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INTERNATIONAL TRADE AND MARITIME TRANSPORT IN NORTH AMERICA: AN ANALYSIS OF PRODUCTIVITY AND FOREIGN DIRECT INVESTMENT

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Abstract: port logistics activity is a vital element in foreign trade. In a globalized environment that demands greater competitiveness, trade agreements and synergies between trade blocs through maritime transport allow commercial development between economies. This research analyzes the relationship between international trade through seaports and investment in the countries that make up the North American Free Trade Agreement (NAFTA) from 1997 to 2017. An econometric panel data model is used to measure the relationship between the variables, and unit root tests, cointegration tests (Kao and Fisher-Johansen tests), and heterogeneous causality tests (Hurlin and Dumitrescu test) are performed. The results show a positive relationship between trade and productivity, as well as a positive relationship between commerce and direct foreign investment; hence, an increase in investment causes a growth in international trade between Mexico, the United States, and Canada.

Keywords: international trade, North America, NAFTA, maritime transport, econometrics.

COMERCIO INTERNACIONAL Y TRANSPORTE MARÍTIMO EN AMÉRICA DEL NORTE: UN ANÁLISIS DE PRODUCTIVIDAD E INVERSIÓN EXTRANJERA DIRECTA

Resumen: la actividad logística portuaria es un elemento vital en el comercio exterior. En un entorno globalizado que exige mayor competitividad, los acuerdos comerciales y las sinergias entre bloques comerciales a través del transporte marítimo permiten el desarrollo comercial entre economías. En esta investigación se analiza la relación entre el comercio internacional a través de puertos marítimos y la inversión en los países que integran el Tratado de Libre Comercio de América del Norte (TLCAN) durante el período de 1997 a 2017. Se utiliza un modelo econométrico de datos de panel para medir la relación entre las variables, y se realizan pruebas de raíz unitaria, pruebas de cointegración (pruebas de Kao y Fisher-Johansen) y pruebas de causalidad heterogénea (prueba de Hurlin y Dumitrescu). Los resultados muestran una relación positiva entre comercio y productividad, así como una relación positiva entre comercio e inversión extranjera directa; por lo tanto, un aumento en la inversión provoca un incremento en el comercio internacional entre México, Estados Unidos y Canadá.

Palabras clave: comercio internacional, América del Norte, TLCAN, transporte marítimo, econometría.

INTRODUCTION

Most of the export volume is transported through ports, including oil and its derivatives. Ports operate as platforms for important industries such as chemicals, petrochemicals, energy and electrical, metallurgical, mining, cement, fishing, nautical, cruise tourism, assembly, logistics, and storage activities (Trejo, 2017). In recent years, Mexican ports have stood out for their high growth in merchandise volumes and the diversification of their activities, generating areas of opportunity for new investments and more job creation in port terminals, facilities, and commercial and industrial businesses (Hossain et al., 2019).

Mexican ports compete with other leading ports in the world, standing out in their efficiency and productivity in the operation of containers, which are proven to be important in the operation of different types of cargo (Ablanedo-Rosas & Ruiz-Torres, 2009).

The national port system plays a fundamental role in the growth of the Mexican economy since it acts as a link with world markets and constitutes an important source of value and competitive advantage at the national, regional, and local levels (Secretaría de Comunicaciones y Transportes [SCT], 2021). Public and private investment in port infrastructure has allowed the country to have a sufficient supply of port services to meet the demand for such services by the export industry, domestic trade, and the national productive apparatus (Villa, 2017).

The processes of international openness and integration represent a powerful instrument for the expansion of trade and investment in infrastructure between countries (Yanikkaya, 2003). An example of this is the North American Free Trade Agreement (NAFTA), currently named the United States–Mexico–Canada Agreement (USMCA). Mexico's border region plays a fundamental role in this context since it is the physical transit space for the flow of productive factors and goods (García-Orozco & Alfaro-Calderón, 2016). In an international environment that is becoming global, ample capacity is required to enable investment flows in infrastructure and trade that facilitate the integration of national economies (Cabral & Mollick, 2012).

