GCI.

Silvapulle, Smyth, Zhang, and Fenech (2017) present an innovative nonparametric panel data approach to model the long-term relationship between the monthly oil price index and the stock market price indices of ten large net oil importing countries. These countries are the United States, Japan, China, South Korea, India, Germany, France, Singapore, Italy, and Spain. The variables that the authors use are the following: the stock market price (dependent variable), crude oil price, unemployment indicator, and a 10-year bond rate. In general, it was found that the nonparametric panel data model best captures the way in which the underlying relationship between the price of oil and the stock has evolved over time compared to specific estimates of the parametric counterpart. The findings made by the researchers have important implications for policy makers and financial speculators.

3. ECONOMETRIC MODELS

Once the theoretical and empirical literature is analysed, it is considered that the competitiveness of the oil industry of the main Latin American oil countries (COMP) depends on the oil barrel production (OBP), the real exchange rate (RER), and the crude oil barrel price (COP). Therefore, the equation can be expressed as follows:

$$COMP_{it} = \beta_{0it} + \beta_{1i} OBP_{it} + \beta_{2i} RER_{it} + \beta_{3i} COP_{it} + e_{it} \quad (1)$$

where i indicates the cross-section referring to the three Latin American oil countries (Mexico, Brazil, and Venezuela), t refers to the period of time established, and e_{it} refers to the error term. The parameters β_1 , β_2 , and β_3 refer to the long-term elasticity of the production of barrels of crude oil, the real exchange rate and the price of a barrel of crude oil with respect to competitiveness. The expected signs are as follows:

- $\beta_1 > 0$ because an increase in the production of oil barrels can generate an increase in the competitiveness of the oil industries.
- $\beta_2 < 0$ as an increase in the real exchange rate can lead to a drop in the competitiveness of the oil industries.
- $\beta_3 < 0$ since an increase in the price of a barrel of crude oil causes a decrease in the competitiveness of the oil industries.

There is a special type of combined data in which the same cross-sectional unit (for example, a family or a company) is studied over time, which are called panel data. The panel data provide very useful information on the behavior dynamics of the units studied (Gujarati and Porter, 2010). According to Baltagi (2008) some of the main benefits of panel data are: that they help control individual heterogeneity; they provide more informational data; and help measure unobservable effects.

A serious problem faced by time series or panel data is that they often tend towards or are affected by persistent innovations in the process. To solve this problem, or at least understand its possible effects, it is common to test if the series are stationary. There is a problem with the regressions that handle nonstationary variables, when the standard errors produced are biased (Maddala and Kim, 1998).

The unit root test is a test on stationarity or nonstationarity. A series of time is said to be stationary if its mean, its variance, and its self-covariance (in the different lags) remain the same regardless of the moment in which they are measured; that is, they are invariant with respect to time (Gujarati and Porter, 2010). In other words, a nonstationary time series will have a mean that varies over time, a variance that changes over time, or both (Gujarati and Porter, 2010). This research uses a second generation panel unit root test (Pesaran, 2007); this test relaxes the cross-sectional independence assumption.

Cointegration is described as a long-term equilibrium relationship between the variables; if this relationship does not exist, the variables would move away from each other over time (Maddala and Kim, 1998). Once the unit root tests are performed on the level variables and evidence is found that there is no stationarity in the variables, it is essential to look for a common nonstationary component through cointegration tests (Maddala and Kim, 1998).

According to the econometric literature, when the variables are cointegrated, the ordinary least squares (OLS) technique to estimate the coefficients of the panel data models turns out to be biased and produces inconsistent estimates (Pedroni, 2001). Consequently, new methods were developed to estimate cointegration relationships using panel data, which are the fully modified ordinary least squares estimators (FMOLS) and the minimum dynamic ordinary squares (DOLS). FMOLS estimators behave relatively well and, even in small samples, generate consistent estimates and allow one to control the endogeneity of their regressors and serial correlation (Pedroni, 2001). Thus,

this research will use FMOLS estimators for cointegrated heterogeneous panel data.

