The Impact of Logistics Performance on the Manufacturing Sector in Algeria: An Econometric Study Using the OLS Method for the Period 2007-2023

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Abstract:

The study aimed to measure the performance of logistics services on the industrial manufacturing sector in Algeria during the period 2007-2023, relying on basic independent variables represented by the port infrastructure quality index and the container traffic index in the port, in addition to independent variables controlled by the volume of incoming foreign direct investment, the freedom of trade index, and the per capita share of the gross domestic product. As for the industrial manufacturing sector expressed by the index of the percentage of manufacturing industries from the gross domestic product as a dependent variable in the study, the study used multiple regression using the ordinary least squares method, and with the help of the EVIEWS12 program. The study found a significant positive relationship between the container traffic index in the port and the manufacturing industries, and a significant and inverse relationship between the container traffic index in the port and the per capita share of the gross domestic product with the industrial manufacturing sector, while the study found that there is no significant relationship between freedom of trade and foreign direct investment with the industrial manufacturing sector in Algeria.

Keywords: Logistics services, industrial manufacturing sector, ordinary least squares method, Algeria**.**

INTRODUCTION

In light of the rapid economic transformations and continuous technological developments, logistics services have become vital to the success of the industrial sector in countries and companies, and the manufacturing industry is among the main sectors that greatly benefit from logistics services to improve its efficiency and enhance its competitive capabilities in the market.

Understanding how these logistics services affect the manufacturing industry is a topic of great importance, as logistics services play a fundamental role in improving production processes, reducing costs and improving product quality. In light of the fierce competition witnessed by global markets, understanding how to improve logistics services and integrate them with manufacturing industry operations is crucial to survival and prosperity in the market.

The manufacturing industry has also witnessed a radical transformation recently, as it faces new challenges such as globalization, market fluctuations, technological changes and customer demand. In this context, investing in improving logistics services and effectively integrating them with manufacturing industry operations is a necessary step to enhance efficiency, reduce costs and better meet customer requirements.

1- Study Problem:

Based on the above, the main problem that will be addressed in this research can be formulated as follows:

Is there an impact of logistics services performance on the industrial manufacturing sector in Algeria during the period 2007-2023?

2-Sub-questions:

Several sub-questions fall under this problem, which we summarize as follows:

 -Is there a statistically significant relationship between the container traffic index and the industrial manufacturing sector in Algeria during the period 2007-2023?

 -Is there a statistically significant relationship between the port infrastructure quality index and the industrial

manufacturing sector in Algeria during the period 2007-2023?

What are the other variables that have an impact on the industrial manufacturing sector in Algeria during the period 2007-2023?

3- Study hypotheses:

In order to facilitate the answer to the raised problem and sub-questions, we will put forward some hypotheses that form the starting point of our study and can be summarized as follows:

 -There is a direct and significant effect of container movement in the port on the industrial manufacturing sector in Algeria during the period 2007-2023.

 -There is a direct and significant effect of the infrastructure quality index on the industrial manufacturing sector in Algeria during the period 2007-2023.

 -There is a positive and significant effect between each of the freedom of trade, foreign direct investment and the per capita share of the gross domestic product on the industrial manufacturing sector in Algeria during the period 2007-2023.

LITERATURE REVIEW

Logistics plays a pivotal role in supporting manufacturing industries, especially in developing countries such as Algeria. This study focuses on analyzing the impact of port infrastructure quality, container traffic, foreign direct investment, trade freedom and GDP per capita on manufacturing value added in Algeria during the period 2007-2023

1- Review of international literature:

Previous international literature is an important source for understanding the joint effects between logistics and the manufacturing sector in different contexts:

 *Celina Ududechinyere et al. 2018): It examined the impact of manufacturing industries on economic growth in Nigeria using an autoregressive distributed time period model. The study recommended the need to improve the economic and social infrastructure to support manufacturing industries. This recommendation is similar to the current focus on the quality of port infrastructure as a critical element in the performance of manufacturing industries in Algeria.

 *Woschank and Dallasega (2021) study: which investigated the impact of implementing "Logistics 4.0" technologies on the logistics performance of manufacturing companies in Central Europe, and showed that the use of technology enhances the efficiency of operations. This is related to the variable of container movement in the port, which can contribute to accelerating production and supply processes in manufacturing industries.

