UNVEILING MACRO-LOGISTICS COMPETITIVENESS: ANALYSIS OF LOGISTICS COSTS, GDP, AND THE LPI

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ABSTRACT

Purpose: This study explores macro-logistics competitiveness by investigating how the ratios of National Logistics Costs (NLC) to Gross Domestic Product (GDP) in countries impact their Logistics Performance Index (LPI) scores. The study defines four logistics cost components: transportation, warehousing, inventory carrying, and administration. Delaney's calculation method is employed to ensure consistency in calculations and to enable a comparative analysis of the ratios across all countries.

Design/methodology/approach: The analysis of logistics efficiency and its economic implications was conducted in two distinct parts: (1) classifying countries into four income categories and (2) conducting a regression analysis to explore the relationship between NLC, expressed as a percentage of GDP, and the LPI. Data were obtained from the National Accounts tables.

Findings: The relationship between NLC, as a percentage of GDP, and the LPI varies significantly across countries at different income levels. The correlation results between the six dimensions of the LPI and NLC for 73 countries showed a moderate negative correlation coefficient across all factors, indicating that improvements in logistics performance are generally associated with lower logistics costs. Thus, countries with higher LPI scores tend to have lower NLC relative to GDP.

Research Limitation/Implications: The study's calculation approach utilizes data from National Accounts, making it cost-effective and time-saving compared to traditional data collection methods. This approach should be valuable for policymakers and academics in the field of macro-logistics, as it can guide their assessment of national macro-logistics competitiveness.

Originality/value: This study employed an identical calculation method and data source, enabling a robust and novel comparison of macro-logistics competitiveness across a broader range of economies. A regression analysis of the ratios of NLC to GDP and the LPI scores identified the factors influencing a country's logistics performance.

Keywords: National logistics cost, Logistics Performance Index

Article classification: research paper

Introduction

National logistics costs (NLC) play a critical role in economic performance and national competitiveness. These costs encompass various expenses related to transportation, warehousing, inventory management, and administration, all of which significantly impact a nation's Gross Domestic Product (GDP) and trade balance. Efficient logistics systems can reduce these costs, thereby enhancing the ability of businesses to compete in global markets by lowering the prices of goods and services. According to the World Bank (2022), countries with lower logistics costs relative to GDP tend to perform better economically and have a more robust trade network, highlighting the importance of continually optimizing logistics operations at the national level.

The Logistics Performance Index (LPI) is a valuable tool that provides a comprehensive measure of a country's logistics efficiency. Published by the World Bank, the LPI evaluates key components of logistics performance, such as customs procedures, infrastructure quality, ease of arranging shipments, and timeliness of deliveries (Arvis et al., 2018). The index allows policymakers and industry leaders to identify strengths and weaknesses within their logistics sectors and develop strategies to improve overall efficiency. Studies have shown a strong correlation between high LPI scores and economic growth, as countries with higher logistics performance are better positioned to participate in international trade and attract foreign investment (Martí et al., 2014). Therefore, understanding and enhancing both national logistics costs and performance through the LPI are essential for fostering economic development and global trade integration.

Literature review

National logistics performance (NLC)

National logistics performance is assessed in the literature from two primary perspectives: logistics performance and trade connectivity, and logistics efficiency as indicated by the ratio of National Logistics Costs (NLC) to Gross Domestic Product (GDP). The first approach predominantly utilizes the World Bank's LPI to gauge a country's trade logistics connectivity, which includes evaluating customs efficiency, infrastructure quality, and other key logistics dimensions (Havenga, 2018). While the LPI provides a comprehensive overview of trade facilitation capabilities and is extensively studied in relation to logistics costs and other performance indicators (Arvis et al., 2010; Ekici et al., 2016; Kinra et al., 2020b), it primarily focuses on international logistics and does not directly measure domestic logistics efficiency. The second perspective focuses on assessing national logistics performance by examining the NLC as a percentage of GDP, which reflects the efficiency of logistics activities within the domestic economy. This approach underscores the impact of logistics costs on a country's overall economic performance (Rantasila and Ojala, 2012; Havenga, 2018). However, there remains a lack of standardization in calculating NLC, presenting challenges in accurately comparing logistics performance across countries (Pishvaee et al., 2009; Pohlen et al., 2009; Rantasila and Ojala, 2012).

