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Spatial Effects of Logistics Infrastructure on Interregional Growth in Indonesia

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Abstract

This study aims to analyze the impact of logistics infrastructure, physical capital growth, human capital, and population growth on interregional economic growth in Indonesia from 2014 to 2023, and to evaluate the presence of interregional spillover effects. The analysis uses panel data of 34 provinces with a Spatial Durbin Model (SDM) under a fixed effect approach. The results indicate that the effect of logistics infrastructure varies across types and regions: road length consistently shows a positive and significant effect, whereas airports and seaports tend to have negative effects, especially in Eastern Indonesia. The land transport (trucks) contributes positively, though significance varies across regions. Spatial analysis indicates heterogeneous spillover effects: roads generate positive spillovers, while airports, seaports, and truck may produce negative spillovers in certain regions. Physical capital has a relatively small and insignificant direct effect, whereas human capital shows positive and significant effects, particularly in Eastern Indonesia. Population growth has a directly negative effect in Eastern Indonesia, but total effects can be positive through labor mobility and interregional market integration. These findings highlight the importance of improving the quality and efficiency of logistics infrastructure, spatially based development planning, and affirmative policies to support more equitable economic growth.

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INTRODUCTION

Economic growth reflects a country's increasing capacity to produce goods and services in a stable and sustainable manner over a specific period, indicating improvements in economic activity and public welfare (Todaro and Smith, 2012). Generally, economic growth is measured by indicators such as Gross Domestic Product (GDP) or Gross Regional Domestic Product (GRDP) (Mankiw, 2013). GDP represents the total market value of all final outputs produced by factors of production within a country during a given period. Therefore, economic growth not only signals production output but also reflects a region's ability to optimally manage its productive resources.

Theoretically, economic growth can be explained through the Solow growth model, which links output with main production factors: capital, labor, and technological progress via the Cobb-Douglas production function. The model assumes constant returns to scale with labor and technology growth as exogenous. Using the effective labor approach, the Solow model describes the dynamics of capital per effective labor until reaching a steady state, where savings replace capital lost due to population growth, technological progress, and depreciation. Long-term growth is mainly determined by technological advancement.

Mankiw, Romer, and Weil (1992) modified the Solow model by adding human capital as an additional production factor. Efficiency and productivity are emphasized as key drivers of growth. External factors, such as logistics infrastructure, also contribute to technological advancement and production efficiency. Logistics infrastructure facilitates the flow of goods and services and expands interregional markets, serving as an external driver for regional economic growth through increased efficiency and integration.

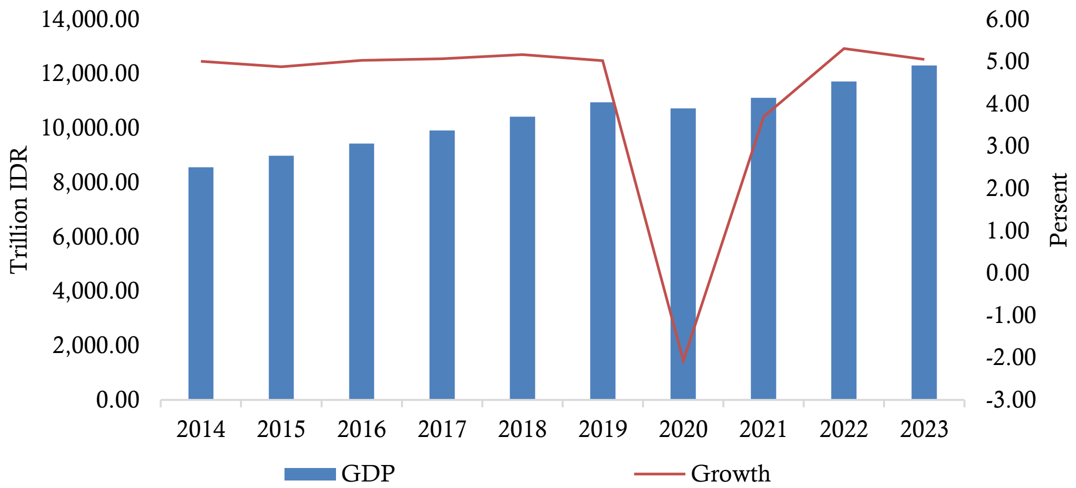

Figure 1. Indonesian GDP and Economic Growth 2014–2023
Source: BPS-Statistics Indonesia, 2025.

Based on Figure 1, Indonesia's economic growth has shown positive development over the past decade. GDP increased from IDR 8,564.87 trillion in 2014 to IDR 10,949.16 trillion in 2019, with a relatively stable growth rate of 4.88–5.17%. The Covid-19 pandemic caused a contraction of -2.07% in 2020 and a decrease in GDP to IDR 10,723.00 trillion. However, the economy rebounded in 2023, reaching IDR 12,301.48 trillion with a 5.05% growth rate, demonstrating strong recovery and continuity.