Although the different "subregions" along the borderline compete with each other, they have also been delegated the task of together constituting an efficient border that provides the country with a relatively advantageous comparative position (Trejo, 2017). It highlights the role of ports in foreign trade in border areas since these ports allow the formation of transportation logistics nodes that facilitate adequate and timely delivery and reception in the regions of consumption. Ports take advantage of a country's extensive coastline and local natural conditions with different scopes and specializations and are recognized globally for the quality and efficiency of their operations. Another notable factor is the direct relationship that the expansion of e-commerce has with globalization and how it impacts ports, given that for every 1% of world economic growth, world container traffic grows by 1.5% (Santos, 2004). Therefore, the level of competitiveness of ports is decisive in the consolidation of international commercial relations (Gil, 2013).

The productivity and the attraction of foreign direct investment generated by the ports play an important role in international trade since they represent the main gateway for goods to enter and exit foreign markets through imports and exports. The importance of analyzing the relationship between port marine productivity and direct foreign investment in international trade agreements between countries, such as the T-MEC, are the benefits generated to the economies involved, in this study case, the U.S.A., Canada, and Mexico. Advantages such as access to big markets, increase competitiveness, access to a greater diversity of products and services, and the elimination of commercial conditions, and barriers, as well as the exchange of technology (Forbes, 2020; Gerónimo & Ruiz, 2022).

The main objective of this work is to analyze port productivity and foreign direct investment and their impact on international trade in maritime transport between Mexico, the United States, and Canada during 1997-2017. To do this, the article is structured as follows: the first section is an introduction, in which the background of the investigation is briefly described; section two is the theoretical framework, followed by empirical literature revision in which similar research by other authors is mentioned. Section fourth is the methodology, in which the econometric models are presented. Section five presents and analyzes the results, and finally, section six shows the conclusions.

1. THEORETICAL FRAMEWORK

Adam Smith's Absolute Advantage Theory, as well as David Ricardo's Comparative Advantage Theory, argues that international trade could be mutually beneficial for countries that trade in the presence of absolute advantage in the production of some good, or at least if there is a comparative advantage (Zavala, 2016). International trade can be explained, in part, by differences in labor productivity, it can also be explained by differences in factor endowments between countries (Koontz & Weihrich, 1998).

Foreign direct investment (FDI) has the purpose of creating a lasting link with long-term economic and business purposes, by a foreign investor in the receiving country (Secretaría de Economía [SE], 2016). In another sense, FDI is that made by individuals or legal entities not resident in the country, which invest in the purchase of shares or participation in a company established or founded in the country (González et al., 2019), it is the result of the opening of international treaties aimed at trade liberalization and the consensus of policies that benefit the member countries of these alliances (Celorio & Luna, 2022).

Productivity is defined as the ratio between the volume produced and the means used to produce it (resources or inputs) (Gerónimo & Ruiz, 2022). This may be from the point of view of the stevedore or port operator providing services, the maritime transport line that is its client, or the port authority seeking to increase traffic, competition, and quality of service at the port. Ports generally use a limited number of performance indicators for their activities (Laxe et al., 2021).

1.1 Empirical Literature Review

In recent studies it was determined that the productivity of the 40 main ports of the Asia Pacific Economic Cooperation Forum (APEC) during 2005-2015 grew an average of 5.10%; the port of Lianyungang in China reached the highest level, while the port of Lazaro Cárdenas in Mexico had the lowest. It is stated that growth for Mexico can benefit from policies that promote investment in human capital and infrastructure (Delfín & Navarro, 2021).

Regarding FDI, the sustained increase in flows and its growing contribution to financing have been some of the most outstanding characteristics of the world economy in recent decades, being one of the main engines of globalization (CEPAL, 2021).

International trade is important to the extent that it contributes to increasing the wealth of countries and their peoples, wealth that we measure through the indicator of the production of goods and services that a country generates annually (Millán & Mendivil, 2020).

2. METHODOLOGY

In any econometric analysis, the methodology applied for the extraction and processing of the information is an important detail to highlight. This study uses the American Association of Port Authorities (AAPA) database and the World Bank (WB) to obtain information on the variables to be analyzed: "port productivity" and "foreign direct investment." These databases are chosen because they are internationally recognized for the reliability and precision of their data.

The object study of this investigation is the ports with the highest performance of containerized cargo in TEUs, according to the AAPA database. Among them are, Long Beach and the Port of Los Angeles in the United States; Manzanillo and Lazaro Cárdenas in Mexico as well as the port of Vancouver and Montreal in Canada (AAPA, 2021). These ports are the ones that have preferential access to the most powerful markets. This encourages foreign investment and foreign trade, consequently promoting a higher employment rate (Thomson Reuters, 2020).

