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TRANSPORT, LOGISTICS, AND ECONOMIC GROWTH NEXUS: A CROSS-COUNTRY ANALYSIS

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Transportation and logistics play a crucial role in the overall supply chain of a country by ensuring the timely delivery of goods for production and consumption. The current study investigates the relationship between economic growth and logistics performance across countries. The study's significant contribution is using logistics performance data from a panel of 107 countries covering the period from 2007 to 2019 and applying panel data-based time-series econometric models to investigate the link between economic growth and logistics performance. The study confirms a long-term relationship between economic growth and logistics performance and shows that short-term disequilibrium is adjusted back to steady-state conditions. The findings suggest that policymakers should focus on developing all aspects of logistics performance rather than physical infrastructure.

Keywords: Transport-logistics, economic growth, cross-country analysis

1. Introduction

Transportation and logistics are crucial elements in a supply chain system, as they play a vital role in procuring and distributing goods. A well-run and integrated logistics network can guarantee the timely acquisition of raw materials for production and the timely availability of finished products for customers. Logistics and transportation are essential in determining a country's economic output or Gross Domestic Product (GDP) (Mankiw, 2015). Without raw materials, production cannot occur; without production, there can be no consumer products or services.

Economic growth is characterized by an increase in Gross Domestic Product (GDP) or per capita GDP over a prolonged period (Mankiw, 2015). As such, one would expect transportation and logistics to be related to economic growth. However, few studies have explored this connection beyond individual or single-country analyses. The limited available research that examines the relationship between economic growth and logistics is often limited to lower levels of disaggregation or is specific to a single country (Chu, 2012) or a small geographic region (Sakyi & Egyir, 2017). This study aims to address this gap in the literature by investigating the link between logistics and economic growth through a cross-country analysis of 107 countries. The study's primary contribution is using World Bank logistics performance indicators for 107 countries and applying advanced panel data-based time-series econometric tools to study the relationship between economic growth and logistics performance. It is the first study to use panel data for such a large sample of countries to examine the logistics performance and economic growth nexus. The study makes a methodological contribution and offers a new perspective on this critical yet under-researched area.

The rest of the study is organized as follows: a literature review is conducted in Section 2; the theoretical model is developed in Section 3; details about the data, its sources, and variables are presented in Section 4; findings and results are presented in Section 5, with a discussion of the results. The study is concluded in Section 6.

2. Literature Review

There is abundant scholarly literature on economic growth and its links with other sectors of the economy. However, to limit the scope of the literature review within the domain of the current study

objectives of economic growth and logistic sector performance, we have divided the current literature review into several sub-sections to discuss various themes associated with this particular subject area.

2.1. Economics of growth

As per standard macroeconomic textbooks, economic growth is modelled using the production function. Primarily, the production function consists of the labour force, stock of capital, and state of technology (Mankiw, 2015; Dornbusch, Fisher, & Startz, 2010). One such popular production function is Cobb–Douglas production function (Cobb & Douglas, 1928) used by several economic growth models, including Solow (1956). In these production functions, the labour force refers to the working force of a country. However, capital refers to plants, equipment, machinery, and other inputs used to produce goods and services (Mankiw, 2015).

It is essential to mention that rich literature is available on modelling economic growth in general. The two significant contributions to the economic growth models are neoclassical and endogenous growth theory (Dornbusch, Fisher, & Startz, 2010). Neoclassical theories emerged during the 1950s and 1960s. Robert Solow (Solow, 1956 and 1957) is the main contributor to the neoclassical growth theories. These models mainly focused on capital accumulation, its link with savings, and how it contributes to economic growth. The second growth model theories emerged during the 1980s and 1990s with significant contributions from Lucas (1988), Romer (1986), and Barro (1996). Their models included the technological progress in their production functions.

These traditional growth models are extended to include other factors in growth function to study the contribution of other factors (other than the factor of production and technology) to economic growth during the last several decades. For example, economic growth is linked with information and communication technologies (Haftu, 2019), foreign direct investment (Sakyi & Egyir, 2017), corruption (Everhart, Vazquez, & McNab, 2009), governance (Islam & McGillivray, 2020), infrastructure (Banerjee, Duflo, & Qian, 2020), and human resources (Ranis, Stewart, & Ramirez, 2000).