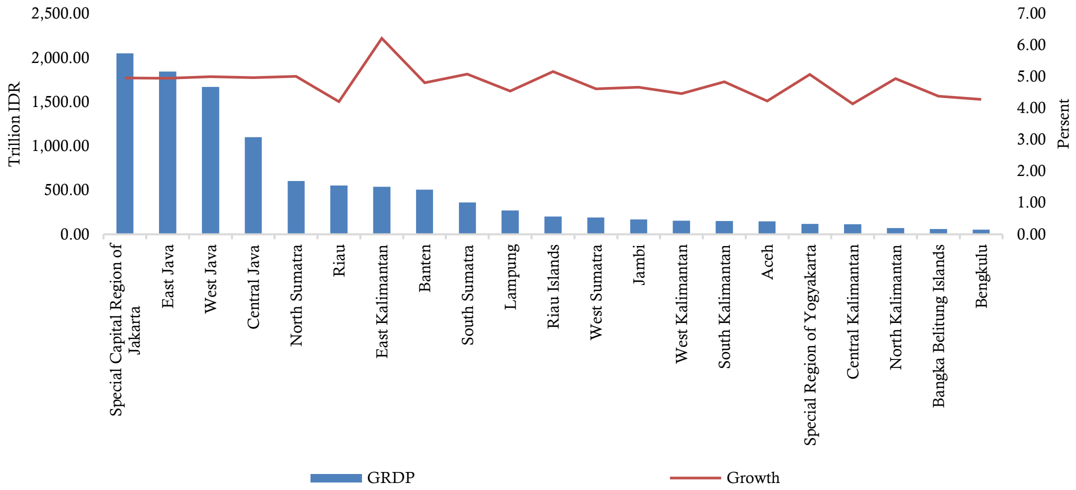

Figure 2. GRDP and Growth of Western Indonesia 2023
Source: BPS-Statistics Indonesia, 2025.

As shown in Figure 2, GRDP data in Western Indonesia reveal substantial disparities among provinces. In 2023, Special Capital Region of Jakarta recorded the highest GRDP at IDR 2,050.47 trillion, while Bengkulu had the lowest at IDR 52.05 trillion. These differences reflect variations in resource distribution, industrial capacity, and infrastructure quality across Western Indonesian provinces.

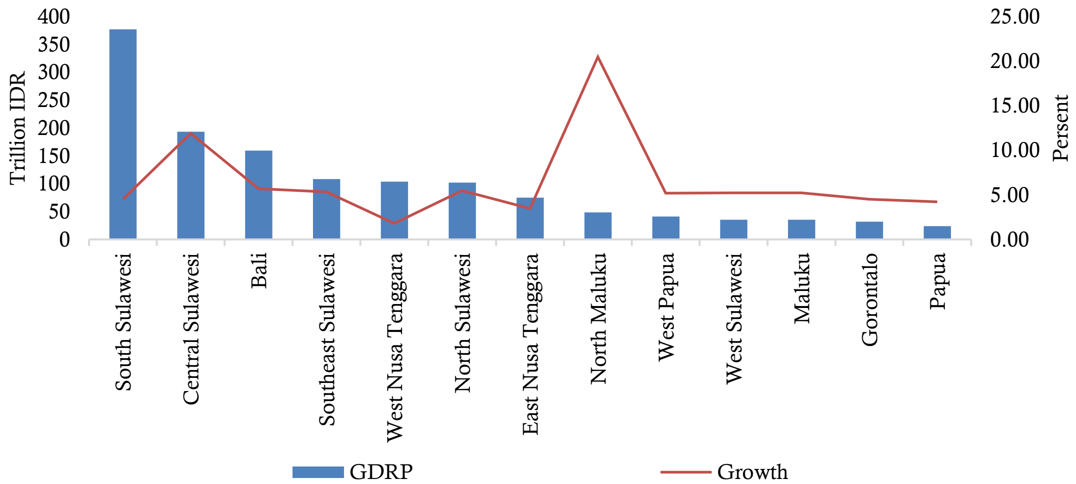

Figure 3. GRDP and Growth of Eastern Indonesia 2023
Source: BPS-Statistics Indonesia, 2025

Figure 3 illustrates GRDP in Eastern Indonesia, highlighting regional disparities. In 2023, South Sulawesi recorded the highest GRDP at IDR 377.21 trillion, whereas Papua had the lowest at IDR 24.01 trillion. This variation underscores differences in economic resources, industrial development, and infrastructure accessibility across Eastern Indonesian provinces.

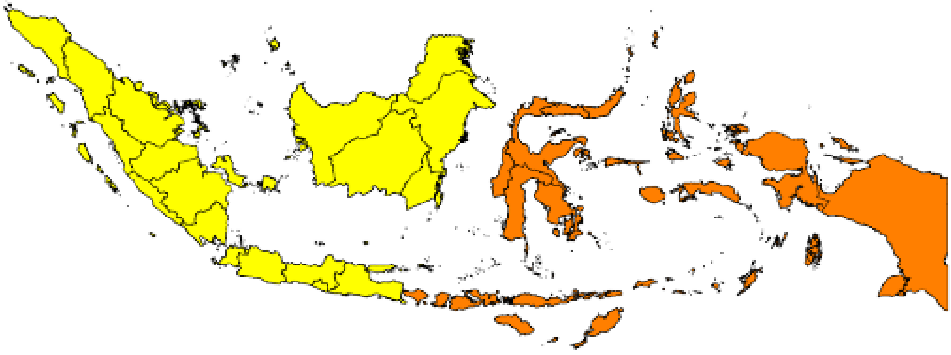

Figure 4. Illustrates this classification, with Western Indonesia highlighted in yellow and Eastern Indonesia in orange.
Source: BPS-Statistics Indonesia, 2025.