Logistics costs significantly influence both firm-level competitiveness and national economic performance by affecting the total cost of goods and services. Effective management of logistics costs requires a holistic approach that minimizes overall costs rather than focusing on individual cost components, as reductions in one area may lead to increases in another (Ballou, 2007). This comprehensive understanding and management of logistics costs—including transportation, warehousing, inventory carrying, and administration—are crucial for improving logistics efficiency and enhancing economic competitiveness (Christopher, 2016). The literature has identified transportation costs as the most significant component of logistics expenses, with trucking alone accounting for a substantial portion in many countries (Cass Logistics Systems Inc., 2023). Other critical components include inventory carrying costs, warehousing costs, and logistics administration costs, all of which contribute to the total logistics expenses (Delaney and Wilson, 2003; Banomyong et al., 2022).

Despite various methodologies developed for calculating NLC, the absence of a standardized approach complicates the assessment and comparison of logistics performance across different national contexts (Banomyong et al., 2022; Heskett et al., 1973). The basic formula for calculating NLC as a percentage of GDP is (Delaney and Wilson, 2003; Banomyong et al., 2022):

NLC as % of GDP = (Total Transport Cost + Total Warehouse Cost + Total Inventory Carrying Cost + Total Logistics Administration Cost) / GDP

Where: Total Logistics Costs represent all expenses associated with the movement, storage, and distribution of goods and services within a country, and Gross Domestic Product (GDP) is the total economic output of a nation.

The CASS method has become a prevalent tool for assessing logistics costs in various countries, including the United States and Thailand, due to its adaptability to both national and firm-level data (Botes et al., 2006; Havenga, 2010). This method focuses on four primary logistics cost components: transportation-related costs, inventory holding costs, warehouse-related costs, and administration costs (Delaney and Wilson, 2003). The calculation of NLC as a percentage of GDP, often referred to as the logistics cost burden, provides a critical indicator of a country's economic efficiency and competitiveness by quantifying the resources allocated to logistics activities relative to the nation's total economic output. Despite the usefulness of the CASS method, the absence of a standardized calculation methodology for NLC presents challenges, particularly in identifying the relevant logistics cost components and selecting the appropriate calculation method (Banomyong et al., 2022).

Logistics Performance Index (LPI)

The World Bank's LPI is a crucial tool for evaluating the logistics performance of countries worldwide. The LPI assigns scores to each of these dimensions, thereby offering a detailed and comparative analysis of logistics performance across countries. Higher scores reflect superior logistics performance, highlighting areas of strength and identifying opportunities for improvement. Developed to help policymakers and stakeholders understand the challenges and opportunities within their logistics sectors, the LPI provides a comparative analysis of logistics efficiency based on six key dimensions (Ojala and Celebi, 2015): Efficiency of the Customs Clearance Process, Quality of Trade and Transport Infrastructure, Ease of Arranging Competitive Shipments, Competence and Quality of

Logistics Services, Ability to Track and Trace Shipments, and Timeliness of Shipments in Reaching the Destination.

The LPI is derived from surveys conducted with international freight forwarders and express carriers, who provide insights into the logistics environments of the countries they operate in. This approach ensures that the LPI captures real-world perceptions of logistics performance, making it a practical tool for identifying strengths and weaknesses in national logistics systems (Arvis et al., 2018). Research has shown that higher LPI scores are associated with better trade facilitation and economic performance, as efficient logistics systems reduce costs and improve the reliability of supply chains (Ekici et al., 2016). Furthermore, the LPI has been instrumental in guiding policy reforms and investments in infrastructure and services, promoting greater integration into the global economy (World Bank, 2018).