 *Muhammad Bello et al. (2022) study: focused on the impact of logistics infrastructure on the manufacturing sector in Africa, and demonstrated that improving this infrastructure leads to improving manufacturing performance. This is consistent with the objectives of this study in Algeria, where improving port infrastructure is a key factor in enhancing the added value of manufacturing industries. Both studies indicate that developing logistics infrastructure is an effective tool for upgrading manufacturing in developing countries.

 *Yan B et al. (2022) study: addressed the interaction between the logistics industry and manufacturing industries in China, and concluded that logistics development directly affects improving industrial performance. However, it stressed the need to manage logistics investments carefully to avoid wasting resources, which is a fundamental point for studying the impact of the size of foreign direct investment in Algeria. This study shows that increasing logistics investments must be in line with thoughtful planning to avoid over-investment that may lead to wasting resources.

2.Review of regional and local literature:

At the regional level, there are studies that examine the relationship between logistics and manufacturing in similar contexts:

 *Walaa Al-Hakami's study 2022): which examined the role of logistics in supporting local non-oil industries within Saudi Vision 2030, and emphasized the importance of developing logistics services to improve supply chains and increase industrial performance, which reinforces the need to improve container traffic in the port in Algeria.

 *Study (Green et al. 2008): which presented a model for logistics performance and its impact on manufacturing performance within the supply chain, and showed that improving logistics performance can significantly enhance industrial performance.

*Study (M.Waqas, 2018): This study provides an in-depth insight into the barriers to implementing reverse logistics in the manufacturing industry in Pakistan, a concept that enhances the sustainability of supply chains. The study relies on Delphi methodology and structural equation modeling to identify key barriers, such as lack of initial capital and shortage of skilled professionals. These barriers are particularly relevant for the manufacturing industries in Algeria, as the country faces similar challenges in attracting foreign direct investment and enhancing human capacity. The reverse logistics barriers identified in Pakistan may also be present in Algeria, highlighting the need to develop logistics infrastructure and professional skills to ensure the sustainability of the country's manufacturing industries. In addition,

this study reinforces the need to use more advanced technologies to develop logistics, which may be linked to improving the container throughput index at the port and enhancing the added value of manufacturing industries.

3- Research Gap:

Despite the abundance of studies on the impact of logistics on manufacturing industries, there is a clear research gap in understanding the interrelationship between the quality of port infrastructure, container traffic in the port, and foreign direct investment in Algeria, in addition to the per capita share of GDP. The current literature lacks a comprehensive study that takes into account these factors together over a long period of time (2007-2023). Previous studies have addressed these factors separately or focused on other geographical areas. In addition, we did not find sufficient studies that addressed the integrated impact of these variables in Algeria. There is also a gap in studies that analyze the impact of these variables over a long period of time (2007-2023), which gives our study an advantage related to analyzing data over an extended period of time.

4-Added value of the study:

 *Integration of variables: This study provides a comprehensive analysis of the factors affecting the manufacturing industrial sector in Algeria.

 *Long time frame: Analyzing the impact of these variables over a period extending from 2007 to 2023 provides deep insights into economic and logistics trends.

 *New vision for decision makers: The expected results of this study will provide a solid basis for developing future strategies aimed at improving infrastructure and attracting foreign investments to support manufacturing industries.

Based on a review of previous literature, international and regional studies show that logistics services are a crucial factor in supporting manufacturing industries. This study seeks to fill the research gap by analyzing the impact of the quality of port infrastructure, container traffic in the port, the volume of foreign direct investment and the per capita depletion of GDP on the added value of manufacturing industries in Algeria, which contributes to strengthening the industrial economy and achieving sustainable development.

METHODOLOGY

In this section, we will address the limits of the study in addition to defining the dependent and independent study variables and the various data sources.

1-Study limits

*Spatial limits: We chose Algeria as a spatial framework for our study.

*Time limits: The time limits were during the period 2007-2023 due to the availability of all data related to the study variables.

