

Export and import-led growth: the Mexican case

Oscar Salomón Castañeda Lozada

Juan Carlos Botello Osorio

Popular Autonomous University of the State of Puebla, Mexico

Keywords

Exports, imports, economic growth, causality, cointegration.

Abstract

This research analyses the short-run and long-run relationship between exports, imports, labour, capital and gross domestic product of Mexico from 2002 to 2024 by means of a neoclassical framework under an autoregressive distributed-lagged error correction model. We reveal that these series are cointegrated. The empirical examination applies several diagnostic tests to analyse the error terms and the appropriateness of the model specification. It was found a long-run convergence among the observed variables providing evidence in the long-run that imports and capital positively influence output net of exports and that exports and labour have negative effects on such variable. In the short-run, estimates showed that exports have a positive impact on GDP net of exports whereas imports and capital display negative coefficients. The findings must also be interpreted in light of Mexico's trade liberalization strategy and its network of free trade agreements. It is important to consider that the 2008 financial crisis and the COVID-19 pandemic, exposed vulnerabilities in Mexico's dependence on external demand. These results raise questions about the sustainability of an export-oriented growth model. JEL Classification: F1, F4, O4, C220, C32, C18.

Corresponding author: Oscar Salomón Castañeda Lozada

Email address for the corresponding author: oscarsalomon.castaneda@upaep.mx

First submission received: 4th February 2026

Revised submission received: 19th March 2026

Accepted: 25th April 2026

Introduction

Understanding the causal relationships between imports, exports, capital, labour and GDP in the short-run and in the long-run is of key relevance in the literature on international economics and constitutes a central issue of major policy concern for governments and international trade policy makers.

Mexico has been a dynamic participant in global trade, especially since the beginning of the 21st century. Its trade policy framework from 2000 to 2024 has been characterized by openness, export promotion and continuous regulatory adjustments. During this period, the government implemented and consolidated several export promotion programs that shaped the country's export-led growth strategy. Among the most relevant were PITEX (Program for Temporary Imports to Produce Export Goods) and the Maquila program, both of which allowed firms to temporarily import inputs and intermediate goods tax-free, provided that the final production was exported. These instruments were instrumental in developing Mexico's export-oriented manufacturing sector, particularly in automotive, electronics and textile industries.

In 2006, these programs were unified and replaced by the IMMEX program (Industria Manufacturera, Maquiladora y de Servicios de Exportación). IMMEX consolidated and streamlined the benefits of PITEX and Maquila, reducing administrative burdens and providing fiscal incentives to strengthen Mexico's

competitiveness in global value chains. This new framework allowed companies not only to import intermediate goods under preferential conditions but also to integrate services into export-oriented operations, widening the scope of foreign trade promotion.

Throughout the period 2000–2024, IMMEX became a cornerstone of Mexico’s industrial and trade policy, boosting the participation of manufacturing exports in GDP and consolidating the country’s role as a key production hub integrated with North American supply chains, especially under NAFTA and later USMCA (T-MEC). Additionally, reforms in customs procedures – such as the adoption of the Ventanilla Única de Comercio Exterior and technological modernization of inspections – complemented these sectoral policies by reducing transaction costs and improving efficiency.

Empirical research has found four possible outcomes regarding the relationships between exports and GDP. The first one, known as the export-led growth hypothesis (ELGH), argues that exports cause economic growth. The second one, the growth-driven export hypothesis (GLEH), claims the opposite behaviour. That is, a rise in GDP generally leads to a corresponding increase in exports, thereby indicating unidirectional causality from GDP to exports. Another potential outcome suggests a bidirectional relationship between exports and economic growth. Finally, some authors maintain a null relationship between exports and economic growth. As for imports and GDP, similar outcomes are likely to occur.

Uncovering the true relationships among these variables is important to prevent problems of misspecification. Therefore, to observe the short-run and long-run relationships between GDP, exports, imports, labour and investment, this paper implements a neoclassical framework by means of an autoregressive distributed-lagged error correction model (ARDL).

This study is organised in five sections: section 2 shows the literature review, section 3 explains the methodology and the econometric model to be applied. Section 4 describes empirical results, section 5 discusses policy implications and section 6 concludes.

Literature Review

The traditional view of international trade maintains that imports and exports act as an engines of economic growth. Adam Smith and David Ricardo recognised the implications of trade liberalization for economic growth. Accordingly, trade should deliver gains by allowing countries to export goods whose production would make relatively heavy use of resources that are locally abundant while importing goods whose production makes heavy use of resources that are locally scarce (Krugman, Obstfeld and Melitz; 2023). Smith (1977) proposed that nations would benefit concurrently if they practiced free trade and specialized in accordance with their absolute advantage. The absolute advantage theory led to international specialization and division of labour. Under this framework, countries are able to buy abroad the products they need instead of producing them by themselves. Later on, Ricardo (1819) developed a more robust and comprehensive theory. David Ricardo’s comparative advantage theory, explains that open economies can reorient their resources towards efficient sectors to improve their wellbeing regardless of their level of development. In this situation, due to the exchange between nations it is possible for them to produce on the frontier of production possibilities and with a more efficient allocation of resources. Hence, world-wide trade should influence economic growth.

The earliest empirical studies applied to exports and economic growth were mainly focused on developing countries. They proposed the existence of a positive relationship between exports and economic growth and suggested that such countries needed to achieve a minimum level of development so as to benefit from export expansion (Kravis, 1970).

The Mexican Case

With regard to Mexico, empirical research displays different results. For instance, Rodríguez-Benavides and Venegas-Martínez (2011), Maneschiöld (2008), McCarville and Nnadozie (1995) and Thornton (1996) support of ELGH whereas Cuadros-Ramos (2000) showed evidence in support of import led growth hypothesis (ILGH). Moreover, Lorde (2011) found a negative relationship between exports and non-export GDP in the long-run. In addition, they found a positive relationship between imports and non-export GDP and provided evidence that imports and investment Granger-cause non-export GDP. Finally, the study of Salazar et al. (2020) provided evidence of bidirectional causality between exports and GDP.

