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Role of Logistics and Transport Sector in Globalization: Evidence from Developed and Developing Economies

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Abstract

This study identifies the influence of the transportation sector in driving the process of globalization across the globe. Various studies have theoretically described this factor but literature has yet to come up with some empirical findings to recognize its role as a cause of globalization. Hence, the present study has proposed a systematic theoretical framework by taking into account three modes of transportation including air, rail, and marine to establish their relationship to globalization over the period of 1995 to 2020. Cointegration results validate the long-run association between globalization and the modes of transportation. Further, Generalized Method of Moments (GMM) estimates are applied by dividing the data into three regions. The data from 109 developed and developing countries shows that all three modes of transportation are significant in shaping the process of globalization worldwide. In the case of 77 developing countries, rail and marine transport are significant while in 32 developed countries only marine transport appeared to be a significant contributor to formulating the trend of globalization. It is important to note that the role of marine transport is more influential in determining the intensity, expansion, and improvement of global networks.

Index Terms: *Air Transport, Cointegration, Globalization, Marine Transport, Rail Transport.*

I. INTRODUCTION

The transportation sector and logistics management play a critical role in the global economy. It is one of the important components among others that have shaped the new world of the global economy. More specifically, transportation has been considered one of the four foundations of globalization along with trade openness, international standardization, and communications [1]. However, the role of the transportation sector remained unnoticed or least visible in shaping the process of globalization. Transnational transportation structures are increasing the probability of linking, unlike import and export across the globe. Technological advancement has allowed transporting a greater amount of freight and people more efficiently. Since, containers, ships, and cargo have drastically increased the efficacy of the global movement of goods and taken the scale of trade to another mega level. Hence, this sector can be referred to as an important means without which globalization could not have occurred.

The interconnection and integration of the world economy are complemented by a wide array of movements of passengers and freight across different regions of the globe. Standardized goods and services in every part of the globe are highly dependent on logistic management. The availability, affordability, and significant diversity of commodities in the global economy are influenced by technology and the capacity of transport mechanisms. It is important to highlight that the availability of a variety of products involves a rather staggering chain of movements. For instance, a commodity may involve multiple stages with different modes of transportation, such as road, railway, airways, and sea-ways supported by trucks, cargo, and containers.

International trade in the contemporary global world is supported by different modes of transportation. It can be considered a prerequisite of globalization as a higher degree of connectivity across the globe has become possible due to well-organized logistic management. International transportation predates globalization but in the modern period their capacities, volume, speed, and efficiency have increased. The very first step for interconnection and supply chain critically depends on the geographical location of production facilities and stocking and sourcing points. In this regard, the strategic decisions for the choice of transportation are more important [2]. Logistic management is fundamental in integrating the transport of freight units by different interconnected transport modes. The availability of organized transportation systems stimulates rapid development by permitting international trade. The transport sector significantly supports international economic relationships and appears as a principal part of forming a global network.

These extended networks allow the interchange of capital and other goods among different countries and regions using several transportation modes. However, the transportation networks are not uniform across the globe. The better infrastructure of the developed and European countries has improved the efficiency and capacity of this sector while developing countries are still far lagging behind to reach up to the level. The transportation networks in various parts of the globe are differently affecting the process of globalization. For instance, countries with limited and restricted transportation networks couldn't facilitate the current wave of globalization, therefore, are unable to cope up with the challenges of globalization. It is important to understand how the extended transportation networks are contributing to designing the global economic, political, and social linkages.

The objective of the present study is to identify the transport sector as an important component of globalization. It further ascertains the impact by including the three major modes of transportation i.e., road, air, and sea-ways. Existing literature recognizes transport as a driving factor of globalization yet the empirical evidence is missing [3-5]. Therefore, the current study fills this gap and provides an analysis of the case of developed and developing countries. The analysis is helpful in understanding the essential views related to transportation under globalization.