*Objective limits: It is represented in studying the impact of logistics performance on the manufacturing sector and focusing on the port infrastructure quality index and the container traffic index in ports as variables that express the performance of logistics services, and the percentage of manufacturing industries in the gross domestic product as a variable that expresses the dependent variable.

2- Procedural definitions of study variables and data sources

In this part of the study, we will address the definition of dependent and independent study variables and data sources.

Dependent study variable and data source

Table No. 01: Dependent Variable and Data Source

Source	Definition	The symbol	Indicator name
World Bank	The value of the gross domestic product of manufacturing industries for a specific period of time (for example, a year) divided by the gross domestic product for the same period of time and the obtained value multiplied by 100 to obtain the percentage of manufacturing industries in the gross domestic product.	*MI*	Manufacturing share of GDP

Source: Prepared by researchers based on database definitions

 *Independent variables indicating the performance of logistics services

In this memorandum, the maritime freight linkage index, the infrastructure index, and the container movement index were adopted as important indicators expressing logistics services. The following is a breakdown of the aforementioned variables.

Table No. 02: Independent study variables expressing the performance of logistics services

Source	Definition	The symbol	Indicator name
World Economic Forum	The Port Infrastructure Quality Index measures business managers' perceptions of their country's port facilities. Sampling follows a double-stratified classification based on firm size and sector of activity. Data are collected online or through personal interviews. Scores range from 1 (port infrastructure is considered very underdeveloped) to 7 (port infrastructure is considered efficient by international standards), using data for only 140 economies.	QPI	Port Infrastructure Quality Index
World Bank	Container port throughput measures the flow of containers from land to sea, and vice versa, in twenty-foot equivalent units (TEUs) – the standard container size. Data refer to sea transport and international voyages. Ship-to-ship traffic is calculated as two loadings at the intermediate port (one for discharge and one for loading the departing vessel), and includes empty units.	CPT	Port container traffic index

Source: Prepared by the researchers based on database definitions.

 *Control variables complementing the explanation of the economic phenomena under study

Table No. 03: Control variables complementing and explaining the phenomenon and data sources .

Source	Definition	The symbol	Indicator name
World Bank	GDP per capita is the total GDP divided by the mid-year population.	$GDPP$	GDP per capita
Heritage Foundation	It is an index issued annually by the World Heritage Foundation, and it is a composite index of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services. A value close to 100 means easy trade, and a value close to 0 means weak trade or the absence of freedom of trade.	TF	freedom of trade
World Bank	Foreign direct investment (FDI) is net inflows of investment to acquire a permanent management interest (10 percent or more of the voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvested earnings, and other long-term and short-term capital, as shown in the balance of payments. This series shows net flows (net new investment inflows less investment withdrawals) into the country from foreign investors. Data are expressed in current U.S. dollars.	FDI	Foreign Direct Investment

Source: Prepared by the researchers based on database definitions

3-Programs and standard model used in the study

We will discuss the programs and standard model used in the study to estimate the model and test the relationship between renewable energy and high-tech industry exports in China. We relied on the Eviews program, which specializes in statistical and standard analysis.

 *Statistical programs

This study uses the EViews program, version 12, which specializes in standard analysis and building and estimating economic models. EViews is one of the advanced and widely used programs in the field of economic research, as it was specifically designed to deal with statistical problems related to estimating regression models, making it an effective tool with accurate results for researchers in this field.

 *The nature of the multiple linear regression model

The simple model of multiple regression assumes that the dependent variable y is a linear function of the independent variables, the number of which is k (where k≥2) and we write the multiple linear regression model as follows: ((Katić et al., 2024(

$i=1\ldots n$ $y_1=\beta_1 x_{1i}+\beta_2 x_{2i}+\beta_3 x_{3i}+\ldots\ldots+\beta_k x_{ki}+\varepsilon_i$

$i=1\dots n$ $y\_1=\sum\_{(j=1)}^{k}$ 〖β_j x_ji〗

The variables x_ji are called the explanatory variables of the dependent variable y_i, and what should be noted is that y is explained by k independent variables.