Export-led Growth Hypothesis

Studies that initially addressed exports and economic growth discovered an association between these two variables (Balassa, 1978; Balassa 1985 and Ram 1985 and 1987). However, the first research that formally expressed a causal relationship was proposed by Jung and Marshall (1985) who studied 37 countries from 1951 to 1981 and found evidence of unidirectional causality from exports to economic growth for the cases of Indonesia, Egypt, Costa Rica, and Ecuador. This analytical framework proposes that exports are a potential driver of economic growth. In this regard, Feder (1983) proposed that the exporting sector can generate positive externalities in non-exporting sectors by introducing technological innovations or by taking advantage of economies of scale linked to increased market size. Feder examined a group of semi-industrialised countries from 1964 to 1973 and showed evidence that a growing export sector generates a stimulus to overall economic growth in so far as marginal factor productivities are higher in this sector than in the rest of the economy. ELGH has been observed in Africa and middle east countries (Al-Yousif, 1997; Jordaan and Eita, 2007; and Jung and Marshall, 1985); in Asia (Abual-Foul, 2004, Jin, 2002, Hye et al., 2016, Shahbaz et al., 2011; Din, 2004; Ghatak et al., 1997; and Venkatraja 2015); in Europe (Bilas et. al., 2015); and in Latin America (Awokuse, 2008, Jung and Marshall, 1985). However, other authors contradict the validity of the ELGH for the case of Vietnam (Ngoc, et al., 2003) and the case of India (Sharma and Panagiotidis, 2005). Table 1 provides previous empirical studies on the causal relationships between exports, imports and GDP.

Other Hypothetical Relationships Revealed by Previous Empirical Research

Growth-led Exports: the growth-led exports hypothesis (GLEH) has been verified for the cases of Jordan (Istaiteyeh et al. 2023); Costa Rica (Gokmenoglu et al. 2015); Pakistan (Hussain, 2014); Nepal (Din, 2004); Greece (Panas and Vamvoukas, 2002); Canada (Henriques and Sadorsky, 1996) and Shanghai (Shan and Tian, 1998).

Import-led Growth: the import-led growth hypothesis (ILGH) was observed for the cases of Kenya (Wamalwa and Were, 2021); Peru and Colombia (Awokuse, 2008).

Growth-led Imports: Evidence of the growth-led imports hypothesis (GLIH) was observed in the short-run for the cases of India and Sri Lanka (Din, 2004).

Bidirectional Causality between Exports and GDP: the countries for which the evidence of bidirectional causality between exports and GDP has been found are Pakistan (Hussain, 2014), Korea (Koh and Mah, 2013), Argentina (Maneschiöld, 2008), Bangladesh, India, and Sri Lanka (Din, 2004), Portugal (Ribeiro-Ramos, 2001) and nine developed countries (Bahmani-Oskooee and Alse, 1993).

Bidirectional Causality between Imports and GDP: with regard to bidirectional causality between imports and GDP, Din (2004) found evidence for Bangladesh, India and Sri Lanka; Awokuse (2008) found evidence for Argentina and Colombia and Ribeiro-Ramos (2001) found evidence for Portugal.

Table 1: Empirical Studies on the Relationship between Exports, Imports and GDP

Evidence	Countries and Period	Variables	Methodology
Unidirectional causality from GDP to exports			
Istaiteyeh et al. (2023)	Jordan, (1976 to 2021)	GDP, merchandise exports, other variables	VAR and causality tests
Gokmenoglu et al. (2015)	Costa Rica, 1980-2013	GDP, exports	Cointegration and causality tests
Hussain (2014)	Pakistan, 1976-2011	GDP, exports, imports	Cointegration and causality tests
Din (2004)	Nepal, 1965-2002	GDP, exports, imports	VAR and VECM
Panas and Vamvoukas (2002)	Greece, 1948-1997	GNP, exports, other variables	VAR
Shan and Tian (1998)	Shanghai, 1990-1996	GDP, exports, other variables	VAR
Henriques and Sadorsky (1996)	Canada, 1870-1991	GDP, exports, terms of trade	Causality tests
Shan and Tian (1998)	China (Shangai)	GDP, exports, other variables	VAR and causality tests
Bidirectional causality between GDP and exports			
Salazar et al. (2020)	Mexico, 1993-2019	GDP, exports	Causality and FMOLS
Hussain (2014)	Pakistan, 1976-2011	GDP, exports, imports	VECM
Koh (2013)	Korea, 1980-2003	GDP, non-textile exports, other variables	ECM
Din (2004)	India and Sri Lanka, 1960-2002	GDP, exports, imports	VAR and VECM
Bahmani-Oskooee and Alse (1993)	9 less developed countries, 1973-1983	GDP, exports	Cointegration test and ECM
Maneschiöld (2008)	Argentina 1993-2006 Mexico 1980-2006	GDP, exports	Cointegration and causality tests
Din (2004)	Bangladesh, 1973-2002	GDP, exports, imports	VAR and VECM
Ribeiro-Ramos (2001)	Portugal, 1865-1998	GDP, exports, imports	VECM
Bidirectional causality between GDP and imports			
Awokuse (2008)	Colombia, Argentina	GDP, exports, imports	Cointegration, impulse response analysis and causality tests
Din (2004)	Bangladesh, 1973-2002	GDP, exports, imports	VAR and VECM
Ribeiro-Ramos (2001)	Portugal, 1865-1998	GDP, exports, imports	VECM
Unidirectional causality from imports to GDP			
Wamalwa, and Were (2021)	Kenya, 1961-2019.	GDP, exports, imports	VECM
Awokuse (2008)	Peru and Colombia	GDP, exports, imports	Cointegration and causality tests
Cuadros Ramos (2000)	Mexico, 1983-1997	GDP, exports, imports	Causality tests
Din (2004)	Pakistan, 1973-2002	GDP, exports and imports.	VAR and VECM
Unidirectional causality from exports to GDP			
Bilas et al. (2015)	Croatia, 1996-2012	GDP and exports	Causality tests
Venkatraja (2015)	India, 1970-2013	GDP and exports	VECM
Lorde (2011)	Mexico, 1960-2003	Non-export GDP, exports other variables	VECM