The current study contributes to the existing literature in the following ways:

- First, it focuses on the importance of the transportation sector as an important driver of globalization. The product range from every part of the world is fundamentally dependent on strategic logistic connections via multiple modes of transportation.
- Second, the literature describes that the lower transportation costs have expedited the process of globalization but the empirical impact is not modeled yet. Hence, a framework is suggested in this study to model the relationship between globalization and modes of transportation.
- Third, the empirical results are obtained not only for the full panel of 109 developed and developing economies but it is also obtained separately for developed and developing countries covering the period of 1995 to 2020. The analysis is important to trace the most influential source of globalization related to transportation in these economies. It will help to supervise the process of globalization in domestic economies.

The remainder of this paper is organized as follows; Section II presents the historical respect for the emergence of global transportation networks. The analytical framework is proposed in Section III, and estimate-able equations are also derived in this section. Results and discussion are elaborated on in Section IV. Finally, the last section i.e., Section V, concludes the study.

II. LITERATURE REVIEW ON THE EMERGENCE OF TRANSPORTATION NETWORKS

There are various driving factors of the global economy and transnational transportation structure is among one of them [3-6]. Theoretically, the bulk of the literature is revealing the role of lower trade barriers, lower cost of information, communication, and transportation advancement as a signification contributor to the process of globalization. However, limited literature has focused on the due importance of the role of the transportation sector. Furthermore, limited studies are available that have empirically investigated the causes of globalization. In this section, the historical emergence of international transport structure is presented to understand its importance as a factor of globalization. This sector is playing a critically essential role in forming a flat world with a variety of linkages through various modes of transportation.

The first international link of the global economy is the 'Silk Road' which streamed from Asia to the Middle East and Europe. It supported international trade with its limited capacity. Therefore, it is the beginning of the rudimentary structure of international trade. The route was active between the 2nd century B.C. and the mid of 15th century. However, the downfall of the Silk Road is attached to the emergence of efficient maritime transportation technology. The transportation system of the Roman Empire was based on road (short distance) and maritime shipping (long distance) that remained effective from the 3rd century B.C. to the 2nd century A.D. The Mediterranean transportation structure played a fundamental role in the support of international trade among major cities of the empire including Rome, Alexandria, Constantinople, Cartage, etc. These cities were mainly linked by road networks that allowed international trade. However, this structure became fragmented with the collapse of the Empire.

The global economy is much supported by maritime transportation structures. Primarily, China established the 'Grand Canal' through various artificial canals and put in place the fluvial transport network. Maritime trade routes have been extensively in operation through the 15th century and medieval times. Some of the canals are partially still in use today [7].

At the start of the 19th century, the first regular maritime routes were formed to link port cities worldwide. Technological advancement in the steam engine and accurate navigation charts allowed longer and safer trips. However, more advancements in technology reduced transportation costs by the end of the 19th century that has significantly increased the global circulation of goods. The capacity and speed of maritime transportation were increased by the end of the 19th century due to further enhancements in engine and propulsion technology. Moreover, energy consumption was reduced because of the shift from coal to oil as a fuel. It substantially affected the operational costs and extended its range. Another important development was the construction of shortcuts, like canals such as the Suez Canal (1869), and the Panama Canal (1914). The Suez Canal increased the accessibility of Asia and Australia, whereas the Panama Canal decreased the travel time between the Atlantic to the Pacific.

Air transport has also performed a major role in the development of the integrated economy. In 1919 the first commercial air transport service was introduced between England and France with the limitations of capacity and range. In the 1920s and 1930s, there was a growth of regional and national air transport services in Europe and the United States but after World War II the range, capacity, and speed of aircraft significantly increased. In the early 1970s, the availability of the Boeing 747 made it a global industry.

International freight moves over various modes of transportation due to geographical scale. Therefore, the role of transportation and logistics is important to facilitate supply networks. In this regard, there are two important modes of transportation that have supported international trade and globalization; maritime and air transportation. However, railways and road networks carry a negligible share of international transportation despite their flexibility and convenience. The prominence of sea transportation networks in trade is exceptional as it handles around 90% of global trade while air transport accounts for around 40% of the value of international trade [4].