The variables (whose number is k) cannot explain y completely, because we can often limit all the phenomena affecting y, and there are also some phenomena that are not To quantize, we include an error term ε_i that includes all the information not provided by the independent variables. The observations are distributed as follows:

1st observation: (y_1,x_11,x_21,…………….x_k1(

2nd observation: (y_2,x_12,x_22,…………….x_k2(

Nth observation (y_n,x_1n,x_2n,…………….x_n2(

The nth observation gives us the nth equation:

)I){█(〖(y〗_1=β_1 x_11+β_2 x_21+ ………+β_k x_k1+ε_1)@ 〖(y〗_2=β_1 x_12+β_2 x_22+ ………+β_k x_k2+ε_2)@.@ 〖(y〗_n=β_1 x_1n+β_2 x_2n+ ………+β_k x_kn+ε_n⌐ ((

This system (I) can be expressed in matrices as follows: y=xβ+ε

y=[█(y_1@y_2@.@.@y_n)],x[█(x_11 x_21 . . x_k1@x_11 x_21 . . x_k1@. .@. .@x_11 x_21 . . x_k1[(

This is the estimation method that we will adopt in our study.

RESULTS

1- Estimation, analysis and interpretation of the study results

*Model formulation

Multiple linear regression was adopted using the ordinary least squares method and explanatory variables were selected to estimate the model for the impact of logistics services on the manufacturing sector, as follows:

$MI=c+\beta\_0\ QPI+\beta\_1\ CPT+\beta\_2\ GDPP+\beta\_3\ TF+\beta\_4\ FDI+\varepsilon$

Where

(MI): The percentage of manufacturing industries in the gross domestic product.

(QPI)): Port infrastructure quality index.

(CPT): Port container traffic index

(GDPP): Per capita share of the gross domestic product

(TF): Free trade index

FDI: Foreign direct investment volume

(c): Constant term

(ε_t): Random error term assuming that it achieves the traditional statistical properties - with a mean equal to zero and a constant variance.

2-Model estimation and necessary tests

*Model estimation

The following table shows the estimation of the model using the ordinary least squares (OLS) method, as shown:

Table No. 04: Model estimation

Dependent Variable: MI
Method: Least Squares
Date: 04/13/24   Time: 17:37
Sample (adjusted): 2007 2023
Included observations: 17 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPT	1.46E-06	5.12E-07	2.850957	0.0158
FDI	5.51E-10	3.93E-10	1.401745	0.1886
GDPP	-0.001631	0.000450	-3.621936	0.0040
QPI	-1.788072	0.834338	-2.143102	0.0553
TF	0.076420	0.067637	1.129860	0.2826
C	11.32002	5.425768	2.086345	0.0610

R-squared	0.609300	Mean dependent var		5.927059
Adjusted R-squared	0.431708	S.D. dependent var		1.158619
S.E. of regression	0.873426	Akaike info criterion		2.837778
Sum squared resid	8.391602	Schwarz criterion		3.131853
Log likelihood	-18.12111	Hannan-Quinn criter.		2.867009
F-statistic	3.430912	Durbin-Watson stat		1.513201
Prob(F-statistic)	0.041134			

Source: EViews12 program outputs

After estimating the model using the ordinary least squares method, we find:

$MI=11.32-(1.46E-6)QPT-0.0016GDPP+(1.46E-06)CPT+0.076TF+(5.51E-10)FDI$

(0.18)(0.28)(0.015)(0.004)(0.055)(0.061)

$n=17 R^2=0.43 F=3.43 DW=1.51$

*Testing the statistical significance of the parameters:

From the estimation results, we find that the calculated statistic for each of the constant coefficient and the quality of the port infrastructure have statistical significance, respectively, 0.061 and 0.055, and therefore they are not significant at 5%, but they are significant at 10% because the level of The significance is less than 10%, so we reject H_0 and accept H_1, meaning that the estimated parameter is significantly different from zero, i.e. it has statistical significance. As for the container movement in the port, we find that it is significant at 5% because the significance level is 0.015, which is less than 0.05, so we reject H_0 and accept H_1, meaning that the estimated parameter is significantly different from zero, i.e. it has statistical significance.