Despite its widespread use, the LPI has also faced criticism, primarily concerning its reliance on perception-based data and its focus on international trade logistics, which may not fully capture domestic logistics performance (Korinek and Sourdin, 2011). However, its strengths in highlighting key areas for improvement and fostering international comparisons make it an indispensable tool for countries seeking to enhance their logistics capabilities. By providing a detailed overview of logistics performance, the LPI enables countries to benchmark their logistics systems against global standards and identify targeted areas for policy intervention and investment.

Research methodology

Analysis methods

The analysis of logistics efficiency and its economic implications were conducted in two distinct parts to provide a thorough understanding of the relationship between NLC and overall logistics performance across different stages of economic development.

In the first part of the analysis, countries were classified into four income categories as defined by the World Bank: low-income, lower-middle-income, upper-middle-income, and high-income. This classification is based on gross national income (GNI) per capita, which serves as a reliable indicator of a country's economic development level (World Bank, 2022). By grouping countries according to these income levels, the study aims to capture the variations in logistics efficiency that correspond with different stages of development. This approach allows for a more granular analysis of logistics performance, recognizing that countries at different economic stages face distinct challenges and opportunities in their logistics sectors. For example, low-income countries may struggle with inadequate infrastructure and inefficient customs procedures, while high-income countries might focus more on optimizing advanced supply chain technologies and reducing logistics costs further (Arvis et al., 2018). The income-based grouping should facilitate a comprehensive understanding of how logistics efficiency evolves as countries progress through different stages of economic development, thereby highlighting the specific needs and priorities of each income group.

The second part of the analysis involves conducting a regression analysis to explore the relationship between NLC, expressed as a percentage of GDP, and the LPI. By examining logistics costs as a proportion of GDP, the study aimed to understand how these costs influence a country's logistics performance as measured by the LPI. This analysis is crucial because high logistics costs can act as a barrier to trade competitiveness and economic growth, particularly in developing countries where logistics inefficiencies are more pronounced (Rantasila and Ojala, 2012). The regression analysis provided empirical evidence on the extent to which NLC impact logistics performance, thereby offering valuable insights for policymakers and industry stakeholders on how to enhance logistics efficiency and drive economic development. Understanding this relationship is essential for formulating targeted policies that can reduce logistics costs, improve supply chain efficiency, and ultimately strengthen a country's competitive position in the global market.

Data used in the analysis

The data for this study were sourced exclusively from the *Key Indicators for Asia and the Pacific 2024: Data for Climate Action* report, published by the ADB. This report provides comprehensive economic data, including the GDP figures at current market prices for 79 member economies in Asia and the Pacific, as well as the GDP data of 21 industrial sectors (Asian Development Bank, 2024).

The transportation and warehousing costs were derived from the GDP value attributed to the Transportation and Storage sector, as indicated in the National Accounts table of the report. For the inventory carrying costs, data were available for specific sectors only, including (1) Mining and Quarrying, (2) Manufacturing, (3) Electricity, Gas, Steam, and Air-conditioning Supply, (4) Water Supply, Sewerage, Waste Management, and Remediation Activities, (5) Construction, and (6) Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles (Asian Development Bank, 2024). In sectors such as agriculture, it was assumed that there would be no inventory left, as agricultural commodities are generally harvested and distributed immediately. Similarly, the service sector was assumed to have no inventory costs, given that services are intangible and cannot be stocked. The methodology for calculating these logistics costs is based on these sectoral GDP data and specific assumptions regarding inventory levels across different sectors.

The obtained NLC are considered as a proper indicator indicating a country's past and future performances related to logistics efficiency (Havenga, 2018). It was observed that many developed and developing countries are not only striving to determine their NLCs but they would like to benchmark their logistics performance with other countries (Banomyong et al., 2022). A common way to benchmark logistics efficiency of nations is the LPI.