Historical evidence and modern literature show that the transportation sector has a significant role in shaping the current form of globalization. However, more attention is required for systematic empirical results to understand the contribution of each mode of transportation to the global economy and international trade. Therefore, this study provides empirical evidence for different countries across the globe. It will further help to expedite the process of globalization.

III. METHODOLOGY

A. Analytical Framework and Model

The relationship between globalization and transportation is hypothesized as follows:

H_o = There is no significant impact of the transportation sector on globalization.

In order to determine the impact of modes of transportation on globalization, a Cobb-Douglas type dynamic function is specified:

$$Glob_t = CGlob_{t-1}^{\alpha_1} Y_t^{\alpha_2} TR_t^{\alpha_3} \quad (1)$$

Where:

$Glob_t, Y_t, and\ TR_t,$ represent globalization, output, and transportation respectively.

A constant, 'C' captures on average the causes of globalization other than the transport sector and output.

In eq. (1), lag of globalization is also included as the existing pace of globalization is affected by the performance of the global economy in the previous period. Moreover, it provides robust coefficients of the effects of independent variables. It also decreases the chances of autocorrelation due to model misspecification. Ignoring the lagged dependent variable creates the problem of omitted variable bias which may lead to unreliable results. Therefore, it is appropriate to include this variable in the specification. Output is also taken in the specification because it is an important variable of any economy to set the pattern for international trade. Transportation is the main variable of interest which is modeled as a cause of globalization.

It is already mentioned that there are different modes of transportation; hence, eq. (2) specifies the three major modes of transportation:

$$TR_t = AT_t^{b_1} RT_t^{b_2} MT_t^{b_3} \quad (2)$$

Where:

$AT_t, RT_t, and\ MT_t$ represent air transport, railway transport, and marine transport respectively.

Substituting eq. (2) in eq. (1) yields:

$$Glob_t = CGlob_{t-1}^{\alpha_1} Y_t^{\alpha_2} [AT_t^{b_1} RT_t^{b_2} MT_t^{b_3}\ ]^{\alpha_3} \quad (3)$$

Solving eq. (3) and assuming C=1 yields:

$$Glob_t = Glob_{t-1}^{\alpha_1} Y_t^{\alpha_2} AT_t^{\alpha_3 b_1} RT_t^{\alpha_3 b_2} MT_t^{\alpha_3 b_3} \quad (4)$$

Taking the log of eq. (4) yields:

$$logGlob_t = \alpha_1 logGlob_{t-1} + \alpha_2 logY_t + \alpha_3 b_1 logAT_t + \alpha_3 b_2 logRT_t + \alpha_3 b_3 logMT_t \quad (5)$$

Or in more compact form:

$$logGlob_t = \alpha_1 logGlob_{t-1} + \alpha_2 logY_t + \beta_3 logAT_t + \beta_4 logRT_t + \beta_5 logMT_t \quad (6)$$

Where:

The composite parameters β_3 to β_5 are described as,

$\beta_3 = \alpha_3 b_1 \qquad \beta_4 = \alpha_3 b_2, \qquad \beta_5 = \alpha_3 b_3,$

For panel data, specification is given as follows:

$$logGlob_{it} = \alpha_1 logGlob_{it-1} + \alpha_2 logY_{it} + \beta_3 logAT_{it} + \beta_4 logRT_{it} + \beta_5 logMT_{it} \quad (7)$$

Eq. (7) is a dynamic panel version that links globalization to modes of transportation.

B. Data and Variables

The dataset of 109 developed and developing countries is analyzed from 1995 to 2020.

a) Globalization:

The globalization index measures the extent of interconnectedness between different areas of the globe. This index is derived by using the three major aspects of globalization, including economic, political, and social globalization. These three dimensions are measured with the help of a total of 23 indicators/variables. Hence, it is a broad index, and the data source of this index is the ETH Zurich database.

b) Air Transport Index:

Air transport reflects international integration via global air networks. These networks are important in controlling the

domestic and worldwide movement of passengers and goods. Hence, these structures are supposed to contribute to the creation of the global system. The air transport index is generated with the help of three variables. It includes air freight, passengers carried, and registered carrier departures worldwide. Each variable is adjusted for country size and followed the standard procedure of normalization to eliminate scale biasness. Finally, a composite index is generated by using the statistical procedure of Principal Component Analysis (PCA). It is a multivariate statistical procedure that assigns different weights to each variable by calculating their factor scores. In this way, it decreases the multidimensional data to lower dimensions without any loss and keeps most of the information. It is more appropriate rather than assigning equal weights as each variable is not equally important. Data are collected from the World Fact Book and the database of the World Bank.

c) Rail Transport Index:

Rail transport is considered to be a cheap mode of transportation for heavy loads through land ways. It also provides the passenger travel facility with convenience and high speed. Various other benefits include lower cost, constancy, and reliability as its routes are not affected by traffic and weather conditions [8]. Two variables are used to describe the degree of connectivity among the different domestic and neighboring regions. The selected variables are goods transported and passengers carried. The index is generated by adopting the same procedure as discussed above. Data sources are World Fact Book and the World Bank database.

d) Marine Transportation:

Marine transportation has a revolutionary impact on trade and commerce. The variable of total merchant marine (fleet) is taken which comprises five indicators. These are oil tankers, bulk carriers, general cargo, container ships, and other types of ships. This variable is also adjusted to country size. Data are taken from UNCTAD.

e) Gross Domestic Product:

It has been taken to represent output in the estimation equation. It is the aggregate gross value by all the resident producers of the country in which taxes are included on the product but not a subsidy. Real GDP is taken from the World Bank database.

C. Estimation Method

The coefficients are estimated by applying the system Generalized Method of Moments (GMM), as it is more, preferable to differentiate GMM because of several advantages. For instance, it adjusts potential endogeneity, measurement error, omitted variable bias, and unobserved country heterogeneity that may influence the efficiency of the estimator. It also takes into consideration first differencing that handles omitted variables bias, measurement error, and unobserved heterogeneity, whereas the potential endogeneity problem is removed by introducing instruments for explanatory variables. It is important to note that biased results may also be obtained in the case of weak instruments. Hence, it is necessary to test the validity of instruments because the results of GMM estimates critically depend on them. The studies proposed two tests to check the validity of instruments [9-11]. The first, Sargan/Hansen test is used to check the over-identifying restrictions. It observes the validity of instruments with the null hypothesis declaring that all instruments are exogenous. The second test checks serial correlation, particularly at the second-order AR (2). The null hypothesis of both tests should not be rejected.

IV. RESULTS AND DISCUSSION

A. Unit Root Test

There are various panel units' root tests in order to test the stationarity of the data series. Few of them are suggested in a study, stating the non-stationarity of the series in the null hypothesis [12], and [13]. The alternative hypothesis takes a homogeneous autoregressive coefficient [14], whereas [15] and Fisher-type tests have heterogeneous autoregressive coefficients. The results are presented in table I, indicating that all the variables are integrated in order one. Hence, the next step is to determine the long-run cointegration relationship among the variables.

Table I: Results of Unit Root Test

Variable	Levin, Lin & Chu t-test	Im, Pesaran, and Shin W-stat	ADF - Fisher Chi-Square Statistic	PP - Fisher Chi-Square Statistic
Globalization ($Glob_{it}$)	-13.623 (0.000)	-18.113 (0.000)	748.152 (0.000)	1323.32 (0.000)
Conclusion	Stationary at the first difference I(1)			
Output(Y_{it})	-15.873 (0.000)	-16.320 (0.000)	705.888 (0.000)	673.601 (0.000)
Conclusion	Stationary at the first difference I(1)			
Air Transport (AT_{it})	-21.983 (0.000)	-24.277 (0.000)	1008.82 (0.000)	1709.22 (0.000)
Conclusion	Stationary at level I(1)			
Railway Transport (RT_{it})	-11.664 (0.000	-22.308 (0.000)	1004.64 (0.000)	1361.78 (0.000)
Conclusion	Stationary at the first difference I(1)			
Marine Transport (MT_{it})	-11.040 (0.000)	-21.779 (0.000)	797.090 (0.000)	1368.05 (0.009)
Conclusion	Stationary at the first difference I(1)			
Note: probability values are given in brackets				