The contemporary focus area of economic growth is energy usage, tourism, environment, and emissions. For example, Khan *et al.* (2021) studied the trilemma of energy use, population growth, and financial development with economic growth while using data from the top ten countries from World Energy Trilemma Index. The study covered the period from 1990 to 2016. The study found significant energy and population growth effects in the long run, while financial development and energy use in the short and long run.

Similarly, economic growth and the environment are also studied in growth literature. For instance, Raihan & Tuspekova (2022a) studied the interrelationship of economic growth, renewable energy usage, and area under forest while reducing emissions and achieving environmental sustainability in Malaysia. Raihan & Tuspekova (2022b) is an extended study similar to Raihan & Tuspekova (2022a) for Brazil. In this study, they linked economic growth, energy usage (from fossil and renewable sources), and urbanization to the emissions in Brazil. Feng (2022) studied the relationship between economic growth, energy consumption, and environmental degradation in China, covering a period from 1968 to 2018 and employing the Quantile-on-Quantile regression method.

Furthermore, another interesting aspect is the link between tourism and economic growth. World Tourism Organization (UNWTO) (2020) found that tourism can play a crucial role in economic recovery, particularly in developing countries. The study found that the tourism industry has a strong multiplier effect. An increase in tourism spending leads to a ripple effect throughout the economy, creating jobs and generating income. World Travel and Tourism Council (WTTC) (2020) found that the travel and tourism sector is one of the world's largest and fastest-growing economic sectors, with the potential to create jobs and drive economic growth. The study found that the sector, directly and indirectly, supported around 319 million jobs worldwide, or 9.8% of total employment. European Travel Commission (ETC) (2019) found that the tourism sector can significantly impact economic growth in Europe. The study found that the sector directly contributed to 4.5% of Europe's GDP and indirectly contributed to 8.9% of Europe's GDP. World Bank (2018) found that tourism can be a powerful driver of economic growth and development, particularly in developing countries. The study found that tourism can create jobs, generate income, and attract foreign investment, leading to improvements in infrastructure and public services.

It is important to note that while tourism can positively impact economic growth, it can also bring negative consequences such as overcrowding, environmental degradation, and a negative impact on local communities and cultures. Therefore, the sustainable development of the tourism industry is crucial to maximizing the positive effects while minimizing the negative consequences. León-Gómez *et al.*, (2021) studied the link between sustainable tourism on economic growth based on a literature review. Based on

over 660 published research articles, the study concluded that sustainable tourism is indispensable for economic growth.

Since the current study aims to link countries' logistic performance with economic growth, we will focus on connecting physical infrastructure and logistics with economic growth. From this point onward, we will not expand the discussion on linking economic growth with other aspects of the economy.

2.2. Economic growth and physical infrastructure

Physical infrastructure (transportation, energy and information & communication) is essential for any country. This infrastructure contributes to the logistic performances of the countries as well. Several studies investigated the relationship between economic growth and physical infrastructure. For example, Wu & Pan (2021) studied the nexus between transportation infrastructure, namely road, rail, air, and water, with economic growth while controlling for oil prices. Their study covers the 1980-2019 and uses a Fourier function-based bootstrap autoregressive distributed lag model. Their study concludes that there is a cointegration between transportation infrastructure and economic growth. Sabir (2021) provides a good overview of the literature on economic growth linked with physical transportation infrastructure, particularly roads and railways.

Sharapiyeva, Antoni, & Yessenzhigitova (2019) studied the impact of the national economy on the quality of the port infrastructure and logistic efficiency using a sample of 37 landlocked countries and employing structural equation models. Similarly, (Munim & Schramm, 2018) used a sample of 91 countries to study the impact of port infrastructure quality, logistic performance, and its contribution to the economy. Using structural equation modelling, their study concluded that developing countries should focus on port infrastructure development as it enhances logistic performance, leading to increased seaborne trade and higher economic growth in these countries. Liang (2020) reported similar findings using a structural equation model to study the impact of logistic performance along with port infrastructure connectivity and trade on the economic growth of 32 countries. Yeo, Deng, & Nadiedjoa (2020) reported a positive relationship between infrastructure and logistic performance improvements in the economic growth of 62 middle-income countries (using data from 2010-2018) by employing a structural equation model.