For the established variables "port productivity" and "foreign direct investment", given the wide range of definitions found in the literature, this research specifically recognizes that productivity is the "ratio between the output obtained by a product or service system and the resources used to obtain it"

(Toro, 1990). Port productivity is measured as the amount of cargo transferred per unit of time, while the indicators are relative to a ship or crane (Dowd & Leschine, 1990). Ship productivity indicates the average amount of cargo transferred by a ship per hour that remains docked at the dock. Crane productivity indicates the average load transferred by a crane per hour of use, gross or net (Sánchez et al., 2003). The container handling rate indicates the efficiency of the crane operation and operations within the terminal (Doerr & Sánchez, 2006)

For this investigation, foreign direct investment involves the placement of financial resources that a company makes to obtain a return on them or receive dividends that help increase the capital of the company (Keynes, 2014), and real or direct investment is that which "is made in tangible assets that are not easy to carry out, such as plant and equipment, inventories, land, real estate, or even an entire company (De la Garza, 2005).

The proposed technique for data analysis is panel data, which allows combining a temporal dimension with another transversal dimension; it enables the analysis of a phenomenon in the long term by means of time series (Perazzi, 2013). In contrast, a cross-sectional dataset allows the observation of multiple phenomena at a given moment (La Fuente & Marin, 2008).

Some of the benefits of using the panel data model are that it helps control for individual heterogeneity, provides a greater amount of informative data, and helps measure unobservable effects (Pignataro, 2018). Most panel data models include an error term composed of a single observable effect NC that is invariant over time and the rest of the disturbance *uit* (Baltagi, 1995).

To analyze the possibility of cointegration in panel data, it is necessary to determine the existence of a unit root in the data series to analyze how the data evolve over time and how they can cause statistical inference problems in the models of temporal series. Additionally, cointegration analysis allows for establishing equilibrium or stationary relationships between variables that individually are not stationary or are not in equilibrium (Montero, 2013). Some authors consider that cointegration analysis has an advantage over other techniques since it allows establishing long-term relationships between different series and avoids manipulating the data, as such occurrence is possible with the construction of some indicators, which can address short-term causes and not long-term causes (Taboada & Sámano, 2003).

The study of long-term relationships with respect to equilibrium makes it possible to establish whether the hypothesis used is a permanent phenomenon in the economies or if it is only a temporary phenomenon (Taboada & Sámano, 2003). This is important in the present analysis given that it was carried out over 20 years.

The methodology handled in this research is panel data using the e-views program in version 10. For the treatment and validation of the econometric panel data model, unit root tests, such as Im, Pesaran and Shin, Levin, Lin and Chu, Augmented Dickey Fuller and Phillips-Perron, were applied to identify the existence of a unit root of the variables that are analyzed. Fisher-Johansen test is applied to identify if the variables are cointegrated, that is, if they share a common stochastic trend or a long-term relationship and thus enable the use of estimators that adjust to the results obtained from the application of each of these tests. Finally, to improve the proposed model, the causality relationship between the variables is evaluated with the causality test in the sense of Granger for panel data (Hurlin-Dumitrescu).

The FMOLS estimator presents the best possible cointegration estimates compared to the common regressions (OLS); it allows us to find asymptotic efficiency (normal distribution), robust estimators for hypothesis testing, and fight with possible endogeneity problems in the regressors, in addition to explaining the stationary serial correlation of the same order, for the application of this method; therefore, the condition must be met that the variables coincide at least with I (1), or of the same order (Vásquez & Rivera, 2018).

One of the important topics in panel data econometrics is the study of the heterogeneity of cross-sectional units (Pedroni, 2012). This article presents a new proposal for standardized panel statistics with good properties in small samples considering that there are two dimensions: the heterogeneity of the causal relationship and the heterogeneity of the regression model used (Dumitrescu & Hurlin, 2012). The null hypothesis of nonhomogeneous causality is raised 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 & Hurlin, 2012).

The general equation for the panel data model can be expressed as follows:

$$ComInt_{it} = \beta_{0it} + \beta_{1i}PP_{it1} + \beta_{2i}IED_{it2} + \varepsilon_{it} \quad (1)$$

where "i" shows the cross-section, which refers to the countries belonging to the USMCA, "t" refers to the established period of time (1997-2017), and "ε_{it}" refers to the error term or disturbance.

- *ComInt* represents the dependent variable "International Trade".
- *PP* represents one of the independent variables, "Port Productivity".
- *IED* represents another independent variable, "Foreign Direct Investment".