Rodriguez-Benavides and Venegas (2011)	Mexico, 1929-2009	GDP, exports	VECM
Shahbaz et al. (2011)	Pakistan, 1990-2008.	GDP and exports	ECM
Maneschiöld (2008)	Mexico, 1980-2006; Brazil, 1991-2006	GDP and exports	Cointegration and causality tests
Awokuse (2008)	Peru, Colombia and Argentina	GDP, exports and imports.	Cointegration and causality tests
Jordaan and Eita (2007)	Namibia, 1970-2005	GDP, GDP per capita and exports	VECM
Abual-Foul (2004)	Jordan, 1976-1997	GDP and exports	VAR and ECM
Din (2004)	Pakistan, 1973-2002	GDP, exports and imports.	VAR and VECM
Jin (2002)	4 Korean provinces	GDP and exports	Causality tests
Al-Yousif (1997)	Saudi Arabia Kuwait UAE Oman 1973-1993	GDP, exports	Engle and Granger procedure
Ghatak et al. (1997)	Malaysia, 1955-1990	GDP, GDP net-of exports and exports	Causality tests and ECM
Thornton (1996)	Mexico, 1895-1992	GDP and exports	Cointegration and causality tests
McCarville and Nnadozie (1995)	Mexico, 1926-1988	GDP and exports	Causality tests
Serletis (1992)	Canada, 1870-1985	GNP, exports and imports	Cointegration and causality tests
Jung and Marshall (1985)	4 out of 37 developing countries 1951-1981	GDP and exports	Causality tests
Exports do not cause GDP or a negative impact to from exports to GDP			
Sharma and Panagiotidis (2005)	India, 1971-2002	GDP net of exports, exports other variables	Causality tests
Ngoc et al. (2003)	Vietnam, 1975-2001	GDP net-of exports, exports other variables	ECM and Causality tests
Richards (2001)	Paraguay, 1966-1996	GDP, exports	VECM
Jung and Marshall (1985)	37 developing countries, 1951-1981	GDP, exports	Causality tests
Unidirectional causality from GDP to imports			
Din (2004)	India and Sri Lanka, 1960-2002	GDP, exports and imports	VAR and VECM

Source: own elaboration.

Methodology

The theoretical relationship is established through the extended production function, which incorporates international trade as a determinant of aggregate output. In an open economy, the traditional production function $Y = f(K, L)$ is modified to reflect the fact that exports represent final demand that must be produced domestically, and that imports supply intermediate inputs, capital goods, and technology not available locally. From the perspective of neoclassical theory, expanding the production function to explicitly include exports and imports is both appropriate and necessary for analysing open economies.

Imports as a factor of production (intermediate factor)

In the actual production of goods and services, especially in globalized economies, imported inputs (raw materials, components, machinery, energy) are used. Excluding them from the production function

means ignoring a relevant factor that affects the productivity and marginal product of domestic factors (capital and labour). An extended neoclassical function of the type:

$Y = A \cdot K^\alpha \cdot L^\beta \cdot M^\gamma$ (where M represents imports of intermediate goods) captures this complementarity, which justifies its inclusion.

Exports as a Share of Total Output

The traditional production function measures gross domestic product. However, to represent the economy's total gross output, it is necessary to include goods and services destined for foreign markets. Exports are not a factor, but rather a destination of output. Nevertheless, by extending the function, we can define $Y_{total} = F(K, L, M, \dots)$ and then *total gross output* = $Y_{total} - M$. Thus, exports are implicit in Y_{total} .

The empirical model to be estimated is

$$Y_t = A_t K_t^\alpha L_t^\beta \quad (1)$$

In this neoclassical framework (equation 1), Y_t represents the aggregate production function at time t . A_t denotes the level of total factor productivity and K and L represent the capital stock and the stock of labour respectively. α and β show the capital and labour's portion of income respectively with values between zero and one. We also assume that total factor productivity can be expressed as a function of exports (E_t), imports (M_t), and other exogenous factors (C_t) assumed to be uncorrelated with E_t and M_t with the following unbiased specification:

$$Y_t = C_t K_t^\alpha L_t^\beta E_t^\delta M_t^\gamma \quad (2)$$

In equation 2, we use aggregate output net of exports in order to separate the economic influence of exports on output from the influence incorporated into the growth accounting relationship. For econometric estimation purposes all data are logged and the model can be expressed as:

$$\ln Y_t = a + \alpha \ln K_t + \beta \ln L_t + \delta \ln E_t + \gamma \ln M_t \quad (3)$$

Where α , β , δ and γ , are the elasticities with respect to K_t , L_t , E_t , and M_t respectively in equation 3.

The data are quarterly observations for the sample period running from 2002 to 2024. GDP, gross fixed capital formation, exports and imports time series (in real terms of 2018) have been obtained from the National Institute of Statistics and Geography (INEGI). As for the total number of people employed, information was collected from the of Labour Statistics published by the International Labour Office (ILO). Table 2 reports the descriptive statistics of variables under analysis.

Incorporation of the Imports Variable

Although it is important to recognize that numerous studies have considered the relationship between exports and economic growth, the role that imports should not be overlooked. Sheehy (1990) emphasizes that since exports are a component of GDP there might be a strong bias in favour of a correlation between the two variables whatever actual causal relationship may exist between them. Awokuse (2008) and Riezman et al. (1996) argue that the relationship between exports and economic growth may be misleading if the imports' variable is not included in their models. The latter argue that the omission of imports could

lead to biased results supported by their analysis of 126 developing countries. They found evidence of spurious test results when the variable of imports was not included. In this regard, Grossman and Helpman (1990) discussed the importance of imports of foreign technology in the growth process. They argued that the importation of foreign equipment creates a more efficient production system, increases productive capacity, global output, technological capacity development and economic growth. Moreover, Din (2004) points out that imports can be instrumental in explaining export-led growth and that omitting such variable in the analysis may conceal or exaggerate the effects of exports on economic growth. For instance, in the case of Pakistan, he finds evidence of long-run causality from both exports and imports to economic growth and from exports and output to imports. In the short-run he finds evidence of bidirectional causality between imports and economic growth.

Table 2 shows a statistical description of the variables through the mean, minimum value, maximum value, and standard deviation, which allows us to know the degree of dispersion of the data during the reference period.

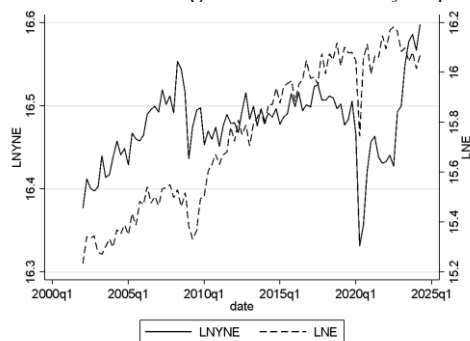
Table 2: Statistical Description of Variables

Variable	Mean	Min	Max	St. Dev.
LNYNE	16.47783	16.33133	16.59756	.0458706
LNE	15.74834	15.23312	16.18253	.2910897
LNM	15.85167	15.33076	16.28171	.2557438
LNK	15.40307	15.03836	15.69445	.1578052
LNL	11.3396	11.14209	11.52386	.1120964

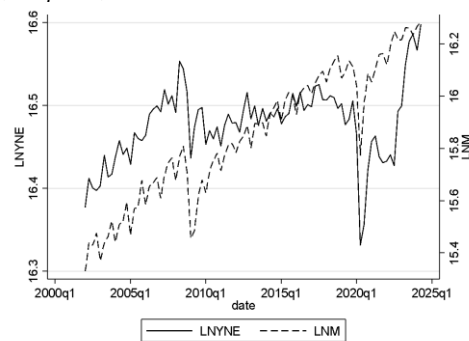
Source: own elaboration.