It is also important to highlight that infrastructure may not contribute to growth in all circumstances. For instance, According to Meng, Zhu, & Han (2022), traditional infrastructure through fixed capital formation and new investment for infrastructure, especially during the time of COVID-19, boost economic activities and does not contribute to economic growth in the short run. However, this new investment can boost the economy in the long run.

Samir & Mefteh (2020) explored the impact of information and communication technologies (ICT) and transport on foreign direct investment (FDI) in countries with varying income levels from 2000-2016. The research shows that these variables affect each other in the long run, and policymakers should focus on improving transport and ICT infrastructure to attract FDI and support economic growth. Arshed *et al.* (2022) examined the impact of different modes of transportation (as part of logistics) on sector-wise growth in Pakistan. The study employed an autoregressive distributed lag model. The results suggest that development in road transport has the highest potential for growth productivity in the agriculture and services sectors, while sea transport performed best in the industrial sector.

Furthermore, African Development Bank (AfDB) (2016) found that the lack of reliable and affordable electricity is one of the major constraints to economic growth in Africa and that addressing this challenge will require a combination of investments in generation, transmission, and distribution infrastructure, as well as regulatory and policy reforms. In conclusion, there is a growing body of literature that suggests a positive relationship between economic growth and electricity infrastructure. However, the relationship is complex and multifaceted, and the success of electricity infrastructure projects is heavily influenced by factors such as government policies, institutions, and regulations. Therefore, governments and other stakeholders should prioritize the development of reliable and sustainable electricity infrastructure to support economic growth and development.

2.3. Economic growth and logistics sector

The other theme that is perhaps most relevant to the subject under study is the link between the overall logistic sector and the economic growth of a country. The logistics sector plays a crucial role in economic growth by facilitating the movement of goods and services across borders and within countries. The logistics sector is a complex system that includes transportation, warehousing, inventory, and supply chain management. In recent years, there has been an increasing focus on the relationship between economic growth and the logistics sector, with a growing body of literature exploring this topic.

In this regard, the relevant literature can be categorized based on studies undertaken at a national (Jubiz-Diaz *et al.*, 2021) or a sub-national level (Chu, 2012) or even studies covering a group of countries (Sharapiyeva *et al.*, 2019) or geographic regions (Sakyi & Egyir, 2017).

At the country level, several studies investigated the impact of logistic services on economic growth. For example, Lean, Huang, & Hong (2014) studied the link between Chinese logistics performance and their economy. The study used the data for entire of China from 1980 to 2009 period. They found that economic growth causes increased logistics, implying a rise in the demand for logistic services with economic development. Similarly, Jubiz-Diaz *et al.* (2021) investigated the role of transportation investment in export freight accessibility regional productivity. Furthermore, they also identified the most benefited regions from improving roads, rivers, and railways networks in Colombia. Han, Wang, & Li, (2019) used a panel data model for data from 1996 to 2015 to study port and logistic improvement impacts on the Beijing-Tianjin-Hebei regions of China. Nguyen, Luong, & Hoang (2021) evaluated the effect of logistic activities on Vietnam's economic development using data from 2007 to 2019. Their study concluded that most logistic determinants such as logistics infrastructure, service quality, on-time shipments, up-to-date delivery information, competitive logistics prices, and convenient customs, positively influenced the Vietnam economy. Wang, Kim, & Kim (2021) studied the causal relationship between logistic infrastructure and China's economic development using data for the period 2000-2017. The study used Vector Autoregression and Vector Error Correction models and reported a long-run equilibrium between the logistic infrastructure and economic development. Furthermore, they stated that logistic infrastructure causes economic growth. (Munim & Schramm, 2018) examine the economic contribution of seaborne trade from a port infrastructure quality and logistics performance perspective across 91 countries with seaports. The results show that investing in port infrastructure quality improvement can lead to higher seaborne trade, yielding higher economic growth, particularly in developing countries, but this association weakens as the countries become richer.

On the other hand, Chu (2012) used data from 30 provinces of China covering 1998 to 2007 to study the long-run relationship between logistic investment and economic growth. They used a panel data technique and concluded that the relationship between logistics and economic growth has been more vital for less developed interior provinces than developed coastal provinces. Some other sub-country level studies also reported similar findings. For instance, Qi *et al.*, (2020) studied the spillover effects of logistics infrastructure in Chinese regions. The study concluded that appropriate infrastructure relevant to the particular area could contribute to regional development.