Spatially, economic growth in Indonesia remains uneven. Western Indonesia, comprising Sumatra, Java, and Kalimantan, is relatively more developed with better infrastructure and connectivity. Eastern Indonesia, consisting of Bali, Nusa Tenggara, Sulawesi, Maluku, and Papua, faces geographical challenges, limited accessibility, and higher logistics costs.

Table 1. Logistics Infrastructure Disparities Western vs Eastern Indonesia in 2023

Type of Logistics Infrastructure	Western Indonesia	Eastern Indonesia	Unit
Road length	8,881	9,922	km
Number of airports	64	182	units
Port cargo handling capacity	0.22	0.08	million tons
Number of trucks	4,602.15	1,489.68	thousand units

Source: BPS-Statistics Indonesia, 2025

Table 1 highlights disparities in logistics infrastructure between Western and Eastern Indonesia in 2023. Western Indonesia has 8,881 km of roads, 64 airports, a port cargo handling capacity of 0.22 million tons, and 4,602.15 thousand trucks, whereas Eastern Indonesia has 9,922 km of roads, 182 airports, a port cargo capacity of 0.08 million tons, and 1,489.68 thousand trucks. These figures indicate that although Eastern Indonesia has longer road networks and more airports, Western Indonesia dominates in port capacity and truck availability, reflecting greater land and logistics support.

Logistics infrastructure plays a critical role in explaining regional economic disparities. Components such as roads, ports, airports, warehouses, and trucks facilitate the movement of goods, support market mechanisms, and enhance economic activity (Presidential Regulation of the Republic of Indonesia Number 26 of 2012 concerning the Blueprint for the Development of the National Logistics System; Todaro & Smith). High-quality infrastructure reduces distribution costs, strengthens competitiveness, and attracts investment (Nijkamp and Poot, 1998; Ayogu, 2007; Wang, Kim and Kim, 2021). Moreover, efficient logistics networks improve the flow of goods and integration of regional economies, which is particularly crucial for underdeveloped areas in Eastern Indonesia.

Empirical studies have confirmed the role of infrastructure in regional economic growth. Qi et al. (2020) in China found that road infrastructure positively affects growth, while air and sea transport effects vary by region. Nenavath (2023) in India showed that road, rail, and port development positively influence long-term economic growth, while airports had mixed effects. These studies highlight the importance of regional-specific infrastructure planning to maximize growth impact.

Despite the growing body of literature on infrastructure and economic growth, several important research gaps remain. First, from a theoretical perspective, many studies treat infrastructure as an aggregate variable without distinguishing specific logistics components such as roads, ports, airports, and freight vehicles. This aggregation limits understanding of the distinct transmission mechanisms and heterogeneous growth effects associated with each type of logistics infrastructure. Second, from an empirical standpoint, studies in the Indonesian context largely rely on conventional panel regression models that do not explicitly account for spatial dependence among provinces. As economic activities and infrastructure networks are inherently interconnected across regions, ignoring spatial spillover effects may result in biased or incomplete estimates. Third, limited research systematically compares the differential impacts of logistics infrastructure between Western and Eastern Indonesia within a unified analytical framework, despite their clear structural and geographical differences.

This study addresses these gaps by examining the disaggregated effects of logistics infrastructure road length, number of airports, port cargo handling capacity, and number of trucks on regional economic growth across 34 Indonesian provinces during the period 2014–2023. By incorporating spatial interdependence and regional heterogeneity, this research provides a more comprehensive analysis of how logistics infrastructure influences regional growth dynamics and contributes to interregional disparities in Indonesia. The findings are expected to strengthen the theoretical understanding of spatial growth mechanisms while offering policy-relevant insights for more balanced and effective infrastructure development strategies.

RESEARCH METHODS

This study employs a quantitative research design using secondary panel data from 34 Indonesian provinces for the period 2014–2023, obtained from BPS-Statistics Indonesia and the Ministry of Transportation. The analysis differentiates between Western Indonesia (Sumatra, Java, and Kalimantan) and Eastern Indonesia (Bali, Nusa Tenggara, Sulawesi, Maluku, and Papua) to capture regional heterogeneity in economic growth and infrastructure conditions.

Table 2. Variables and Data Sources

Measured Variable	Definition	Unit	Sources
GRDP per capita	Gross value added of goods and services per capita, representing regional real economic growth	Billion IDR	BPS-Statistics Indonesia
Physical Capital	Gross fixed capital formation, representing investment in buildings and machinery	Trillion IDR	BPS-Statistics Indonesia
Labor Force	Number of working-age population employed or actively seeking work	Persons	BPS-Statistics Indonesia
Human Capital	Average years of schooling of population aged 25+	Years	BPS-Statistics Indonesia
Population Growth	Annual population growth rate affecting resources and market size	%	BPS-Statistics Indonesia
Road Length	Length of national and strategic roads in good condition, indicating land logistics capacity	km	BPS-Statistics Indonesia
Airport	Number of operating airports, representing air logistics capacity	Units	BPS, Ministry of Transportation
Port Capacity	Total cargo loading/unloading volume at strategic ports	Million tons	BPS-Statistics Indonesia
Truck	Number of trucks in operation, indicating land freight transport capacity	Thousand units	BPS-Statistics Indonesia

The dependent variable in this study is regional economic growth, measured by real GRDP per capita to reflect changes in economic performance across provinces. The independent variables include physical capital, proxied by gross fixed capital formation; labor force, representing productive workers; human capital, measured by average years of schooling; population growth, capturing demographic pressures; and logistics infrastructure, represented by road length, number of airports, port cargo handling capacity, and the number of trucks. Collectively, these variables indicate the availability and efficiency of regional logistics networks.