Figure 1 shows the GDP net of exports variable in relation to each of the four independent variables which will be included in the model: exports (Graph 1a), imports (Graph 1b), investment (Graph 1c) and labour (Graph 1d).

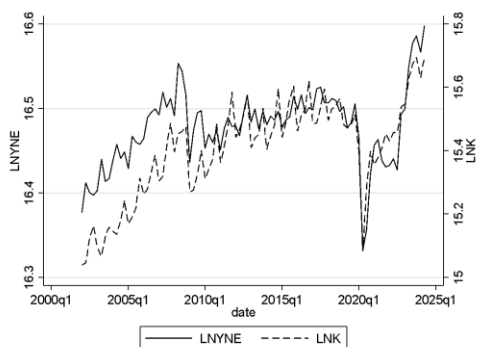
Figure 1: GDP Net of Exports, Exports, Imports, Investment and Labour



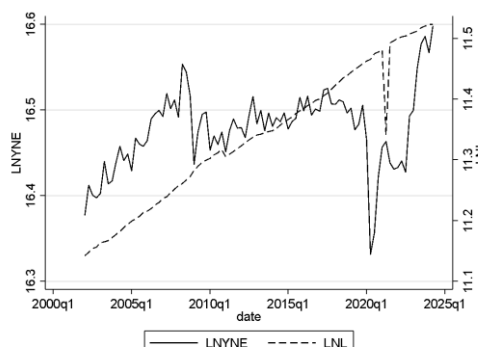
Graph 1a. GDP Net of Exports and Exports



Graph 1b. GDP Net of Exports and Imports



Graph 1c. GDP Net of Exports and Investment



Graph 1d. GDP Net of Exports and Labour

Source: own elaboration.

Determining the optimal lag length

Evaluating the number of lags involved in the model is essential in specifying the ARDL model. Table 3 reports the final prediction error (Akaike, 1970), Akaike’s information criterion (Akaike, 1974), Schwarz’s Bayesian information criterion (Schwarz, 1978), and the Hannan and Quinn information criterion (Hannan and Quinn, 1979) lag-order selection statistics for a series of vector autoregressions from order 1 through a maximum lag order 8. Each test at 5 percent level of significance, revealed different number of lags that can be selected. The present model will use five lags as proposed by Hannan and Quin (HQIC).

Table: 3 Optimal Lag Selection Criteria

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	569.854		7.20E-13	-13.7769	-13.718	-13.6302
1	817.841	495.97	3.10E-15	-19.2156	-18.8621	-18.3351*
2	859.280	82.879	2.10E-15	-19.6166	-18.9685	-18.0023
3	901.669	84.778	1.40E-15	-20.0407	-19.098	-17.6927
4	968.822	134.3	5.20E-16	-21.0688	-19.8315	-17.987
5	1027.75	117.87	2.40E-16	-21.8964	-20.3646*	-18.0809
6	1058.76	62.016	2.20E-16	-22.043	-20.2165	-17.4937
7	1095.61	73.705	1.9e-16*	-22.3321	-20.211	-17.049
8	1120.80	50.373*	2.20E-16	-22.3366*	-19.921	-16.3198

Source: own elaboration

Unit Root (Integration) Test

In order to determine the order of integration of the series we apply the stationarity or unit root tests. For this purpose, we apply the augmented Dickey-Fuller (ADF) test (Dickey and Fuller; 1979, 1981) the Phillips-Perron (PP) test (Phillips-Perron (1988) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test (Kwiatkowski et al., 1992). Results of these tests are provided in table 4. Using the rule that a conclusion will be drawn based on agreement of at least two of the three tests and applying such tests at level values, we conclude that all variables are not stationary. However, *LNM* is trend stationary at significance levels. With reference to the first difference of variables, such series are stationary, and therefore, we reject the null hypothesis of a unit root at all common significance levels. Consequently, *LNYNE*, *LNE*, *LNM*, *LNK*, *LNL* are integrated of order 1 or I(1) at conventional levels of significance. The p-values of the tau test statistics

for the ADF, KPSS and PP tests were less than 0.05, and hence the null hypotheses were rejected. Accordingly, we found evidence that series are integrated in the same order.

Table: 4 Unit Root Test Results

Variables	PP Lags 5		ADF Lags 5		KPSS (Maxlag = 5)	
	Random walk without drift $\delta = 0$ $\delta = 0$ Default	Random walk with or without drift (Trend)	Random walk without drift $\delta = 0$ Default	Random walk with or without drift (Trend)	Trend stationary	Level stationary
Critical values	-2.899	-3.461	-2.903	-3.466	0.148	0.462
LNYNE	-2.804 [0.0577]	-3.056 [0.1172]	-1.755 [0.4029]	-1.901 [0.6540]	0.119 [0.1028]	0.308 [0.1315]
LNE	-1.433 [0.5661]	-4.611 *** [0.0010]	-1.419 [0.5733]	-2.014 [0.5940]	0.172 [0.0290]	1.540 [0.0000]
LNLM	-1.356 [0.6030]	-5.475 *** [0.0000]	-0.941 [0.7741]	-3.461 *** [0.0437]	0.069 [0.3683]	1.552 [0.0000]
LNK	-2.477 [0.1211]	-3.915 ** [0.0116]	-1.890 [0.3369]	-2.660 [0.2531]	0.221 [0.0095]	1.058 [0.0025]
LNL	-0.682 [0.8515]	-8.800 *** [0.0000]	-0.500 [0.8921]	-3.270 ** [0.0713]	0.124 [0.0927]	1.591 [0.0000]
First differences						
Critical values	-2.900	-3.462	-2.904	-3.467	0.148	0.462
DLNYNE	-10.429 *** [0.0000]	-10.369 *** [0.0000]	-3.450 *** [0.0094]	-3.429 ** [0.0477]	0.112 [0.1239]	0.111 [0.5442]
DLNE	-16.552 *** [0.0000]	-16.589 *** [0.0000]	-4.118 *** [0.0009]	-4.218 *** [0.0042]	0.047 [0.6394]	.090 [0.5815]
DLNM	-13.053 *** [0.0000]	-12.954 *** [0.0000]	-5.097 *** [0.0000]	-5.069 *** [0.0002]	0.036 [0.8100]	0.047 [0.9033]
DLNK	-12.770 *** [0.0000]	-12.697 *** [0.0000]	-3.736 *** [0.0036]	-3.717 *** [0.0212]	0.065 [0.4155]	0.076 [0.7260]
DLNL	-24.303 *** [0.0000]	-24.171 *** [0.0000]	-6.137 *** [0.0000]	-6.109 *** [0.0000]	0.034 [0.8361]	0.041 [0.9371]