One of the important topics in the panel data econometrics is the study of the heterogeneity of cross-sectional units; this article considers a new proposal that has a standardized panel statistic with good properties in small samples. This proposal considers that there are two dimensions: heterogeneity of the causal relationship and heterogeneity of the regression model used (Dumitrescu and Hurlin, 2012). The null hypothesis of homogenous non-causality is posed against the alternative, that there are two subgroups: one characterized by the causal relationship between these two variables and another subgroup for which there is no causal relationship between these two variables (Dumitrescu and Hurlin, 2012).

4. DATA AND ANALYSIS OF RESULTS

This study uses data from Mexico, Brazil, and Venezuela from the 1996-2017 period. The competitiveness index data (national oil exports among world oil exports) were taken from the Organization of the Petroleum Exporting Countries (OPEC) (<https://asb.opec.org/index.php/data-download>), PEMEX, institutional database and statistical yearbooks of the oil countries (<https://www.pemex.com/ri/Publicaciones/Paginas/AnuarioEstadistico.aspx>). The data of the productivity variable were calculated from the production of barrels of crude oil (thousands of b/d) and the total number of workers in the oil industry, the price (thousands of b/d) both were taken from OPEC (<https://asb.opec.org/index.php/data-download>) and statistical yearbooks of the oil countries. On the other hand, the exchange rate (Peso / dollar) was taken from the International Monetary Fund, based on the year 2010 (<http://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B&slId=1390030341854>).

The tests carried out for the proposed model are shown below; it is worth mentioning that all the variables are expressed in natural logarithms. In the cross-section dependence test (Pesaran, 2004), the null hypothesis refers to the fact that there is no cross-section dependence. The results of the CD cross-section dependence test are presented in Table 1. The hypothesis of nondependence is rejected for the variables COMP and RER at a 5% significance level and COP at 1% of its levels. The only hypothesis accepted is for the OBP variable. Therefore, in most of the variables, there is a transversal dependence, and the variables of each country are correlated with each other.

Due to the above mentioned and as seen in Table 1, it is very important to apply second generation unit root tests that yield consistent results in the presence of cross-section dependence, for which reason, the Cross-sectional Augmented Dickey Fuller (CADF) suggested by Pesaran (2007) is applied.

Table 1
Pesaran (2004) test for cross-sectional dependence

Variable	COMP	OBP	RER	COP
CD statistic	-2.217 **	-0.539	-2.517 **	7.178 ***
P value	0.026	0.589	0.011	0.000

Notes: *** and ** denote a rejection of the null hypothesis at 1% and 5% in levels, respectively.

Table 2 shows the results obtained from second generation unit root test, which confirms that the variables are integrated in order one and all the variables have a unit root in the levels, but are stationary in first differences. The variables COMP and COP reject the null hypothesis of unit root at a 1% level of significance. In the case of OBP, it has a 5% level of significance, and the variable RER has a 10% level of significance.

Table 2
CADF, second generation unit root test by Pesaran (2007).

Variable	Deterministic parameters	Z test
COMP	CT	0.565
OBP	CT	-0.441
RER	CT	1.252
COP	CT	0.868
COMP (First differences)	C	-5.455***
OBP (First differences)	C	-1.949**
RER (First differences)	C	-1.373*
COP (First differences)	C	-2.670***

Note: ***, ** and * denote a rejection of the null hypothesis at 1%, 5%, and 10% in levels, respectively. C denotes the constant, and CT denotes constant and trend.

With the Kao cointegration test (Kao, 1999), the null hypothesis of non-cointegration is rejected at a level of significance of 1%; therefore, it is accepted that there is a long-term relationship between the variables, as indicated in Table 3.