Saini & Hrušecká (2021) investigated the link between the logistics performance index, ease of doing business, and economic development for a group of countries, including China, France, Germany, India, Japan, United Kingdom, and the USA, using correlation and fuzzy qualitative approach. Their study concluded a positive impact of LPI on economic growth with mixed results for ease of doing business. Li *et al.* (2018) evaluate whether logistics infrastructure has contributed to economic growth in the region as a part of "the Belt and Road Initiative." The study identifies telecommunication and airway transportation as the most influential factors for promoting economic growth and reducing inter-region economic inequalities in developing regions. The research confirms that logistics is a driving force for economic growth in China and can be a useful reference for developing countries to prioritize investment in different logistics sectors across regions. Giuffrida *et al.* (2017) reviewed 32 scientific publications on logistics in cross-border e-commerce to China, with a focus on the role of other countries in the Greater China region. The study identifies research gaps and proposes key areas for future research to encourage the development of CBEC logistics, including distribution network design and logistics outsourcing.

Khadim *et al.* (2021) examine how logistics performance affects economic growth in developing countries. Using the World Bank's Logistics Performance Index, the researchers analyze data from 50 developing economies between 2010 and 2018. They find that the efficiency of a country's logistics infrastructure plays a moderating role in the impact of labor and capital on economic growth in developing economies. Similarly, Göçer *et al.* (2022) develop a methodological framework to recommend logistics policies for improving specific countries' Logistics Performance Index (LPI) score. Their study framework consists of two main steps using both qualitative and quantitative methods. It analyzes countries' logistics strategies and their impacts on LPI scores and provides policy recommendations for improving the LPI score of specific countries under consideration. The developed framework can be used by countries to benchmark and implement relevant logistics policies, thus improving their LPI scores and worldwide trade performances. The study implemented the framework to provide strategic recommendations for Turkey. Similarly, Can *et al.* (2021) examined the relationship between the logistics sector and the economy of Turkey. Their result also results suggest a positive relationship between the logistics sector and economic growth in the long term but not in the short term.

There is literature discussing one or other types of transportation networks or transportation investment with economic growth. For example, Munim & Schramm (2018) studied the role of logistic performance and port quality on the economy using data from 91 countries with seaports. Similarly, Ali *et al.* (2023) compare Gawadar Port (Pakistan) and Chabahar Port (Iran) based on various factors, including the infrastructure and how it could be attractive for trade, using cost-benefit analysis.

In conclusion, the literature on economic growth and the logistics sector highlights a positive relationship between logistics and economic development. Logistics infrastructure, efficiency, and connectivity are essential factors in promoting economic growth and international trade. Additionally, the literature also highlights the challenges faced by the logistics sector, particularly in developing countries, and the importance of government policies and regulations, technology and digitalization.

2.4. Logistic performance, economic growth, and scholarly literature gaps

The literature survey indicates that intensive scholarly work is undertaken in economic growth, infrastructure, and, to some extent, logistic performance. However, few studies link economic growth with the logistic performance index (e.g., Saini & Hrušecká, 2021). However, that study is also limited to Pearson correlation coefficients and fuzzy qualitative analysis. Furthermore, different grouping levels of economics may not be a good idea if one cannot control for country-specific effects. Again, no earlier study has undertaken the panel data-based cross-country analysis to investigate the link between economic growth and the logistic performance of a country. The current research does address these issues and not only uses a sample of 107 countries but also the application of a panel data-based econometric model does control for country-level heterogeneity and thus combining the different sizes of economies is addressed by the superior methodology itself.