Source: own elaboration

Autoregressive Distributed-lagged Model Bounds Test for Cointegration

An Autoregressive Distributed-lagged Model ARDL contains the lagged values of the dependent variable and the current and lagged values of regressors as explanatory variables. It can be specified if the variables are integrated of different orders. That is, a model having a combination of variables with I(0) and I(1) order of integration.

The generalised ARDL (p q) model is specified in equation (4):

$$LNYNE_t = \gamma_{0i} + \sum_{i=1}^p \delta_i LNYNE_{t-i} + \sum_{i=0}^q \beta'_i X_{t-i} + \varepsilon_{it} \quad (4)$$

Where $LNYNE$ is a vector and the variables in $(X't)$ are allowed to be purely I(0) or I(1) or cointegrated; β and δ are coefficients, γ is the constant, $i = 1, \dots, k, p, q$ are optimal lag orders for endogenous and exogenous variables respectively, and ε_{it} is a vector of the error terms.

ARDL cointegration technique is useful when dealing with variables that are integrated of different order, I(0), I(1) or a combination of both and there is a single long-run relationship between the underlying variables in a small sample size.

Error Correction Model

Provided that we find evidence of cointegration we would proceed estimating the following ECM (equation 5):

$$\begin{aligned} \Delta LNYNE_t = & a_{01} \\ & + \sum_{i=1}^p a_{1i} \Delta LNYNE_{t-i} + \sum_{i=1}^p a_{2i} \Delta LNE_{t-i} + \sum_{i=1}^p a_{3i} \Delta LNM_{t-i} + \sum_{i=1}^p a_{4i} \Delta LNK_{t-i} \\ & + \sum_{i=1}^p a_{5i} \Delta LNL_{t-i} + \lambda ECT_{t-1} + e_t \end{aligned} \quad (5)$$

Where:

$\lambda = 1 - \sum_{i=1}^p \delta_i$ represents the speed of adjustment with an expected negative sign.

$ECT_{t-1} = LNYNE_{t-i} - \theta X_t$, characterises the error correction term. This is the lagged value of the residuals obtained from the cointegrating regression of the dependent variable. It contains long-run information derived from the long-run cointegrating relationship.

$\theta = \frac{\sum_{i=0}^q \beta_i}{\alpha}$, depicts the long-run parameter.

$a_{1i}, a_{2i}, a_{3i}, a_{4i}, a_{5i}$ are short-run dynamic coefficients of the model's adjustment long-run equilibrium.

e_t are residuals (stochastic error terms often called impulses or shocks).

Autoregressive Distributed-Lagged Test for Cointegration

The long run relationship of the underlying variables is detected through the F -statistic. In this approach, long run relationship of the series is said to be established when the F-statistic exceeds the critical value band. The major advantage of this approach lies in its identification of the cointegrating vectors where there are multiple cointegrating vectors. This test was proposed by Pesaran et al. (2001). The hypotheses for the bounds test for cointegration with 4 variables is specified as:

$$H_0: b_{1i} = b_{2i} = b_{3i} = b_{4i} = b_{5i} = 0 \quad (6a)$$

$$H_1: b_{1i} \neq b_{2i} \neq b_{3i} \neq b_{4i} \neq b_{5i} \neq 0 \quad (6b)$$

Where $i = 1, 2, 3, 4, 5$, and H_0 and H_1 in equations 6a and 6b are the null hypothesis and the alternative hypothesis respectively. Results from the bounds test provided in Table 5 reject the null hypothesis and find evidence that variables are cointegrated. The ARDL test for cointegration shows the F -statistic

surpassing the upper bound critical values from which we find no evidence against the null hypothesis of no levels relationship from the 10 percent to the 2.5 percent levels of significance.

Table 5: *Autoregressive Distributed-Lagged Test for Cointegration*

F-statistic Critical Values (0.1-0.01)	Bounds	
	[I_0]	[I_1]
L_0.1	2.45	3.52
L_0.05	2.86	4.01
L_0.025	3.25	4.49
L_0.01	3.74	5.06
AIC Lags 5	F-statistic = 4.874	

Source: own elaboration.

Results

Once we have applied the ARDL test for cointegration and observed that variables are cointegrated, we proceed to estimate the autoregressive distributed-lagged regression and uncover both the short-run and the long-run estimates. Results displayed in table 6 show that the adjustment parameter is significant at one percent with the expected negative sign. Therefore, we find evidence of long-run convergence among the variables. It also indicates that previous errors will be corrected in the current period and the speed of adjustment will be 0.76 percent. As for the long-run coefficients, imports and capital are associated with 0.57 percent and 0.25 percent increases in output net of exports respectively. On the other hand, exports and labour have negative impacts on GDP net of exports of 0.36 percent and 0.48 percent respectively. All estimated long-run coefficients are significant at the one percent level. It is important to mention that long-run coefficients in the ARDL model indicates Granger-causality. In the short-run, at the fourth lag the OLS parameter of exports is positive and significant at the one percent level and associated with a 0.21 percent increase. Imports and capital at the fourth lag display negative coefficients at the one percent level of significance.