Findings

Income-based classification of countries

Table 1 shows the LPI scores and NLC per GDP of 73 countries in 2022. The relationship between NLC, expressed as a percentage of GDP, and the LPI varies significantly across countries at different income levels, reflecting the diverse challenges and opportunities they face in optimizing logistics performance. In low-income countries, high logistics costs relative to GDP were found to be associated with lower LPI scores, indicating inefficiencies in logistics systems. These countries typically contend with inadequate infrastructure, limited access to technology, and cumbersome customs procedures, which collectively impede the smooth movement of goods and increase overall logistics costs (Arvis et al., 2018). Any elevated costs in these contexts highlight the pressing need for substantial investments in infrastructure development and capacity building to enhance logistics efficiency and support economic growth (Rantasila and Ojala, 2012).

In contrast, lower-middle-income and upper-middle-income countries were found to exhibit more varied relationships between NLC and the LPI. While some countries in these categories continue to face challenges similar to those of low-income countries, others have made significant strides in improving logistics efficiency. For these nations, reducing logistics costs often correlates with enhanced the LPI, reflecting improvements in infrastructure, regulatory frameworks, and the adoption of modern logistics technologies (World Bank, 2018). High-income countries, on the other hand, were found to demonstrate a strong inverse relationship between NLC and the LPI. These countries benefit from well-developed infrastructure, advanced logistics networks, and efficient customs procedures, which contribute to lower logistics costs as a percentage of GDP and higher LPI scores (Korinek and Sourdin, 2011). The lower logistics costs in high-income countries underscore their ability to maintain a competitive advantage in global trade through the continuous optimization of logistics operations and investments in cutting-edge technologies (Havenga, 2018). This analysis highlights the importance of targeted policy interventions and investments tailored to the specific needs of countries at different stages of economic development to improve logistics performance and reduce costs.

Country	LPI	NLC/GDP	Country	LPI	NLC/GDP	Country	LPI	NLC/GDP
Low income								
Afghanistan	1.9	10.4%						
Lower middle income								
Bangladesh	2.6	12.8%	Micronesia	2.9	13.9%	Sri Lanka	2.8	19.0%
Bhutan	2.5	18.4%	Mongolia	2.5	15.5%	Tajikistan	2.5	19.9%
Cambodia	2.4	15.6%	Myanmar	2.8	27.5%	Timor-Leste	3.5	9.8%
Cook Islands	2.6	10.1%	Nepal	2.9	13.5%	Ukraine	2.7	15.9%
India	3.4	10.2%	Pakistan	3.3	15.4%	Uzbekistan	2.6	21.6%
Indonesia	3.0	13.7%	Papua New Guinea	2.7	8.6%	Vanuatu	2.6	5.3%
Kiribati	2.7	11.5%	Philippines	3.3	8.5%	Viet Nam	2.3	10.1%
Kyrgyz Republic	2.3	16.5%	Samoa	2.8	6.4%			
Lao PDR	2.4	19.6%	Solomon Islands	2.8	12.4%			
Upper middle income								
Armenia	2.5	9.8%	Malaysia	3.6	6.6%	Thailand	3.5	13.7%
Azerbaijan	4.0	20.3%	Maldives	3.6	12.5%	Tonga	2.5	8.9%
China	3.7	7.2%	Marshall Islands	3.3	14.5%	Turkey	3.4	12.4%
Fiji	2.3	9.2%	Palau	3.3	6.6%	Turkmenistan	3.4	21.5%
Georgia	2.7	13.2%	Russia	3.2	16.1%	Tuvalu	3.4	8.5%
Kazakhstan	2.7	17.0%	South Africa	3.7	11.6%			
High income								
Australia	3.7	6.7%	Hong Kong, China	4.0	7.7%	Portugal	3.4	11.2%
Austria	4.0	8.8%	Ireland	3.6	8.6%	Romania	3.2	12.9%
Belgium	4.0	8.3%	Italy	3.7	9.3%	Singapore	4.3	14.1%
Brunei Darussalam	3.2	5.8%	Japan	3.9	5.8%	Spain	3.9	8.9%
Canada	4.0	9.0%	Korea	2.7	9.4%	Sweden	4.0	7.9%
Denmark	4.1	9.2%	Nauru	2.9	20.8%	Switzerland	4.1	8.6%
Finland	4.2	8.8%	Netherlands	4.1	7.8%	Taiwan	2.3	6.2%
France	3.9	9.1%	New Zealand	3.6	7.0%	United Kingdom	3.7	8.6%
Germany	4.1	8.4%	Norway	3.7	9.2%	United States	3.8	8.7%
Greece	3.7	12.9%	Poland	3.6	10.8%			