3. Theoretical Model

To meet the study objective, we may start with the famous Cobb–Douglas (Cobb & Douglas, 1928) production function as given below:

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta}, \quad (1)$$

where, Y, K, L, and A refer to the output, capital, labor, and technology, respectively, in-country i at a given time, t. Furthermore, α and β are parameters of capital and labor, respectively. The sum of these parameters is assumed to be equal to *1* (i.e., $\alpha + \beta = 1$) to ensure a constant return to scale. Equation (1) shows that the country's output comes from the labor and capital resources of a country with a given level of technology. We have augmented this production function with another essential variable, *transport, and logistics* of a country, to achieve the objectives of this study. Therefore, Equation (1) may be re-written as:

$$Y_{it} = A_{it} L_{it}^{\alpha} K_{it}^{\beta} I_{it}^{\gamma}, \quad (2)$$

where I shows the *logistic performance* of a country at a given time, and γ measures its impact size. The assumption of constant return to scale is still valid, i.e., $\alpha + \beta + \gamma = 1$. Furthermore, Equation (2) can be transformed into a linear regression model by using standard log transformation.

$$LogY_{it} = Log\ A_{it} + \alpha\ LogL_{it} + \beta Log\ K_{it} + \gamma Log\ I_{it} + \varepsilon_{it} \quad (3)$$

or

$$LogY_{it} = \theta + \alpha\ LogL_{it} + \beta Log\ K_{it} + \gamma Log\ I_{it} + \varepsilon_{it}, \quad (4)$$

where θ is equal to $Log\ A_{it}$.

Equation (5), shows the relationship among a country's output, labour force, and logistic performance at a given period with a given state of technology.

4. Data and its sources

This research studies the relationship between countries' logistics performance and economic growth. As per the developed theoretical model, two data sets are needed to perform this analysis. First, the logistic performance of different countries. Secondly, the data on macroeconomic variables, namely, output, labour force, and capital of the same countries.

World Development Indicators (WDI) is a rich data source from the World Bank (WDI, 2022). WDI contains a logistic performance index for around 170 countries. The World Bank's logistic performance index (LPI) is made of six components namely, the efficiency of customs (ranked through customs and border management clearance), quality of infrastructure (for trade and transportation), shipment arrangements (how easy its to arrange competitive shipments), quality of logistic services (such as of trucking, forwarding, and customs brokerage), tracking of consignments and the timeliness (how frequently the consignments reach destinations as per scheduled time) (WDI, 2022). These six components are combined through the standard statistical procedure to create an index called the logistic performance index (LPI). World Bank uses this index to rank around 170 countries based on their logistic performance. Till September 2022, the LPI ranking has been published for 2007, 2010, 2012, 2014, 2016, and 2018.

We obtained LPI data from the World Development Indicators 2022 (WDI, 2022) for about 170 countries. Although this data does cover 2007 to 2018, it is available only for the years 2007, 2010, 2012, 2014, 2016, and 2018. Accordingly, we only selected the countries with LPI available for maximum periods between 2007-2018 (dropping those with maximum missing values). Furthermore, since the LPI is based on six indicators (as explained already), and it may not be changed significantly in a couple of years, we filled the missing years with the previous year's data.1 For instance, LPI was available for 2010 and 2012, so we filled the year 2011 with the value of 2010, assuming that the major components of the logistic performance score or the LPI may not change significantly in this missing year. We did the same process for all missing years from 2007 to 2018. In this way, we created a balanced panel of 107 countries covering 13 years (2007-2019). The list of these 107 countries is given in Annex 1.

The data on other variables, namely, output, labour force, and capital, were available for 2007-2019 from WDI. For production, we used real Gross Domestic Product (RGDP); for labour force, we used total labour force (ll); and for capital, we used gross capital formation respectively. The selection of these variables for measuring output, labour force, and capital is a standard practice in the scholarly literature on growth economics.

5. Estimation, results, and findings

This section is divided into several sections and sub-sections to show the results and discuss them smoothly. We first obtained descriptive statistics, followed by stationarity checks of the variables, tests for cointegration, and finally short-run and long-run relationships.

5.1. Descriptive analysis

To get an overview of our data, we have obtained summary statistics of our four variables that are presented in Table 1. It is important to indicate that all variables are used in the logarithmic form as it ensures elasticities after the estimation that is easy to interpret.

The real GDP value ranges between 20.44 to 30.63, with a mean value of 25.25 and a standard deviation of 1.96. It is notable to observe that most variables had skewness of about 0 and kurtosis equal to around 3, indicating that they are almost normally distributed. The total sample size is 1391, and the data is panel data for 107 countries (complete list of countries in Annex-1).