Based on the findings of table I, the panel cointegration test of researcher 'Pedroni', is applied to the selected variables [16], and [17]. The results are presented in table II. A total of seven statistics are segregated into two parts. The first part presents four statistics based on common autoregressive coefficients within dimensions while the second part displays the result of three statistics of individual autoregressive coefficients between dimensions. Seven statistics are showing inconsistent results; therefore, a decision would be taken on the basis of the majority results. Out of seven statistics, four statistics are showing the existence of long-run cointegration among the selected variables as the null hypothesis of no cointegration is rejected against the alternative of cointegration. The Kao test of cointegration is also applied [18]. The obtained result is in line with the finding of the 'Pedroni test'; hence, it is

also validating the existence of cointegration among the variables.

Table II: Results of the Cointegration Test

Pedroni Cointegration Tests				
Common AR Coefficients Within Dimension				
	Stat.	**Prob.**	**Weighted Statistic**	**Prob.**
Panel v-Stat.	0.901	0.161	0.303	0.381
Panel rho-Stat.	3.064	0.998	2.819	0.997
Panel PP-Stat.	-2.966	0.002	-4.400	0.000
Panel ADF-Stat.	-4.714	0.000	-5.879	0.000
Individual AR Coefficients Between Dimension				
	Stat		**Prob.**	
Group rho-Stat.	5.675		0.905	
Group PP-Stat.	-5.776		0.000	
Group ADF-Stat	-8.532		0.000	
Kao Cointegration Test				
	t-Statistic		Prob.	
ADF	-6.999		0.000	

The results of the GMM estimate are displayed in table III by using eq. (7).

The selected sample is divided into three cases:

- First, the results are obtained for the full panel of all the developed and developing countries based on 109 countries.
- Second, estimates are also presented separately for the panel of developing countries in which 77 economies are selected.
- Finally, 32 developed economies are taken into consideration in order to determine the role of the transport sector in globalization.

Table III: Results of GMM Estimate

	Full Panel	**Developing**	**Developed**
Variable	Coefficient	Coefficient	Coefficient
$GLOb_{it-1}$	0.905*** (0.000)	0.937*** (0.000)	0.871*** (0.000)
Y_{it}	0.011*** (0.000)	0.043 (0.152)	0.020 (0.422)
AT_{it}	0.0016*** (0.000)	0.004 (1.066)	0.002 (0.732)
RT_{it}	0.010*** (0.000)	0.081*** (0.000)	0.022 (0.195)
MT_{it}	0.018*** (0.000)	0.098*** (0.000)	0.077*** (0.003)
Diagnostic Test			
No. of Obs.	2667	1923	768
AR(1)	Z= -4.81 (0.000)	Z=-3.60 (0.000)	Z=-2.43 (0.015)
AR(2)	Z= -0.27 (0.789)	Z=-0.14 (0.889)	Z=-0.19 (0.813)
Hansen	54.49 (0.891)	43.44 (0.791)	42.33 (0.654)

Note: * Indicates the level of significance at 1%. Probability values are given in parentheses.**

The coefficient of lag of globalization ($GLOb_{it-1}$) is significant at a 1% level in all three cases, including the full sample, developing and developed countries. It indicates that the process of globalization in the preceding years is the most powerful force in promoting and facilitating the present structure of globalization. The self-motivated mechanism of globalization generates pressure on commercial, financial, social, and political structures across boarder that leads to more globalization. Hence, it can be concluded that globalization begets globalization in all economies across the globe.