Spatial data were obtained from the Indonesia Geospatial Portal to construct a distance-based spatial weight matrix, which accounts for interregional interactions among provinces. The spatial weight matrix is calculated based on the inverse squared distance between provincial centroids, as defined by:

$$W_{ij} = \begin{cases} 0, if\ i = j \\ \dfrac{1}{d_{ij^2}}, if\ i \neq j, and\ d_{ij} \leq D \end{cases}$$

where d_{ij} denotes the Euclidean distance between the centroids of province i and province j. To ensure comparability across regions and facilitate interpretation of spatial effects, the matrix is row-standardized, so that the sum of weights in each row equals one:

$$\sum_{j=1}^{N} W_{ij} = 1$$

This specification allows closer provinces to exert stronger spatial influence than more distant ones, consistent with spatial economic theory and previous empirical studies (Anselin, 1988; LeSage and Pace, 2009).

To estimate the impact of logistics infrastructure on regional economic growth while accounting for interregional spillover effects, this study employs the Spatial Durbin Model (SDM). The SDM allows spatial dependence in both the dependent variable and the independent variables, making it suitable for identifying direct and indirect (spillover) effects (LeSage and Pace, 2009). The model is estimated using Maximum Likelihood Estimation (MLE), which provides consistent and efficient parameter estimates in spatial panel regression. The SDM model is specified as:

$$ln\, y_{it} = \beta_0 + \beta_1\, ln\, y_{it} + \beta_2\, ln\, s_{it}^{k} + \beta_3\, ln\, s_{it}^{h} + \beta_4\, (n_{it} + g_{it} + \delta_{it}) + \beta_5\, ln\, road_{it} + \beta_6\, ln\, airport_{it} + \beta_7\, ln\, port_{it} + \beta_8\, ln\, truck_{it} + \theta_1 \sum_{j=1}^{N} w_{ij}\, ln\, y_{jt} + \theta_2 \sum_{j=1}^{N} w_{ij}\, ln\, s_{jt}^{k} + \theta_3 \sum_{j=1}^{N} w_{ij}\, ln\, s_{jt}^{h} + \theta_4 \sum_{j=1}^{N} w_{ij}\, (n_{jt} + g_{jt} + \delta_{jt}) + \theta_5 \sum_{j=1}^{N} w_{ij}\, ln\, road_{jt} + \theta_6 \sum_{j=1}^{N} w_{ij}\, ln\, airport_{jt} + \theta_7 \sum_{j=1}^{N} w_{ij}\, ln\, port_{jt} + \theta_8 \sum_{j=1}^{N} w_{ij}\, ln\, truck_{jt} + \rho \sum_{j=1}^{N} w_{ij}\, ln\, y_{it} + u_{it} \quad (1)$$

with the error term:

$$u_{it} = \lambda w_{ij} u_{jt} + \varepsilon_{it}$$

where y_{it} denotes economic growth in province i at time t, s_{it}^{k} represents physical capital investment, s_{it}^{h} human capital, n_{it} population growth, and $g + \delta$ the exogenous rate of technological progress and capital depreciation assumed to be constant across regions. The logistics infrastructure variables include road length ($road_{it}$), number of airports ($airport_{it}$), port cargo capacity ($port_{it}$), and the number of trucks ($truck_{it}$). The term w_{ij} is an element of the spatial weight matrix W, where $j \neq i$ denotes neighboring provinces. In the SDM framework, regional economic growth is influenced not only by local characteristics but also by economic performance and logistics infrastructure conditions in surrounding regions, reflecting the presence of spatial spillover effects.

RESULTS AND DISCUSSION

As shown in Table 3, the descriptive statistics provide an overview of economic growth, production factors, and logistics infrastructure across Indonesian provinces during 2014–2023. Western Indonesia, comprising Sumatra, Java, and Kalimantan, consistently exhibits higher averages in GRDP per capita, physical capital, and human capital compared to Eastern Indonesia (Bali, Nusa Tenggara, Sulawesi, Maluku, and Papua). The average GRDP per capita in Western Indonesia is substantially higher than in Eastern Indonesia, reflecting pronounced disparities in regional income levels. Physical capital per worker and average years of schooling similarly favor Western provinces, indicating more concentrated investment and higher educational attainment in the west.

Logistics infrastructure also shows contrasting patterns between the two regions. Western Indonesia dominates in port cargo handling capacity and truck availability, supporting more efficient land and maritime logistics. In contrast, Eastern Indonesia has a larger average number of airports, reflecting geographic needs for air connectivity across its islands. However, lower port and truck capacities in Eastern provinces indicate weaker terrestrial and maritime transport networks. Road length presents mixed results: Eastern provinces have slightly longer total road networks due to their expansive geographic coverage, but overall connectivity remains less efficient than in the west because of sparse population distribution and challenging terrain.