Table 1: LPI score versus NLC/GDP (2022) (the authors)

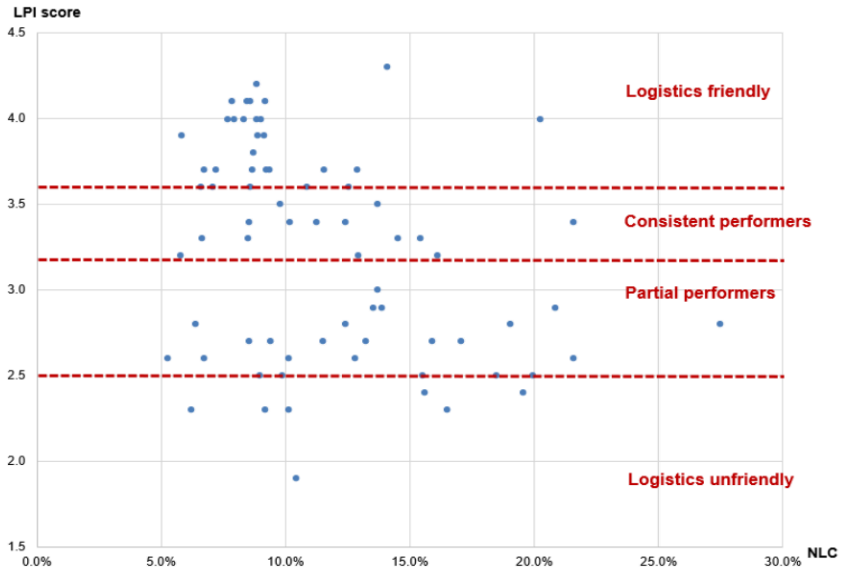

Figure 1: Relationship between NLC and the LPI of 73 countries (the authors)

Figure 1 provides a graphical representation of NLC/GDP and the LPI of 73 countries in 2022. These data can be divided into four zones by dashed red lines, categorizing countries into different performance groups based on their LPI scores: (1) Logistics Friendly: Countries in this category generally have high LPI scores (above 3.5) and relatively lower NLC (often below 10%). These countries are efficient in logistics, with strong infrastructure, streamlined customs processes, and effective logistics services. Most high-income countries fall into this category, demonstrating advanced logistics capabilities. (2) Consistent Performers: Countries in this range have moderate LPI scores. They show consistent logistics performance but have room for improvement. These countries may have moderate NLC and represent middle-income economies that are developing their logistics infrastructure and processes. (3) Partial Performers: Countries within this range have lower LPI scores, indicating average logistics performance with certain inefficiencies. The NLC for these countries are higher, often above 10%, reflecting a higher cost burden for logistics activities. These countries may be in transition, striving to enhance their logistics capabilities. (4) Logistics Unfriendly: Countries in this category have the lowest LPI scores, reflecting significant logistics inefficiencies. The NLC can vary widely, but the high costs typically correspond to poor infrastructure, inadequate logistics services, and inefficient customs processes. These are often low-income countries facing major challenges in their logistics systems.