The next coefficient is output; it is significant in the case of the full panel but it turned out to be insignificant in developed and developing countries. It implies that a 1% increase in output will increase globalization by 0.011% in the full sample, showing the role of global output is important in shaping globalization. Production of more commodities on a mega-scale with efficient technology has increased the volume of global output in recent years. Economies are producing in surplus and exporting the excess to the rest of the world, which consequently increases global interdependence among countries. Production chains of goods and services are critically vital in generating international integration, therefore, forming a single structure referred to as globalization. The global output remained an essential component of globalization in the first and second waves of globalization. These periods reported a significant growth in international trade that has taken the pace of globalization to another advanced level [19]. The constructive role of trading blocks in expanding the network of the supply chain through channeling surplus output among different countries is forceful in causing the wave of globalization. Higher investment and production result in higher output that has generated a coherent policy strategy to stimulate the process of globalization across the globe.

All three modes of transportation in the full panel are revealing their essential role in expediting the process of globalization across the whole globe. Air transport, railway transport, and marine transport are highly significant in the combined panel of all the economies. The magnitude of marine transport is more influential i.e., 0.02% while air transport is showing least contribution i.e., 0.002% in shaping the process of globalization. The worldwide degree of connectivity has increased due to multiple modes of transportation. Air transportation has connected the unlikely regions to the rest of the world. In recent decades, the presence of a highly advanced medium of transportation has made the isolation issue trivial. It is now the choice of economies to control the degree of connectivity in an era of hi-tech mega-scale transportation. In developing countries, rail and marine transport are significant while air transport is not a driving factor of globalization. It shows that developing countries have more linkages via rail and sea-ways with other economies. Another plausible explanation is that most of the international trade is ongoing in these economies through rail and marine transport as their cost is comparatively low. Therefore, the degree of connectivity in the developing world has increased through these modes of transportation. In this case, again the coefficient of marine transport is relatively high having a value of 0.098. In developed

economies only marine transport is appeared to be significant, while the remaining two modes of transportation are insignificant. The value of the coefficient shows that if marine transport increases by 1% then it will affect globalization by 0.08%. Developed economies are exporting their surplus in bulk through marine transport, thereby reducing the cost of transportation to a minimum. It can be concluded that marine transport is analytically important in developed economies to promote the process of globalization.

The diagnostic tests in table III show the validity of the instruments through serial correlation presented as AR (1) and AR (2). Results indicate no evidence of serial correlation in AR (2), which is more relevant. Moreover, the Hansen test shows exogeneity of instruments as we are unable to reject the null hypothesis [20].

V. CONCLUSION

The role of the transportation sector has always been critical in determining the current form of globalization. Transport infrastructure is an important and vital part of cities. Technological development has helped this sector to expand worldwide by carrying the bulk of commodities. Every individual can now enjoy varieties of products from different regions of the world. For instance, one can enjoy the tea of Kenya in Europe or any other part of the world. All this is possible due to strong networks of transportation. However, the literature has not provided any systematic framework to empirically test the role of the transport section in globalization. Therefore, this study is an attempt to propose such a framework that establishes a relationship between globalization and the modes of transportation. It is obvious that air, rail, and marine transport together provides a flexible network to link each and every part of the globe to one another. In general, marine transport is considered to be the most inexpensive way that can carry heavy bulk from one place to another place. In this study, these three modes of transportation are taken to analyze their impact in flourishing the pace of globalization.

A sample of 109 countries has been selected during the period from 1995 to 2020. Non-availability or missing data restricted the sample size. The result of 109 developed and developing countries show that all three modes of transportation drive the process of globalization across the globe. The panel of 77 developing economies reveals the importance of rail and marine transport in the emergence of the recent wave of globalization in developing countries. While 32 developed countries show only the significant role of marine transport. It appeared as a main contributor to the design trend of globalization in this region. Therefore, in general, the empirical results show that the modes of transportation have contributed to the advancement of globalization in various parts of the world. Improvement and expansion of transportation networks are critical in determining the process of globalization. Economies can strategically control the intensity of globalization through the contraction and expansion of networks that link various parts of the globe.

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Authors Contributions

Both authors equally contribute to achieve the objectives of this research study.

Conflict of Interest

The authors declare no conflict of interest and confirm that this work is original and not plagiarized from any other source, i.e., electronic or print media. The information obtained from all of the sources is properly recognized and cited below.

Data Availability Statement

The testing data is available in this paper.

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