Table 6: *Autoregressive Distributed-Lagged Regression*

	D.LNYNE	Coef.	Std.Err.	P> t
ADJ	LNYNE			
	L1.	-0.7604920	0.1778288	0.000
SR	LNYNE			
	LD.	0.2552936	0.1862220	0.176
	L2D.	0.0724046	0.1662939	0.665
	L3D.	0.0556118	0.1428128	0.698
	L4D.	0.5793572	0.1270990	0.000
	LNE			
	D1.	0.0123052	0.0865718	0.887
	LD.	0.1230409	0.0950057	0.200
	L2D.	0.0974307	0.0866338	0.265
	L3D.	0.0213968	0.0661438	0.747
	L4D.	0.2099322	0.0546613	0.000
	LNM			

D1.	-0.1062596	0.1001230	0.293
LD.	-0.1808735	0.1000085	0.076
L2D.	-0.1791576	0.0930798	0.059
L3D.	-0.1067842	0.0753977	0.162
L4D.	-0.1706925	0.0653992	0.011
LNK			
D1.	0.0830826	0.0799424	0.303
LD.	-0.1135992	0.0835018	0.179
L2D.	-0.0339294	0.0787735	0.668
L3D.	-0.0305424	0.0724217	0.675
L4D.	-0.3013431	0.0642083	0.000
_cons	11.0768400	2.5456370	0.000
LR			
LNE	-0.3625293	0.0560053	0.000
LNМ	0.5771443	0.0925260	0.000
LNK	0.2527102	0.0307986	0.000
LNL	-0.4774450	0.0883997	0.000

Source: own elaboration.

Diagnostic Tests

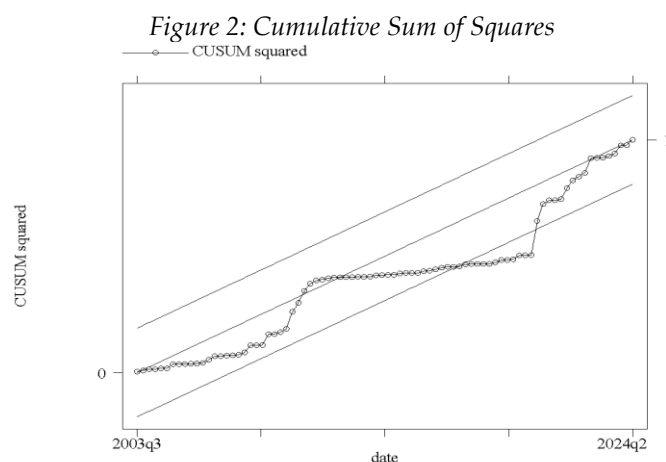
On the basis of Breusch-Godfrey LM Test (Breusch and Godfrey, 1978), for the residuals (table 7), we cannot reject the null hypothesis of no serial correlation. This table also provides evidence that the error terms of this model are homoscedastic and shows that these are normally distributed by means of the Jarque-Bera test (Jarque and Bera, 1987).

Table 7: Diagnostic Tests

Name of the Test	Chi2	Prob>Chi2	Conclusion
Breusch-Godfrey LM Test for Autocorrelation			
Lags 5	5.636	0.3433	No serial correlation
Cameron and Trivedi's Decomposition of Information Matrix Test			
Heteroskedasticity	85	0.4490	Homoskedasticity
Skewness	21.88	0.5864	Not skewed
Kurtosis	2.47	0.1159	Mesokurtic
Total	109.35	0.4725	
Jarque-Bera Test			
Normality	0.989	0.6099	Normal distribution

Source: own elaboration.

Finally, in order to observe the stability of the model, the cumulative sum of squares' graph provides evidence that the model is stable (figure 2).



Source: own elaboration.

Discussion

The empirical analysis of the relationships between exports, imports, capital, labour, and GDP in Mexico must be framed within the broader dynamics of trade policy and regional integration. The findings of this research should be interpreted considering that Mexico's export-led model has been strongly shaped by trade liberalization, policy trade, and its extensive network of free trade agreements.

In the long term, exports and the labour force have negative impacts on economic growth as a result of specialization in sectors that require low technology, low value added, and are labour-intensive. An export-oriented maquiladora model that markets goods manufactured using unskilled labour will tend to concentrate its resources on activities characterized by low productivity, depressed wages, and high levels of informality, which will not foster economic growth. Low innovation capacity hinders the transition to sectors of greater technological complexity, and firms have no incentives to raise wages. The education sector, for its part, also has no incentives to improve its quality. As a result, the economy remains below its potential and vulnerable to technological changes. In the long term, the country risks losing its low-wage advantage, as wages become insufficiently low to compete with lower-cost economies and lacks the productivity and knowledge to compete with advanced economies. Firms invest little in research and development, and individuals with few incentives to acquire specialized technical training run the risk of their labour becoming obsolete. As a result, economic growth slows, and the workforce lacks the skills required by dynamic sectors.

Finally, it is necessary to highlight the role of global shocks—such as the 2008 financial crisis and the COVID-19 pandemic—which exposed vulnerabilities in Mexico's dependence on external demand, especially from the United States. This raises questions on the sustainability of an export-oriented growth model and the importance of diversifying both markets and productive structures.

Conclusions

This paper studies the effect of exports, imports, labour, and capital on Mexican gross domestic product net of exports from 2002 to 2024. We uncovered a cointegrated relationship and therefore long-run convergence among the observed variables and estimated the autoregressive distributed-lagged regression providing evidence for the short-run and the long-run. In the long-run we found evidence that imports and capital are associated with positive impacts on output net of exports and that exports and labour have

negative effects. Moreover, in the short-run, OLS estimates shows that exports have a positive impact on GDP net of exports whereas imports and capital display negative coefficients.

Since NAFTA, Mexico has followed a maquiladora and export platform model. This has the following long-term adverse effects:

Low domestic value added and limited production linkages: most manufacturing exports are processed under the temporary import regime. Components are imported, assembled using low-cost labour, and then re-exported. Domestic value added is minimal (approximately only 17 percent of the final value). This means that export growth does not translate into GDP growth. On the contrary, it has a negative effect because most of the value is generated in the country of origin of the components.

Productivity stagnation: by competing on the basis of cheap labour rather than innovation, exporting companies have little incentive to invest in technology or improve the skills of their workforce. This keeps total factor productivity (TFP) at low levels. In the long run, GDP will stagnate because the country fails to make the transition to a knowledge-based, value-added economy.

High levels of informality and low productivity: more than half of the workforce is employed in the informal sector (without social security, benefits, or contracts). These workers are in very low-productivity jobs (street vending, low-paid domestic work and small-scale subsistence farming). An increase in the workforce absorbed by the informal sector will not lead to GDP growth.

Finally, it is important to emphasise that the findings of this research are highly consistent with the empirical work of Lorde (2011), whose study of Mexico between 1960 and 2003 analysed the effect of the independent variables of exports, imports, labour and capital on long-term growth, and encourages further research to be carried out in other countries and different contexts.