Relationships between NLC and the LPI

The analysis reveals a correlation between a country's NLC as a percentage of GDP and its LPI score. Generally, countries with higher LPI scores were found to have lower NLC relative to GDP. Such relationship suggests that more efficient logistics systems, which facilitate the quicker and more cost-effective movement of goods and services, are associated with reduced logistics costs as a proportion of economic output.

However, it is crucial to recognize that correlation does not imply causation; the observed association between LPI scores and logistics costs does not necessarily indicate that one directly causes the other (Glymour, 2006). As presented in Table 2, the correlation results between the six dimensions of the LPI and national logistics costs for 73 countries show a moderate negative correlation coefficient across all factors, indicating that improvements in logistics performance are generally associated with lower logistics costs. Both Pearson and Spearman correlation coefficients indicated that countries with lower logistics costs relative to GDP tend to have higher LPI scores, suggesting more efficient logistics performance. Specifically, the Pearson correlation coefficient between NLC/GDP and the overall LPI score is -0.6275, while the Spearman coefficient is -0.6460, both indicating a moderate negative correlation. This suggests that as logistics costs as a percentage of GDP decrease, the overall efficiency and effectiveness of logistics systems, as measured by the LPI, tend to improve. These results indicate that improvements in logistics infrastructure, international shipment handling, timeliness, customs efficiency, service competence, and tracking capabilities are associated with lower national logistics costs relative to GDP.

NLC/GDP with	Peason	Interpretation	Spearman	Interpretation
LPI overall	-0.672301296	Moderate	-0.687015061	Moderate
Infrastructure	-0.658014939	Moderate	-0.683464215	Moderate
International Shipment	-0.65429354	Moderate	-0.665876864	Moderate
Timeliness	-0.639521657	Moderate	-0.648145157	Moderate
Customs	-0.655143865	Moderate	-0.689989785	Moderate
Competency	-0.655652353	Moderate	-0.671528003	Moderate
Track & Trace	-0.662193438	Moderate	-0.673743813	Moderate

Table 2: Correlations between NLC and the LPI (the authors)

Figure 2 offers a graphical representation of the correlation between each dimension of the LPI and NLC for the 73 countries. The correlation analysis between NLC as a percentage of GDP and the various dimensions of the LPI showed a consistent moderate negative relationship across all factors.