As for both freedom of trade and foreign direct investment, they have statistical significance, respectively, 0.28 and 0.18, which are greater than the significance level of 5%, so we accept H_0 and reject H_1, meaning that the two estimated parameters β_0, β_1 are significantly equal to zero, i.e. they have no statistical significance.

*Testing the overall significance of the model:

Since the value of Fisher's significance level F is equal to 0.041, we reject H_0 and accept H_1, and thus the model has statistical significance and has the ability to explain, and it is statistically acceptable at the level of 5%.

*Coefficient of determination: (testing the strength or quality of the model(

We note in Table No. (02-10) that the coefficient of determination of the model is equal to 0.609, and this indicates that there is an acceptable quality in the reconciliation and association between the explanatory variables and the dependent variable, as we find that the explanatory ability of the model is acceptable, as all the determinants explain the percentage of manufacturing industries by 60.9%, and the rest is due to other variables not included in the model.

*Conditions of the Ordinary Least Squares Method

After estimating the regression function using the Ordinary Least Squares method, we will conduct the necessary tests to ensure its validity through several conditions, which are as follows: (Ezell & Land, 2005(

Independence test between errors (non-autocorrelation test between errors(

We will rely on the Breusch-Godfrey test

Table No. 05: Results of the Godfrey-Breusch test of the first degree

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.330318	Prob. F(1,10)	0.5782
Obs*R-squared	0.543584	Prob. Chi-Square(1)	0.4610

Source: EViews12 program outputs

From the table above, we notice that Fisher's critical probability is equal to 0.57, so we accept the hypothesis at a significance level of 5%, i.e. there is no autocorrelation between the first-order errors. Therefore, we will conduct the second-order test as shown in the following table:

Table No. 06: Results of the Godfrey-Breusch test of the second order

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.701667	Prob. F(2,9)	0.2361
Obs*R-squared	4.664607	Prob. Chi-Square(2)	0.0971

Source: EViews12 program outputs

From the table above, we notice that Fisher's critical probability is equal to 0.23, so we accept the hypothesis at a significance level of 5%, i.e. there is no autocorrelation between second-degree errors.

Test of homogeneity of variance of errors:

We will rely on White's test as shown in the table below

Table No. 07: White's test results

| Heteroskedasticity Test: White			
Null hypothesis: Homoskedasticity			
F-statistic	0.634217	Prob. F(5,11)	0.6783
Obs*R-squared	3.804114	Prob. Chi-Square(5)	0.5779
Scaled explained SS	1.151528	Prob. Chi-Square(5)	0.9494

Source: Source: EViews12 program outputs

From the table above, we notice that the probability of the Fisher test and the Lagrange test are 0.67 and 0.57, respectively, which are greater than the significance level of 0.05, which requires accepting the null hypothesis and rejecting the alternative hypothesis, and thus the variance of the errors is homogeneous.

Normal distribution test of residuals:

The test is shown in the following figure:

Figure No. 08: Normal distribution coefficients of residuals.
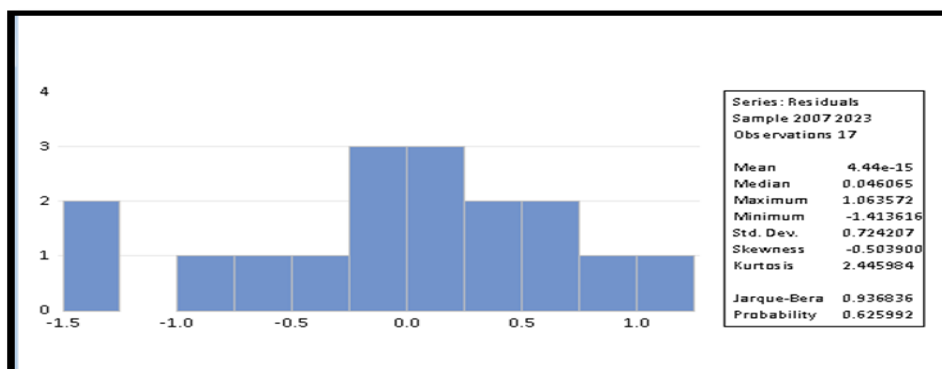
Source: EViews12 program outputs

Since the probability value (p-value) of the Jarque-Bera statistic, which is equal to 0.62, is greater than the significance level of 0.05, we cannot reject the hypothesis H0, and therefore we accept the hypothesis of the normal distribution of the residuals series at the significance level of 0.05.