Table 1. Descriptive statistics

Variables (log)	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
RGDP	25.25	25.07	30.63	20.44	1.96	0.00	2.67	1391
LRGFCF	23.74	23.67	29.07	17.75	2.01	-0.10	2.85	1391
LLF	15.61	15.44	20.01	11.98	1.47	0.19	3.00	1391
LLOGISTIC	1.08	1.06	1.44	0.47	0.20	0.02	2.21	1391

5.2. Stationarity analysis

To estimate the regression model to study the nexus between countries' logistics performance and economic growth, we first need to investigate the stationarity of all four variables. Afterwards, we can explore the long-run relationship (cointegration) between our two main variables, namely logistic performance (measured as Logistic Performance Index (LPI)) and economic growth (measured as real GDP).

[1] It is important to mention that WDI also uses the same methodology to fill up the missing values in their survey for logistic performance score and its country's logistic ranking. This assumption may appear unrealistic, but we performed analysis by removing the missing values countries fully, the results were not different, therefore we presented the results of the balanced panel in the study. The results of the smaller sample with a balanced panel can be provided on request.

To check the stationarity of all variables, we have to apply stationarity tests. Our data is panel data from 107 countries. Therefore, we have to use the unit root tests of Levin, Lin, & Chu (2002). The results of unit root tests are presented in Table 2. The results clearly show that the variables are non-stationary at the level. However, all four variables are stationary at first difference. It implies that all variables are integrated of order one, i.e., I~ I(1).

Table 2. Results of Unit Root Tests (Levin, Lin & Chu Tests)

	Level		*First Difference*		
Variables (log form)	**Test Statistic**	**Probability**	**Test Statistic**	**Probability**	**I~ I(d)**
RGDP	19.53	1.000	-9.283*	0.000	I~ I(1)
LRGFCF	8.135	1.000	-20.050*	0.000	I~ I(1)
LLF	10.653	1.000	-4.5923*	0.000	I~ I(1)
LLOGISTIC	2.528	0.994	-34.413*	0.000	I~ I(1)

5.3. Cointegration analysis

The second step to studying cointegration is to apply the cointegration test. In panel data, we apply panel cointegration tests of Pedroni's (2004) test. And to check the sensitivity of our results, we also used Kao (1999) and Johansen and Fisher, developed byMaddala & Wu (1999). The results of these panel cointegration tests are presented in Table 3.

The results of the Pedroni Test consist of 11 statistics, out of which seven show that there exists cointegration among these variables. Furthermore, the results of Kao (1999) and Johson Fisher tests (by Maddala & Wu, 1999) also show the presence of cointegration among these variables. Overall, all these tests confirm a cointegration or long-term relationship among these variables.

5.4. Long-run and short-run relationship

In the next step, we estimated panel cointegration regression for the long-run relationship using Fully Modified OLS (FMOLS) estimation. The results of panel cointegration regression are presented in Table 4. Furthermore, we also calculated the Error Correction Model (ECM) to find a short-run adjustment in our model. The results of the short-run cointegrating error vector are also presented in Table 4.

The results of panel cointegration regression show statistically significant results among the dependent variable real GDP, and the independent variables laborforce (LLF), capital (LRGFCF) and logistic performance (LLOGISTIC) of a country. All the variables also have plausible signs. The results indicate that a one per cent increase in the logistic performance index may change a country's real gross domestic product by 0.14 per cent, keeping other things constant. Similarly, the labour force and capital also have a positive and statistically significant relationship with real GDP. The results indicate a 0.553 and 0.328 per cent increase in real GDP for a 1 per cent change in the labour force and a 1 per cent change in capital, respectively, keeping other things constant.

The short-run coefficient is negative, less than 1, and is statistically significant. This implies that the disequilibrium in the short run is adjusted at a speed of 0.020 toward the long-run equilibrium. The negative sign of the coefficient, with a value lesser than 1, indicates that there is convergence towards long-run equilibrium, and it is statistically significant.