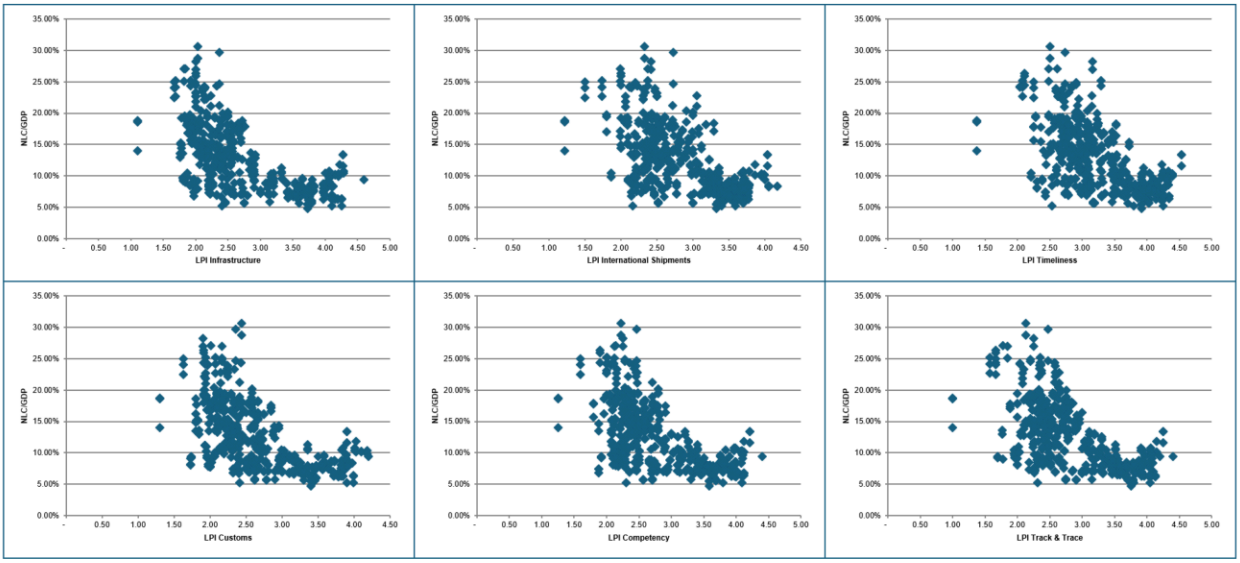

Figure 2: LPI dimensions factor correlation with NLC (the authors)

The findings underscore the importance of enhancing various components of logistics performance to reduce overall logistics costs and improve economic efficiency. The moderate negative correlations suggest that while there is a significant relationship between logistics costs and performance, other factors may also influence logistics efficiency. Moreover, the consistency of the moderate negative correlations across both Pearson and Spearman coefficients highlights the robustness of this relationship, irrespective of the assumptions regarding the distribution of the data (Mukaka, 2012). This analysis provides valuable insights for policymakers and stakeholders aiming to enhance logistics performance by focusing on these key dimensions.

Conclusion

The relationship between National Logistics Costs (NLC) as a percentage of a nation's Gross Domestic Product (GDP) and the Logistics Performance Index (LPI) for 73 countries provide significant implications for economic development and regional integration. Efficient logistics systems are crucial for enhancing country's competitiveness in the global trade arena. Member states should prioritize strategic initiatives aimed at improving logistics performance, including reducing logistics costs and optimizing operational efficiencies. Such improvements are vital for facilitating intra-regional trade and ensuring that country remains a formidable competitor in international markets. Critical steps in this process include harmonizing regulations across member states and streamlining customs procedures, which can significantly reduce trade barriers and improve overall logistics efficiency.

Moreover, achieving lower logistics costs and higher LPI scores can enhance country's attractiveness to foreign direct investment (FDI). To leverage this potential, member states should continue to invest in infrastructure development and regulatory enhancements, fostering a conducive environment for sustainable economic growth. As the region pursues economic development, it is imperative to consider sustainability and resilience within logistics systems. Adopting green logistics practices and enhancing disaster preparedness are essential for building a robust and resilient logistics network capable of withstanding economic shocks and environmental challenges. Collaborative efforts among 73 countries, including regional agreements, joint infrastructure projects, and the sharing of best practices, are crucial for overcoming logistics challenges. Additionally, embracing digital technologies and innovations can lead to significant cost savings and efficiency gains, further bolstering logistics performance. Through these concerted efforts, countries can strengthen their positions, driving sustained growth and prosperity for the region and its member states.

The calculation methodology used in this study presents several limitations that may affect the accuracy and comparability of the results. Firstly, the transportation costs included in the Asian Development Bank's (ADB) national account database encompass both passenger and freight transport. Passenger transportation should be excluded to accurately reflect only freight logistics efficiency. Additionally, the warehousing costs recorded in the national accounts only account for outsourced warehousing activities, omitting expenses associated with in-house warehousing. For a

more comprehensive understanding of logistics costs, both outsourced and in-house warehousing expenses should be considered.

Furthermore, the methodology employed a constant factor of 10% as a proxy to estimate logistics administration costs. This uniform approach does not account for the varying capabilities in logistics management and differing economic conditions across countries, which can significantly influence logistics administration expenses. Lastly, although the LPI provides valuable insights into logistics efficiency, it is based on a perception survey and does not consider logistics costs. This means that a country can achieve a high LPI score despite having elevated logistics costs.

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