On the other hand, the Fisher – Johansen cointegration test (Maddala and Wu, 1999) indicates that there are there are at least two cointegration relationships, since the null hypothesis is rejected at a significance level of 1% and 5%, confirming a long-term relationship between the variables (Table 4).

Table 4
 Results of the Fisher – Johansen cointegration test.

<i>Nully Hypothesis</i>	Trace Test	Max- Eigen Test
R = 0	68.68 ***	56.03 ***
R ≥ 1	22.26 ***	12.14 **
R ≥ 2	17.69 **	9.455

Notes: *** and ** denote a rejection of the null hypothesis at 1% and 5% in levels, respectively

The long-term model is estimated with the FMOLS and is shown in Table 5. An increase in OBP generates an increase in COMP, that is, there is a positive relationship. In the case of RER and COP there is a negative relationship, an increase in them produces a decrease in COMP.

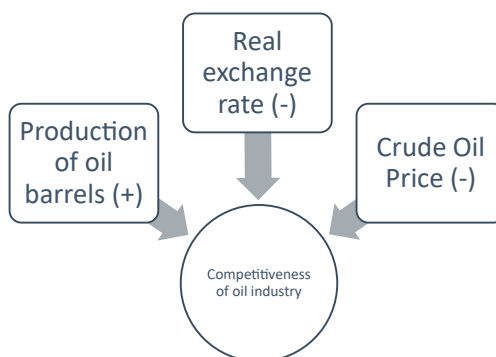
Table 5
 Estimation of long – term coefficients.

<i>Variable</i>	FMOLS Coefficients	p-value
OBP	1.700 ***	0.000
RER	-0.062 **	0.041
COP	-0.117 ***	0.011

Note: *** and ** denote rejection of the null hypothesis at 1% and 5% in their levels, respectively.

Figure 1 shows, then, what is the relationship between the independent variables (Production of oil barrels, Real exchange rate and price of a barrel of crude oil) with respect to the dependent variable (the competitiveness of the oil industry). Based on the above mentioned and revised, it seems that there must be at least one causal relationship in at least one direction after confirming the existence of a long-term relationship between the variables (Granger, 1988).

Figure 1
 Analysis of the results of the estimators in the variables.



According to Table 6, in the long term, there is a causality relationship from OBP, RER, and COP with respect to COMP at the 1% level of significance, which implies that any movement of these variables affects the behaviour of the oil industry competitiveness. There is also, in the long term, a causality relationship from COMP, OBP, and RER with respect to COP at a 1% level of significance. In the short term, there is a unidirectional causality relationship from COMP to OBP, from OBP to RER, from OBP to COP, and from RER to COP at a 1% level of significance and from COMP to COP at a 5% level of significance.

Table 6
Granger causality test results.

Dependent Variables	Short Run			Long run	
	Δ COMP	Δ OBP	Δ RER	Δ COP	ECT-1
			T-Statistic	Coefficient	
Δ COMP	-	1.307	1.258	-0.389	-0.31***
Δ OBP	2.192***	-	1.368	0.031	-0.001
Δ RER	1.506	3.208***	-	-0.007	0.037
Δ COP	2.298**	-5.257***	-3.656***	-	-0.850***

Note: *** and ** denote rejection of the null hypothesis at 1% and 5% in their levels, respectively

One of the important issues in the econometrics of panel data is the heterogeneity across the cross-section units. This is why the test developed by Dumitrescu and Hurlin (Pesaran, 2004), to prove causality in a heterogeneous panel data model, is considered. Therefore, the null hypothesis of homogeneous noncausality is raised against the alternative, that there are two subgroups: one characterized by the causal relationship between two variables and another subgroup for which there is no causal relationship between these two variables.

According to Table 7, there is a bidirectional causality relationship between OBP and COMP. The variables are complementary, and each has important information that helps to better predict the behavior of the other. Similarly, there is a unidirectional relationship between COMP and RER and between RER and OBP.