Table 2. Descriptive Statistics Result

Variable	**Min**	**Max**	**Mean**	**Std. Dev.**
Western Indonesia				
y	19,63	192,13	49,35	37,26
sk	0,00	0,15	0,03	0,03
sh	6,82	11,42	8,97	0,87
n	0,38	3,90	1,62	0,65
road	7	1.806	619,33	385,66
airport	1	11	4,4	2,67
port	0,45	160,88	25,34	34,29
truck	5,20	904,27	208,22	208,93
Eastern Indonesia				
y	10,74	71,92	30,25	12,45
sk	0,01	0,05	0,02	0,09
sh	5,73	10,38	8,62	1,00
n	0,73	4,13	1,64	0,53
road	88	1.811	712,68	355,87
airport	1	65	9,75	13,28
port	0,16	20,13	4,06	4,71
truck	2,62	337,42	57,08	61,00
Indonesia				
y	10,74	192,13	42,05	31,80
sk	0,00	0,15	0,02	0,02
sh	5,73	11,42	8,84	0,93
n	0,38	4,13	1,63	0,61
road	7	1.811	655,02	376,77
airport	1	65	6,45	8,85
port	0,16	160,88	18,24	29,84
truck	2,62	904,27	150,43	183,68

Source: author's calculation.

Overall, when considering all provinces, Indonesia exhibits wide variation across all variables. These descriptive statistics underscore persistent regional disparities, with Western Indonesia leading in economic performance, human capital, and land/maritime logistics, while Eastern Indonesia faces lower economic outputs but a relatively greater reliance on air transport. The observed differences highlight the importance of spatial econometric analysis to examine how logistics infrastructure influences regional growth and interregional spillover effects.

A spatial weight matrix (W) was constructed to represent spatial relationships among Indonesian provinces based on geographic proximity, using inverse distance weighting (IDW) and K-Nearest Neighbors (KNN). The IDW method assumes that closer regions have stronger spatial interactions (Arbia and Baltagi, 2009). The matrix was standardized using min–max normalization in STATA. The matrix has a dimension of 21 × 21, with a minimum nonzero weight of 0.0063, an average weight of 0.0285, and a maximum of 0.3494 (Table 3). For Moran's I spatial autocorrelation tests, a KNN matrix with k = 5 was used to ensure a balanced neighborhood structure and reliable detection of spatial spillover effects.

Table 3. Summary of Spatial Weight Matrix

Description	Value
Type of matrix	Inverse Distance (IDW)
Normalization method	Min–Max
Matrix dimension	21 × 21
Minimum weight (non-zero)	0.0063
Average weight	0.0285
Maximum weight	0.3494

Source: author's calculation.

Global spatial autocorrelation was examined using Global Moran's I and Geary's c to identify overall spatial dependence among provinces. These statistics indicate whether economic growth is spatially clustered or randomly distributed. The results show a Moran's I value of 0.987, with an expected value of −0.005, standard deviation of 0.038, and a highly significant z-score of 25.966 ($p < 0.01$), indicating very strong positive spatial correlation among provinces (Table 5). Similarly, Geary's c equals 0.021 with an expected value of 1.000, standard deviation of 0.059, and a significant z-score of −16.515 ($p < 0.01$), corroborating the strong spatial dependence pattern. The consistency between both measures provides robust evidence of spatial dependence in regional economic growth, justifying the use of spatial econometric models in subsequent analyses.

Table 4. Global Moran's I and Geary's c Tests

Model	I / c	E(I)/ E(c)	Std. Dev.	z
Moran's I	0.987***	−0.005	0.038	25.966
Geary's c	0.021***	1.000	0.059	−16.515

Note: *** denotes significance at the 1% level.
Source: author's calculation.

Spatial autocorrelation is further illustrated using a Moran's scatterplot, which visualizes the relationship between provincial economic growth and the spatially lagged average of neighboring provinces. The scatterplot exhibits a clear positive slope, with most provinces located in the High-High and Low-Low quadrants, indicating spatial clustering of similar growth levels (Figure 5). The Moran's I value of 0.987 ($p < 0.01$) confirms strong and significant positive spatial dependence, suggesting that provinces with high (low) economic growth are generally surrounded by provinces with similarly high (low) growth.

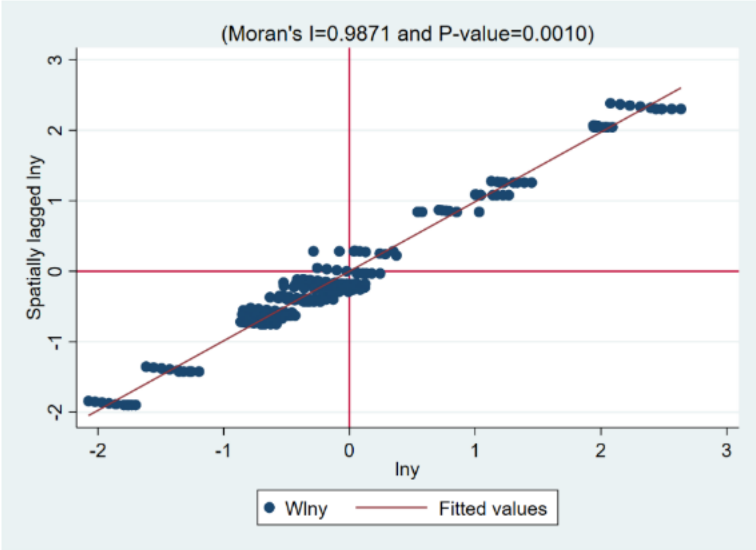

Figure 5. Moran's Scatterplot of Economic Growth in Indonesia
Source: author's calculation.