Table 3. Panel Cointegration Tests

Pedroni Test				
Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistic	**Prob.**	**Statistic**	**Prob.**
Panel v-Statistic	12.020*	0.000	1.631*	0.052
Panel rho-Statistic	6.133	1.000	6.312	1.000
Panel PP-Statistic	- 15.266*	0.000	- 20.079*	0.000
Panel ADF-Statistic	- 3.159	0.001	- 8.598*	0.000
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistic	**Prob.**		
Group rho-Statistic	9.777	1.000		
Group PP-Statistic	- 31.471*	0.000		
Group ADF-Statistic	- 7.431*	0.000		

Continuation of Table 3

Kao Test		
	t-Statistic	**Prob.**
ADF	-1.598*	0.055

Johansen Fisher Test				
Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue)				
Hypothesized	Fisher Stat.*		Fisher Stat.*	
No. of CE(s)	**(from trace test)**	**Prob.**	**(from max-eigen test)**	**Prob.**
None	3823*	0.000	383*	0.000
At most 1	1628*	0.000	1629*	0.000
At most 2	1233*	0.000	1076*	0.000
At most 3	540*	0.000	540*	0.000

Table 4. Long-run cointegration and short-run adjustment

Variable*	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
Long-run relationship				
LRGFCF	0.328*	0.011	30.266	0.000
LLF	0.553*	0.313	1.767	0.078
LLOGISTICS	0.140*	0.024	5.862	0.000
Short-run cointegration vector				
Error Correction Vector	-0.020*	0.004	5.313	0.000
**RGDP Dependent variable*				

6. Conclusion and Policy Implications

Transportation and logistics play an essential role in the economy of a country. It is not easy to quantify a country's logistic sector and link it with its macroeconomic conditions. However, the logistic performance index of the World Bank combines various aspects of logistics, including the quality of infrastructure, the tracking and expected time of consignments, the efficiency of the customs at borders, the quality of logistic services, and the tracking of consignments with timely deliveries. This study used this logistic performance indicator to study the link between economic growth and logistic performance across 107 countries. The study uses a sample covering a period from 2007-2019 and uses advanced econometric tools. The results show a long-term relationship between a country's economic growth and the logistics sector. The findings indicate that the impact of a one per cent improvement in the logistic performance index of a nation contributes 0.14 per cent to its real GDP keeping other things constant and that this result is statically significant. Furthermore, the short-run disequilibrium converges back to the equilibrium states, as the error correction model found.

In light of the findings from the study, it could be attributed that the logistic sector contributes significantly to the country's economic growth. Therefore, policymakers should consider the entire logistics industry. While the policymakers (in particular in developing countries) are mainly focused on the development of physical infrastructure (the hardware) that is of equal importance, however, the other aspects of logistics (the software) such as border management, quality of logistic services (such as performance of freight forwarders), the efficiency of customs, and provision of competitive rates for freight are equally important. These all can only be enhanced through better governance and law enforcement.

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Data Availability Statement

The data that support the findings of this study are openly available in the World Development Indicator (WDI) of the World Bank at https://databank.worldbank.org/reports.aspx?source=World-Development-Indicators. All variables used in this study are obtained from the same database.

Appendix-1

List of Countries

Algeria	Costa Rica	Honduras	Mexico	Senegal
Argentina	Cote d'Ivoire	Hong Kong	Moldova	Serbia
Armenia	Croatia	Hungary	Nepal	Singapore
Australia	Cyprus	India	Netherlands	Slovak Republic
Austria	Czech Republic	Indonesia	New Zealand	Slovenia
Bahrain	Denmark	Ireland	Niger	Solomon Islands
Belgium	Dominican Republic	Italy	Nigeria	South Africa
Benin	Ecuador	Jamaica	North Macedonia	Spain
Bhutan	Egypt	Japan	Norway	Sudan
Bolivia	El Salvador	Jordan	Oman	Sweden
Bosnia & Herzegovina	Estonia	Kazakhstan	Pakistan	Switzerland
Brazil	Finland	Kenya	Panama	Syria
Bulgaria	France	Korea, Rep.	Paraguay	Thailand
Burkina Faso	Gabon	Kyrgyz Republic	Peru	Togo
Cambodia	Germany	Latvia	Philippines	Tunisia
Cameroon	Ghana	Lebanon	Poland	Turkey
Canada	Greece	Lithuania	Portugal	Ukraine
Chad	Guatemala	Luxembourg	Romania	United Arab Emirates
Chile	Guinea	Madagascar	Russian Federation	United Kingdom
Colombia	Guinea-Bissau	Malaysia	Rwanda	United States
Comoros	Haiti	Mauritania	Saudi Arabia	Uruguay
				Uzbekistan
				Vietnam