Table 7

Nully Hypothesis	Wald Test	Decision
OBP does not homogeneously cause COMP	7.668 ***	Reject
COMP does not homogeneously cause OBP	8.095 ***	Reject
RER does not homogeneously cause COMP	2.696	Accept
COMP does not homogeneously cause RER	5.595 **	Reject
COP does not homogeneously cause COMP	1.414	Accept
COMP does not homogeneously cause COP	2.519	Accept
RER does not homogeneously cause OBP	28.761 ***	Reject
OBP does not homogeneously cause RER	3.301	Accept
COP does not homogeneously cause OBP	4.900	Accept
OBP does not homogeneously cause COP	1.978	Accept
COP does not homogeneously cause RER	3.033	Accept
RER does not homogeneously cause COP	2.741	Accept

Note: *** and ** denote rejection of the null hypothesis at 1% and 5% in their levels, respectively

5. CONCLUSIONS

As was studied throughout this research, the oil industry has been of vital importance for the growth and economic development of almost every country in the world. In Latin America, the case is no different; for Mexico, Brazil, and Venezuela, the oil sector has played a preponderant role throughout history, being one of the main factors that has helped take these countries to high levels in political, economic, and social terms.

That is why it is very important to study in detail the behavior, performance, and competitiveness at an international level that this industry can have, since, although these levels depend to some extent on the internal capacity of each country, making reference to the ability to produce barrels of crude oil, no one can be exempt from the behavior of this industry globally, mainly because it is a product of high demand worldwide; therefore, there will be factors, as observed in this work, such as the real exchange rate and the price of a barrel of crude oil, that will influence the performance of the competitiveness of the oil industry in each country.

This research, therefore, analyzes the relationship between the production of crude oil, the real exchange rate, and the price of a barrel of crude oil with the competitiveness of the oil industry for the main oil countries in Latin America (Mexico, Brazil, and Venezuela) in the period 1996-2017. Econometric tests were carried out using the E-Views program version 9 and STATA. First, the specification of the econometric model was carried out taking into account that this is a panel data methodology, which implies that the econometric treatment of the data is different from that if it were only time series or cross section.

For the treatment and validation of the econometric model in panel data, the Pesaran cross-section dependence tests were applied, then the second-generation unit root, Kao cointegration, and Fisher-Johansen tests were performed. The FMOLS was used to estimate the long-term model, and the Hurlin-Dumitrescu (2012) panel data heterogeneous causality test was applied.

The estimation of the panel data model, through its elasticities, shows a positive relationship between the competitiveness of the oil industry (COMP) and the production of crude oil (OBP), which means that an increase in the production of oil barrels will source an increase in the competitiveness of the oil industry of the country that applies it. On the other hand, there is also a negative relationship between the competitiveness of the oil industry (COMP) with the real exchange rate (RER) and with the price of a barrel of oil (COP).

The negative reason between the competitiveness of the oil industry and the price of a barrel of oil is due to the fact that, as mentioned above, there are two large global oil-producing groups composed of different countries that compete with each other; therefore, as is decreed by the law of supply and demand, when the price of a barrel of oil falls in a certain group of bidders, it becomes more attractive for buyers, so they will prefer to buy the cheapest one and to stop buying the one that has a higher price.

With respect to the negative behavior of the real exchange rate with the competitiveness of the oil industry, this is because when the real exchange rate increases, taking the US dollar as a reference, investment in terms of production in the oil industry tends to have a fall, which will generate a slowdown in the growth of said industry and its ability to increase sales of this input.

Therefore, we concluded that the competitiveness of the oil industry regarding the main oil countries of Latin America has been greatly influenced by their levels of crude oil production and by the movement and adjustment of the real exchange rate and variations in the price of barrels of oil, and, taking into account how they have to behave, the best decisions in terms of economic policy can be made for each country to improve such competitiveness internationally. Likewise, it is suggested to have a competitiveness exchange rate, so that the oil industry can benefit through international crude oil prices.

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