Lagrange Multiplier (LM) and Robust LM tests were conducted to detect spatial dependence in the regression model, distinguishing between spatial lag and spatial error effects (Anselin, 1988; Elhorst, 2014). Both LM and Robust LM statistics for spatial lag and spatial error are highly significant at the 1% level, indicating the presence of spatial dependence in the dependent variable and in the error term. The simultaneous significance of both effects suggests that the Spatial Durbin Model (SDM) is the most appropriate specification to capture spatial spillovers and interregional dependence (Table 6).

Table 5. Lagrange Multiplier and Robust LM Test Results

Test Method	Statistic
LM Spatial Error	210.40***
Robust LM Spatial Error	27.46***
LM Spatial Lag	269.24***
Robust LM Spatial Lag	86.30***

Note: *** denotes significance at the 1% level.
Source: author's calculation.

To account for unobserved regional heterogeneity in the spatial panel analysis, the Hausman test was applied to determine whether the SDM should be estimated using fixed effects or random effects. The Chi-square statistic of 46.42 ($p < 0.01$) indicates that individual effects are correlated with the regressors, favoring the fixed effects specification. Consequently, the fixed effects SDM is the most appropriate model to capture both spatial and temporal heterogeneity across regions (Table 7).

This study applies a fixed-effects Spatial Durbin Model (SDM) to analyze the effects of economic factors and logistics infrastructure on regional economic growth. The SDM explicitly accounts for spatial dependence by incorporating spatial lags of both the dependent and independent variables, allowing the model to capture direct impacts as well as interregional spillover effects. Table 8, presented immediately after this paragraph, reports the main estimation results for Western Indonesia, Eastern Indonesia, and the national sample

Table 6. Hausman Test Results

Test Method	Statistic
Chi-square (χ^2)	46.42***

Note: *** denotes significance at the 1% level.
Source: author's calculation.

Table 7. Spatial Durbin Model (SDM) Estimation Results

Dep. Variable lny_{it}	**Western**	**Eastern**	**Indonesia**
$\ln s_{it}^{K}$	0,003	0,027	0,010
	(0,013)	(0,031)	(0,018)
$\ln s_{it}^{H}$	0,470***	-0,213	0,441***
	(0,167)	(0,318)	(0,170)
n_{it}	0,001	-0,108***	-0,048***
	(0,011)	(0,017)	(0,011)
$\ln road_{it}$	0,019***	-0,004	0,024***
	(0,007)	(0,023)	(0,009)
$\ln airport_{it}$	-0,015	-0,066***	-0,040***
	(0,015)	(0,023)	(0,014)
$\ln port_{it}$	-0,002	-0,042***	0,000
	(0,006)	(0,013)	(0,006)
$\ln truck_{it}$	0,023	0,088*	0,032
	(0,020)	(0,045)	(0,024)
$w_{ij} \ln s_{jt}^{K}$	-0,017	-0,023	-0,041
	(0,021)	(0,053)	(0,031)
$w_{ij} \ln s_{jt}^{H}$	1,728***	2,772***	0,645
	(0,595)	(0,572)	(0,570)
$w_{ij}\, n_{jt}$	0,172***	0,275***	0,051
	(0,065)	(0,055)	(0,087)
$w_{ij} \ln road_{jt}$	0,047	0,169***	0,092*
	(0,036)	(0,060)	(0,053)
$w_{ij} \ln airport_{jt}$	0,076	-0,282**	0,191**
	(0,048)	(0,125)	(0,079)
$w_{ij} \ln port_{jt}$	-0,062	-0,277***	-0,106*
	(0,042)	(0,07 2)	(0,058)
$w_{ij} \ln truck_{jt}$	0,370***	-0,228**	0,073
	(0,090)	(0,099)	(0,086)
ρ	0,163	0,591***	0,603***
	(0,218)	(0,157)	(0,189)
R^2	0,034	0,070	0,099
Log Likelihood	270,207	104,200	316,211
Wald χ^2	901,70***	243,35***	519,83***

Notes:*** , ** , and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Values in parentheses () are standard errors.
Source: author's calculation.

The SDM estimation results reported in Table 8 indicate that the magnitude and significance of spatial spillover effects differ across regions. In Eastern Indonesia, the spatial autoregressive coefficient (ρ) is 0.591 and statistically significant at the 1% level, indicating strong positive spatial dependence. This implies that a 1% increase in economic growth in neighboring provinces is associated with a 0.591% increase in local economic growth, reflecting a high degree of interregional economic linkage.