References

- Akaike, H. (1970). Statistical predictor identification. *Annals of the Institute of Statistical Mathematics*, 22, 203-217. <https://doi.org/10.1007/BF02506337>
- Akaike, H. (1974). A New Look at the Statistical Model Identification. *IEEE Transactions on Automatic Control*, AC-19, 716-723. <https://doi.org/10.1109/TAC.1974.1100705>
- Al-Yousif, Y. (1997). Exports and economic growth: some empirical evidence from the Arab Gulf countries. *Applied Economics*, 29, 693-697. <https://www.tandfonline.com/doi/abs/10.1080/000368497326624>
- Abual-Foul, B. (2004). Testing the export-led growth hypothesis: evidence from Jordan. *Applied Economics Letters*, 11(6), 393-396. <https://doi.org/10.1080/1350485042000228268>
- Awokuse, T. (2008). Trade openness and economic growth: is growth export-led or import-led? *Applied Economics*, 40, 161-173. <https://www.tandfonline.com/doi/abs/10.1080/00036840600749490>
- Balassa, B. (1978). Exports and economic growth: Further evidence. *Journal of Development Economics*, Vol. 5: 181-189. [https://doi.org/10.1016/0304-3878\(78\)90006-8](https://doi.org/10.1016/0304-3878(78)90006-8)
- Balassa, B. (1985). Exports policy choices and economic growth in developing countries after the 1973 oil shocks. *Journal of Development Economics*, Vol. 18: 23-35. [https://doi.org/10.1016/0304-3878\(85\)90004-5](https://doi.org/10.1016/0304-3878(85)90004-5)
- Bahmani-Oskoei, M. and Alse, J. (1993). Export Growth and Economic Growth: An Application of Cointegration and Error-Correction Modelling. *Journal of Developing Areas*, Vol. 27: 535-542. <https://www.jstor.org/stable/4192260>
- Bilas V., Bošnjak, M. and Franc, F. (2015). Examining the Export-led Growth Hypothesis: The case of Croatia. *Naše Gospodarstvo / Our Economy*, Vol. 61 No. 3. 22-31. <https://doi.org/10.1515/ngoe-2015-0010>
- Breusch, T. and Godfrey, L. (1978). Misspecification tests and their uses in econometrics. *Journal of Statistical Planning and Inference*, 49, 241-260. [https://doi.org/10.1016/0378-3758\(95\)00039-9](https://doi.org/10.1016/0378-3758(95)00039-9)
- Cuadros-Ramos A. M. (2000). Exports and economic growth: a causality analysis for Mexico. [Exportaciones y crecimiento económico: un análisis de causalidad para México]. *Estudios Económicos*, 15(1), 37-64. <https://www.jstor.org/stable/40311425>

- Dickey, D. and Fuller, W. (1979). Distribution of Estimators of Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association*, 74, 427-31. <https://doi.org/10.1080/01621459.1979.10482531>
- Dickey, D. and Fuller, W. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica*, 49(4):1057-72. <https://doi.org/10.2307/1912517>
- Din, M. (2004). Exports, Imports, and Economic Growth in South Asia: Evidence Using a Multivariate Time-series Framework, *The Pakistan Development Review* 43: 2, 105-124. <https://www.jstor.org/stable/41260615>
- Feder, G. (1983). On exports and economic growth. *Journal of Development Economics*, 12, 59-73. [https://doi.org/10.1016/0304-3878\(83\)90031-7](https://doi.org/10.1016/0304-3878(83)90031-7)
- Ghatak S., Milner, Ch. and Utkulu, U. (1997). Exports, export composition and growth: cointegration and causality evidence for Malaysia. *Applied Economics*, 1997, 29, 213-223. <https://doi.org/10.1080/000368497327272>
- Gokmenoglu, K., Sehnaz, Z., and Taspinar, N. (2015). The Export-Led Growth: A Case Study of Costa Rica. *Procedia Economics and Finance*, Vol. 25: 471-477. [https://doi.org/10.1016/S2212-5671\(15\)00759-5](https://doi.org/10.1016/S2212-5671(15)00759-5)
- Grossman, G. and Helpman, E. (1990). Comparative Advantage and Long-Run Growth. *The American Economic Review*, 80(4), 796-815. <http://www.jstor.org/stable/2006708>
- Hannan, E. and Quinn, B. (1979). The Determination of the Order of an Autoregression. *Journal of the Royal Statistical Society*. <https://doi.org/10.1111/j.2517-6161.1979.tb01072.x>
- Henriques, I., and Sadorsky, P. (1996). Export-Led Growth or Growth-Driven Exports? The Canadian Case. *The Canadian Journal of Economics*, Vol. 29, No. 3, 540-555. <https://doi.org/10.2307/136249>
- Hussain, M. (2014). Economic Growth, Exports and Imports in Pakistan: Granger Causality Analysis. *The Journal of Business in Developing Nations*, Volume 13: 31-62.
- Hye, Q., Wizarat, S., and Lau, W. (2016). The Impact of Trade Openness on Economic Growth in China: An Empirical Analysis. *Journal of Asian Finance, Economics and Business*, 3(3), 27-37. <https://doi.org/10.13106/jafeb.2016.vol3.no3.27>
- Istaitieh, R., Najem, F., and Saqfalhait, N. (2023). Exports- and Imports-Led Growth: Evidence from a Time Series Analysis, Case of Jordan. *Economies*, 11, 135. <https://doi.org/10.3390/economies11050135>
- Jarque, C. and Bera, A. (1987). A Test for Normality of Observations and Regression Residuals. *International Statistical Review*, 55, 163-172. <http://dx.doi.org/10.2307/1403192>
- Jin, J. (2002). Exports and growth: is the export-led growth hypothesis valid for provincial economies? *Applied Economics*, Vol. 34: 203-215. <https://doi.org/10.1080/00036840010025632>
- Jordaan A. and Eita J. (2007). Export and economic growth in Namibia: A granger-causality analysis. *South African Journal of Economics*, Vol 75:3. September 2007. <https://doi.org/10.1111/j.1813-6982.2007.00132.x>
- Jung, W. and Marshall, P. (1985). Exports, growth and causality in developing countries. *Journal of Development Economics*, 18, 1-12. [https://doi.org/10.1016/0304-3878\(85\)90002-1](https://doi.org/10.1016/0304-3878(85)90002-1)
- Kravis, I. (1970). Trade as a Handmaiden of Growth: Similarities Between the Nineteenth and Twentieth Centuries. *The Economic Journal*, 80: 850-872. <https://doi.org/10.2307/2229902>
- Kwiatkowski, D., Phillips, P., Schmidt, P. and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics*, 54, 159-178. [https://doi.org/10.1016/0304-4076\(92\)90104-Y](https://doi.org/10.1016/0304-4076(92)90104-Y)
- Koh S., and Mah J. (2013). The Effect of Export Composition on Economic Growth: The Case of Korea. *The Journal of Developing Areas*, Volume 47, Number 1, pp. 171-179. <https://dx.doi.org/10.1353/jda.2013.0020>.
- Krugman, P., Obstfeld, M., Melitz, M. (2023). *International Trade: Theory & Policy*, 11th ed. Pearson Education, U.S.A.
- Lorde, T. (2011). Export-led Growth: A Case Study of Mexico. *International Journal of Business, Humanities and Technology*, Vol. 1 No.1, pp. 33-44.
- Maneschiöld, P. (2008). A Note on the Export-Led Growth Hypothesis: A Time Series Approach. *Cuadernos de Economía*, Instituto de Economía, Vol. 45(132), 293-302. <http://dx.doi.org/10.4067/S0717-682120080002000006>
- McCarville, M., and Nnadozie, E. (1995). Causality tests of export-led growth: The case of Mexico. *Atlantic Economic Journal*, 23, 140-145. <https://doi.org/10.1007/BF02300439>
- Ngoc, P., Anh, N. and Nga, P. (2003). Exports and Long-Run Growth in Vietnam, 1975-2001. *ASEAN Economic Bulletin*, Vol. 20, No. 3, pp. 211-232. <https://muse.jhu.edu/article/387668>
- Panas, E., and Vamvoukas, G. (2002). Further evidence on the Export-Led Growth Hypothesis. *Applied Economics Letters*, Vol. 9(11): 731-735. <https://doi.org/10.1080/13504850210126840>