Testing the existence of multicollinearity between the independent variables:

According to the results shown in the table below, we find that all values of the variance inflation factor (VIF) are less than 5, and thus we can confirm that there is no problem of multicollinearity between the independent variables that enter into the formation of the estimated model

Table No. 09: Testing the existence of multicollinearity between the independent variables

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	29.43895	656.0230	NA
CPT	2.62E-13	12.57098	1.776752
FDI	1.55E-19	9.578547	2.720252
GDPP	2.03E-07	90.91853	2.144457
QPI	0.696120	170.0103	2.131890
TF	0.004575	431.4102	2.561227

Source: EViews12 program outputs

Accordingly, after conducting all tests to ensure the validity of the application of the ordinary least squares method. Accordingly, the regression results can be relied upon to interpret the results.

Conclusion

In this study, we tried to focus on the impact of logistics services on the industrial manufacturing sector in Algeria during the period 2007-2023. We reached the following:

Hypothesis test results:

-There is a direct and significant impact of container traffic in the port on manufacturing industries in Algeria during the period 2007-2023. Through the estimation results, we were able to prove the validity of the first hypothesis. This indicates that the increase in container traffic in ports is positively related to the growth of manufacturing industries in Algeria.

This is logical, as the increase in container traffic may reflect an increase in the flow of goods and raw materials, which supports industrial activity by facilitating the access of raw materials and intermediate products to factories as well as the export of finished products. Therefore, this effect is positive and strengthens the validity of the first hypothesis.

-There is a direct and significant effect of the infrastructure quality index on manufacturing industries in Algeria during the period 2007-2023. Through the estimation results, we concluded that there is a significant and inverse relationship between the infrastructure quality index and manufacturing industries in Algeria during the study period, and therefore the second hypothesis is invalid. This means that despite the improvement in the quality of infrastructure, the impact on manufacturing industries was negative during the period studied, and this is due to several possible reasons, including that investment in improving infrastructure is insufficient or not effectively directed towards supporting manufacturing industries, and that the manufacturing industrial sector in Algeria suffers from other challenges such as lack of funding, technology or trained labor, which reduces its benefit from infrastructure improvements. -There is a positive and significant impact between each of trade freedom, foreign direct investment, and per capita GDP on manufacturing industries in Algeria during the period 2007-2023. Through regression analysis, we concluded that there is an insignificant relationship between each of foreign direct investment and trade freedom with manufacturing industries in Algeria, while there is a significant and negative relationship with per capita GDP. Accordingly, the third hypothesis was proven invalid. The explanation for the lack of impact of foreign direct investment on manufacturing industries is due to the weak investment environment in Algeria due to bureaucracy, regulatory instability, and lack of incentives, which makes foreign investors avoid manufacturing industries and prefer other sectors or alternative countries. In addition, foreign investments in Algeria have often focused on sectors such as oil and gas, while neglecting the manufacturing sector, which explains its weak impact on manufacturing industries. As for the lack of a relationship with trade freedom despite the existence of trade liberalization policies, they are not effective enough to support manufacturing industries, due to the continuation of trade restrictions or complications in customs procedures. In addition, trade liberalization has led to increased competition from imported goods, which has weakened the local manufacturing sector instead of strengthening it. The inverse and significant relationship between GDP per capita and manufacturing industries in Algeria is due to the heavy reliance on the oil and gas sector, which raises per capita income without positively reflecting on the growth of manufacturing industries, in addition to the weakness of economic diversification and the low demand for local manufacturing products, which also contribute to this decline.

Recommendations:

Based on the research findings, the following recommendations can be made to support the manufacturing sector in Algeria:

-Improving the quality of infrastructure and better directing investment

-Enhancing the investment climate and attracting foreign direct investment

-Reforming trade policies and strengthening protection for manufacturing industries

-Diversifying the economy to reduce dependence on the oil and gas sector

-Building workforce capacities and promoting innovation

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