In contrast, Western Indonesia exhibits a smaller and statistically insignificant spatial lag coefficient (ρ = 0.163), suggesting that economic growth in this region is predominantly driven by internal provincial characteristics rather than by spillovers from neighboring provinces. At the national level, the spatial lag coefficient is 0.603 and significant at the 1% level, confirming the presence of strong positive spatial dependence in interprovincial economic growth.

Overall, these findings indicate that spatial dependence is more pronounced in Eastern Indonesia and at the national level than in Western Indonesia. This highlights the importance of regional integration and spatially coordinated development policies, particularly in less developed regions. Consequently, direct interpretation of SDM coefficient estimates alone is insufficient; therefore, the analysis proceeds by decomposing the results into direct, indirect (spillover), and total effects to provide comprehensive logistics infrastructure effect and economic factors in regional growth dynamics.

To provide a more comprehensive understanding of the determinants of regional economic growth, the estimated Spatial Durbin Model (SDM) is decomposed into direct, indirect (spillover), and total effects. The direct effect captures the impact of an explanatory variable within the same region, the indirect effect reflects spillovers transmitted through spatial interactions with neighboring regions, and the total effect represents the combined influence of both components. Table 9, presented immediately after this paragraph, reports the spatial effects decomposition for Western Indonesia, Eastern Indonesia, and the Indonesia level.

Table 8. Spatial Effects Decomposition Result

Dep. Variable $\boldsymbol{lny_{it}}$	**Effect**	**Western**	**Eastern**	**Indonesia**
$ln\ s_{it}^{K}$	*Direct Effect*	0,002 (0,013)	0,026 (0,028)	0,009 (0,018)
	Indirect effect	-0,012 (0,013)	-0,011 (0,066)	-0,034 (0,022)
	Total Effect	-0,010 (0,009)	0,015 (0,065)	-0,025 (0,018)
$ln\ s_{it}^{H}$	*Direct Effect*	0,489** (0,171)	0,167 (0,321)	0,471*** (0,165)
	Indirect effect	1,279*** (0,0255)	4,099*** (0,931)	0,884* (0,384)
	Total Effect	1,768*** (0,192)	4,265*** (1,028)	1,355*** (0,343)
n_{it}	*Direct Effect*	0,003 (0,011)	-0,077*** (0,022)	-0,048*** (0,012)
	Indirect effect	0,122** (0,043)	0,327** (0,105)	0,021 (0,086)
	Total Effect	0,125** (0,048)	0,250* (0,118)	-0,026 (0,090)
$ln\ road_{it}$	*Direct Effect*	0,019** (0,007)	0,020 (0,024)	0,027** (0,010)
	Indirect effect	0,036 (0,026)	0,259*** (0,081)	0,103* (0,053)
	Total Effect	0,055* (0,030)	0,279** (0,093)	0,131* (0,058)
$ln\ airport_{it}$	*Direct Effect*	-0,014 (0,015)	-0,112* (0,047)	-0,034* (0,014)
	Indirect effect	0,052 (0,035)	-0,497 (0,266)	0,163* (0,076)
	Total Effect	0,038 (0,036)	-0,610* (0,310)	0,129 (0,080)

Dep. Variable **lny_{it}**	**Effect**	**Western**	**Eastern**	**Indonesia**
$ln\ port_{it}$	*Direct Effect*	-0,002 (0,006)	-0,086** (0,029)	-0,004 (0,007)
	Indirect effect	-0,044 (0,031)	-0,468** (0,165)	-0,103 (0,059)
	Total Effect	-0,047 (0,034)	-0,554** (0,193)	-0,107 (0,064)
$\ln truck_{it}$	*Direct Effect*	0,027 (0,020)	0,063 (0,047)	0,035 (0,024)
	Indirect effect	0,265*** (0,044)	-0,273 (0,155)	0,089 (0,071)
	Total Effect	0,292*** (0,043)	-0,210 (0,172)	0,124 (0,070)

Notes:*** , ** , and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.
Values in parentheses () are standard errors.
Source: author's calculation.

Table 9 presents the decomposition of spatial effects across Western Indonesia, Eastern Indonesia, and the national level. First, regarding direct effects, physical capital shows a relatively small impact in Western Indonesia (0.002), a higher impact in Eastern Indonesia (0.026), and 0.009 at the national level, indicating positive but limited contribution to economic growth (Mankiw, Romer and Weil, 1992; Aspiansyah and Damayanti, 2019). Human capital exhibits stronger direct effects, with 0.489 in Western Indonesia (significant at 5%), 0.167 in Eastern Indonesia, and 0.471 nationally (significant at 1%), highlighting its central role in enhancing productivity and regional growth (Mankiw, Romer and Weil, 1992; Todaro and Smith, 2012; Maryaningsih, Hermansyah and Savitri, 2014). Population growth shows mixed direct effects: slightly positive in Western Indonesia (0.003) but negative and significant in Eastern Indonesia (-0.077) and nationally (-0.048), indicating potential constraints on growth if not accompanied by improvements in human capital and physical capital (Hong, Chu and Wang, 2011).