The parameters β_1, β_2 and β_3 that are exposed in the model refer to the elasticity generated in the long term for the international trade, port productivity, and foreign direct investment variables.

3. RESULTS AND DISCUSSION

Table 1 shows the results obtained from the unit root test, where it is confirmed that the variables are integrated into order one. All variables have unit roots in the levels but are stationary in first differences with a 5% level of significance. Each one has specifications according to the needs of the variables. According to the results obtained, cointegration tests are carried out to test the presence of equilibrium or long-term relationships between the integrated variables of the same order. In this research, two integration tests are used in the panel data: the Kao test (Kao, 1999) and the Fisher-type test, applying the Johansen methodology (Maddala & Wu, 1999).

Table 1. Unit Root Test of Levin, Lin & Chu (LL&C); Im, Pesaran and Shin (IPS); Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP)

Variable	Deterministic Parameter	LL&C	IPS	ADF	PP
ComInt	--	2.53956	--	0.48539	0.34256
PP	C	-2.43285**	-0.34315	5.63861	6.12998
IED	C	-1.54559	-0.97818	8.59529	15.4682**
First Differences					
ComInt	C	-37.696***	21.0974***	279.959***	40.5445***
PP	C	3.50863***	2.86295***	19.0675***	37.7793***
IED	C	5.50989***	5.12322***	34.235***	423.793***

Note: ** and *** denote a rejection of the null hypothesis at the 1% and 5% levels, respectively; C denotes the constant, and "-" denotes neither constant nor trend.

Source: own elaboration based on results obtained from e-views.

In this test, the null hypothesis of no cointegration is rejected at a significance level of 1%; therefore, it is accepted that there is a long-term relationship between the variables, as indicated in the following table.

Table 2. Kao Cointegration Test

Test	t-Statistic
ADF	-12.50963*
Value-p	0.0000

Note: * denotes rejection of the null hypothesis at 1% in its levels

Source: own elaboration based on results obtained from e-views.

In this article, a second cointegration test was applied (Table 3), which indicates that there are at least two related cointegrations since the null hypothesis is rejected at a significance level of 1% and 5%, which confirms a long-term relationship between the variables. When the variables are cointegrated, the Ordinary Least Squares (OLS) technique for estimating the coefficients of panel data models turns out to be biased and produces inconsistent estimates. The new methods developed to estimate cointegration relationships using panel data are the FMOLS and DOLS estimators (Phillips & Moon, 1999).

Table 3. Fisher-Johansen Cointegration Test

Null hypothesis	Trace Test	Max-Eigen Test
R=0	68.56***	44.84***
R ≥1	11.7	12.96**
R ≥2	3.575	3.575

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

Source: own elaboration based on results obtained from e-views.

FMOLS estimators perform relatively well, even in small samples, as they generate consistent estimates, and allow control of the endogeneity of their regressors and serial correlation (Pedroni, 2012). Hence, in the present investigation, FMOLS estimators are used for heterogeneous cointegrated panel data. The cointegration test through the FMOLS estimator determines the behavior of the signs. Table 4

shows that an increase in port productivity causes an increase in international trade, which is also the case for foreign direct investment, where an increase affects international trade in a positive way.

Table 4. Long-term estimation of the coefficients

Variable	FMOLS coefficients	Value- *p*
PP	1.0374***	0.0000
IED	0.2846*	0.0691

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

Source: own elaboration based on results obtained from e-views.

Figure 1 shows the relationship that the independent variables port productivity and foreign direct investment have with respect to the dependent variable: international trade.

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

Source: own elaboration based on the results obtained.

Figure 1 shows that both independent variables (port productivity and investment) have a positive relationship with respect to the dependent variable, which in this case is international trade. The existence of at least one causal relationship in at least one direction is considered after confirming the existence of a long-term relationship between the variables (Granger, 1988). That is why causality tests are carried out in Table 5.

Table 5. Hurlin-Dumitrescu causality test results

Null hypothesis	Wald Test	Prob	Decision
IED does not homogeneously cause to ComInt	3.32461**	0.0328	Rejection
ComInt does not homogeneously cause to IED	5.25803***	0.00006	Rejection
PP does not homogeneously cause to ComInt	4.25215***	0.0024	Rejection
ComInt does not homogeneously cause to PP	1.53774	0.6936	Accepted
PP does not homogeneously cause to IED	5.59403***	0.00001	Rejection
IED does not homogeneously cause to PP	1.63484	0.6252	Accepted

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

Source: own elaboration based on results obtained from e-views.