- Pesaran, M., Shin, Y., and Smith, R. (2001).** Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16(3), 289–326. <http://www.jstor.org/stable/2678547>
- Phillips, P. and Perron, P. (1988).** Testing for a unit root in time series regression. *Biometrika*. <https://doi.org/10.1093/biomet/75.2.335>
- Ram, R. (1985).** Exports and Economic Growth: Some Additional Evidence. *Economic Development and Cultural Change*, Vol. 33: 415-425. <https://doi.org/10.1086/451468>
- Ram, R. (1987).** Exports and Economic Growth in Developing Countries: Evidence from Time-Series and Cross-Section Data. *Economic Development and Cultural Change*, Vol. 36: 51-72. <https://doi.org/10.1086/451636>
- Ricardo, D. (1819).** *On the Principles of Political Economy and Taxation*. Georgetown, D.C., J. Milligan; Washington city, J. Gideon, junior, print. <https://www.loc.gov/item/05020722/>.
- Ribeiro-Ramos, F. (2001).** Exports, imports, and economic growth in Portugal: evidence from causality and cointegration analysis. *Economic Modelling*, 18 613-623. [https://doi.org/10.1016/S0264-9993\(00\)00055-9](https://doi.org/10.1016/S0264-9993(00)00055-9)
- Richards, D.G. (2001).** Exports as a Determinant of Long-Run Growth in Paraguay: 1966-1996. *Journal of Development Studies*, Vol. 34:128-146. <https://doi.org/10.1080/00220380412331322211>
- Riezman, R., Whiteman, C. and Summers, P. (1996).** The engine of growth or its handmaiden? *Empirical Economics*, 21, 77–110. <https://doi.org/10.1007/BF01205495>
- Rodríguez-Benavides, D. and Venegas-Martínez, F. (2011).** The impact of exports on Mexico's economic growth: A cointegration analysis, 1929–2009 [Efectos de las exportaciones en el crecimiento económico de México: Un análisis de cointegración, 1929-2009]. *EconoQuantum*. 7(2), 55-71. http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S1870-66222011000100004&lng=es&tlng=
- Salazar-Núñez, H., Lozano-Díez, J. and Venegas-Martínez, F. (2020).** Why does Mexico need to focus its economic growth on exports under the USMCA? Empirical evidence, 1993–2019. [¿Por qué México tiene que orientar su crecimiento económico hacia a las exportaciones en el T-MEC? evidencia empírica 1993-2019.] *Panorama Económico*, Vol. XVI, Núm. 31, julio-diciembre, 2020, pp. 139-156. <https://doi.org/10.29201/pe-ipn.v16i31.266>
- Schwarz, G. (1978).** Estimating the Dimension of a Model. *The Annals of Statistics*, 6(2), 461–464. <http://www.jstor.org/stable/2958889>
- Shan, J. and Tian, G. (1998).** Causality Between Exports and Economic Growth: The Empirical Evidence from Shanghai. *Australian Economic Papers*, 37(2): 195-202. <https://doi.org/10.1111/1467-8454.00015>
- Shahbaz, M., Azim, P., and Ahmad, K., (2011).** Exports-led Growth Hypothesis in Pakistan: Further Evidence. *Asian Economic and Financial Review*, 1(3), 182–197. Retrieved from <https://archive.aessweb.com/index.php/5002/article/view/724>
- Sharma, A. and T. Panagiotidis (2005).** An Analysis of Exports and Growth in India: Cointegration and Causality Evidence (1971-2001). *Review of Development Economics*, Vol. 9: 232-248. <https://doi.org/10.1111/j.1467-9361.2005.00273.x>
- Sheehey, E. (1990).** Exports and growth: a flawed framework. *The Journal of Development Studies*, Vol. 27: 111-116. <https://doi.org/10.1080/00220389008422186>
- Serletis, A. (1992).** Export growth and Canadian Economic Development. *Journal of Economic Development*, Vol. 38: 133-145. [https://doi.org/10.1016/0304-3878\(92\)90022-2](https://doi.org/10.1016/0304-3878(92)90022-2)
- Smith, A. (1977).** *An Inquiry into The Nature and Causes of the Wealth of Nations*. The University of Chicago Press.
- Thornton, J. (1996).** Cointegration, causality and export-led growth in Mexico, 1895–1992 *Economics Letters*, Volume 50, Issue 3, Pages 413-416. [https://doi.org/10.1016/0165-1765\(95\)00780-6](https://doi.org/10.1016/0165-1765(95)00780-6)
- Venkatraja, B. (2015).** Testing the Export-Led Growth Hypothesis for India: An Econometric Analysis. *International Affairs and Global Strategy*, Vol.37, 74-83
- Wamalwa P., and Were M. (2021).** Is it Export- or Import-Led Growth? The Case of Kenya, *Journal of African Trade*, Vol. 8(1), pp. 33–50. <https://doi.org/10.2991/jat.k.210818.001>