For logistics infrastructure, direct effects of roads are positive and significant across regions (0.019 in Western Indonesia, 0.020 in Eastern Indonesia, 0.027 nationally), supporting regional mobility and market integration (Dehghan Shabani and Safaie, 2018; Nurmansyah and Wikarya, 2023). Airports show negative direct effects (-0.014 in Western Indonesia, -0.112 in Eastern Indonesia, -0.034 nationally), reflecting limited operational efficiency and connectivity (Karim, Suhartono and Prastyo, 2020; Qi *et al.*, 2020). Port capacity also has negative direct effects across all regions, suggesting that increased capacity without operational improvements does not stimulate economic growth (Bottasso *et al.*, 2014; Qi *et al.*, 2020; Nenavath, 2023). Conversely, land transport (trucks) positively influences growth in all regions, particularly in Eastern Indonesia (0.063), emphasizing its strategic role in regional logistics (Wang, Kim and Kim, 2021).

Regarding indirect (spillover) effects, roads generate positive spillovers in Eastern Indonesia (0.259, significant at 1%) and nationally (0.103, significant at 10%), but not in Western Indonesia, reflecting regional differences in connectivity and operational efficiency (Dehghan Shabani and Safaie, 2018; Nurmansyah and Wikarya, 2023). Airport spillovers are positive in Western Indonesia and nationally, but negative and insignificant in Eastern Indonesia (-0.497), indicating early-stage infrastructure limitations (Karim, Suhartono and Prastyo, 2020; Qi *et al.*, 2020). Port capacity spillovers are negative across all regions, significant in Eastern Indonesia (-0.468), highlighting inefficiencies and limited integration

(Bottasso *et al.*, 2014; Qi *et al.*, 2020; Nenavath, 2023). Truck spillovers are positive in Western Indonesia (0.265, significant at 1%) but negative in Eastern Indonesia (-0.273), reflecting environmental and congestion externalities (Wang, Kim and Kim, 2021; Hussain *et al.*, 2022).

Finally, total effects combine direct and indirect impacts. Physical capital shows positive effects only in Eastern Indonesia (0.015), while human capital remains strongly positive across regions (1.768 in Western Indonesia, 4.265 in Eastern Indonesia, 1.355 nationally), underscoring its importance for sustained growth (Mankiw, Romer and Weil, 1992; Todaro and Smith, 2012; Maryaningsih, Hermansyah and Savitri, 2014). Population growth total effects are positive in Western (0.125) and Eastern Indonesia (0.250), supporting market expansion. Road infrastructure exhibits positive total effects in all regions (0.055 in Western Indonesia, 0.279 in Eastern Indonesia, 0.131 nationally), while airport total effects are asymmetric, negative in Eastern Indonesia (-0.610) but positive elsewhere (Karim, Suhartono and Prastyo, 2020; Qi *et al.*, 2020). Port capacity has negative total effects, most pronounced in Eastern Indonesia (-0.554, significant at 5%) (Bottasso *et al.*, 2014; Qi *et al.*, 2020; Nenavath, 2023). Truck transport maintains positive total effects in Western Indonesia (0.292, significant at 1%) and nationally (0.124), but negative in Eastern Indonesia (-0.210), highlighting dependence on regional system capacity and environmental management (Hussain *et al.*, 2022). Overall, these results confirm that road and truck infrastructure strategically strengthen regional growth, whereas airport and port limitations may reduce the net benefits due to negative spillovers.

CONCLUSION

This study examines the impact of logistics infrastructure on interregional economic growth in Indonesia during 2014–2023 using a fixed-effects Spatial Durbin Model (SDM). The results indicate heterogeneous effects across infrastructure types and regions. Road infrastructure consistently produces positive local and spillover effects, highlighting its key role in enhancing connectivity and market integration. In contrast, airport and port infrastructure often show negative effects, particularly in Eastern Indonesia, reflecting operational inefficiencies, limited intermodal connectivity, and suboptimal logistics integration. Truck fleets generally contribute positively, although spillover effects vary regionally. Physical capital has weak and mostly insignificant effects, while human capital emerges as the strongest growth driver, with substantial direct and spillover effects, especially in Eastern Indonesia. Population growth exhibits mixed effects, with negative direct but positive indirect and total impacts.

This study has several limitations. First, port data are incomplete and cover only 21 provinces, limiting the representativeness of maritime logistics effects. Second, the analysis uses provincial-level data, which aggregates smaller administrative units and may obscure micro-level economic interactions. Third, although spatial autocorrelation was tested using a KNN matrix, the SDM estimation relies on an inverse-distance weight matrix, and alternative spatial weight specifications were not examined, leaving potential sensitivity of spillover estimates untested.

Based on these limitations, future research directions include expanding data coverage to all provinces and incorporating additional logistics indicators, using finer spatial units such as districts or municipalities to capture more granular interactions, and conducting sensitivity analyses with alternative spatial weight matrices (e.g., distance thresholds, inter-regional trade flows, or Input–Output–based matrices) to assess robustness. Additionally, dynamic spatial panel models or models including operational efficiency and logistics integration variables could better capture long-term growth dynamics and interregional spillovers.

The findings also suggest several policy implications. Enhancing road infrastructure quality, strengthening spatial coordination among provinces, improving logistics efficiency, and investing in human capital development are critical, especially in Eastern Indonesia, to maximize the benefits of infrastructure investment. Coordinated planning and intermodal integration are necessary to ensure positive spillover effects and inclusive regional economic growth.

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