Table 5 shows the existence of a two-way causal relationship between IED and ComInt. The variables are complementary, and each variable has important information that helps better predict the behavior of the other. On the other hand, there is a unidirectional relationship between PP and ComInt and between PP and IED.

According to the results obtained, port productivity had a positive relationship during the period studied. Nevertheless, this situation has changed since the activity in international maritime trade has decreased since 2018. This slowdown is due to various causes, such as trade and protectionist conflicts between China and the United States of America, geopolitical tensions, interruptions in oil supply, and currently the pandemic caused by the SARS-CoV-2 virus (COVID-19) that has reduced the volume of trade (United Nations Conference on Trade and Development [UNCTAD], 2021). According to Delfín and Navarro (2021), by 2015, the port of Lianyungang in China had reached the highest level.

Various problems have arisen, such as the increase in demand for products, the accumulated delays of container ships due to COVID-19, the increase in freight prices, and the shortage of port workers and truck drivers, which have combined to double or triple waiting in ports, which is why international trade has been disadvantaged (Reta, 2021). Global FDI flows recovered in 2019 when they reached $1.5 trillion; however, due to the effects of the crisis, they were reduced in 2020 to approximately 1.0 trillion dollars, an amount that represents the lowest value recorded since 2005 (Bárcena et al., 2021). This reaffirms the importance of conducting scientific research on international trade, which contributes to generating wealth for countries, as stated by Navarro *et.al* (2020).

4. CONCLUSIONS

This research analyzes the relationship between the productivity of ports and foreign direct investment with international trade among the treaty member countries (Mexico, the United States and Canada) during 1997-2017. Based on the objectives of this research, econometric tests were carried out using the e-views program in version 10. For the treatment and validation of the panel data econometric model, unit root tests were applied, such as Im, Pesaran and Shin, Levin, Lin and Chu, Augmented Dickey Fuller and Phillips-Perron, to determine whether the variables studied are stationary or nonstationary, because all the variables seemingly have a unit root within the expected levels; however, they are stationary in first differences with a 5% level of significance, as well as running the Kao cointegration tests and the Fisher-Johansen test, where it was determined that there is cointegration between the variables. Finally, the causality test was applied in the sense of Granger for panel data (Hurlin-Dumitrescu) to evaluate the causality relationship between the three variables.

The main contribution of this research study was to demonstrate how port productivity and foreign direct investment influenced international trade between Mexico, the United States, and Canada during 1997-2017. The results obtained show that the variables are integrated into order one and that there is a long-term relationship between them. Therefore, we choose to use the panel data model through completely modified ordinary least squares, where elasticities show a positive relationship between international trade and port productivity, which indicates that an increase in port productivity will cause an increase in international trade. The same happens with foreign direct investment and international trade. There is a positive relationship, which shows that an increase in foreign direct investment will generate an increase in international trade. Finally, it is concluded that international trade between Mexico, the United States, and Canada has been significantly influenced by investment,

as well as by the productivity of seaports through twenty-foot containers, which are the most used in terms of maritime transport.

This research seeks to shed light on the relationship between the productivity of ports and foreign direct investment with international trade between the member countries of the treaty (Mexico, the United States, and Canada) during 1997-2017. The proposed methodology "Panel Data" allows carrying out this analysis in a detailed manner throughout the 20-year period. An interesting finding that makes future research possible is the positive relationship between the variable's foreign direct investment and ports, which independently generates an increase in international trade. A limitation of the present research is the aggregation of the information in the variables, specifically in the investment, so it is recommended to deepen the direct investment to the ports to identify a breakdown in which areas of investment are more fruitful in future research (Panamax and Post-Panamax cranes, gantry cranes, draft, or even terrain).

Additionally, port productivity and FDI are important factors that affect international trade since they increase job creation, increase development and foreign exchange earnings, stimulate competition, encourage the transfer of new technologies and boost exports. These benefits are reflected in the fact that the domestic consumer obtains a greater variety of products at better prices (Zavala, 2016).

AUTHORS' CONTRIBUTIONS

María Guadalupe Cortés-Medina: collection, analysis, and interpretation of the data.
Irma Cristina Espitia Moreno: design of the research. Dalia, García-Orozco: formal analysis and drafting-revising and editing. Oscar V. de la Torre-Torres: conceptualization and methodology validation. All authors have read and accepted the published version of the manuscript.

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CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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