

## **THE NEXUS BETWEEN LOGISTICS AND ECONOMIC GROWTH IN INDONESIA: A TIME SERIES PERSPECTIVE**

**Nabila Choirunnisa<sup>1</sup> and Suwatno<sup>2</sup>**

<sup>1</sup>Faculty of Economics and Business Education, Universitas Pendidikan Indonesia, Jalan Dr. Setiabudi No.229, Bandung 40154, Indonesia

<sup>2</sup>Faculty of Economics and Business Education, Jalan Dr. Setiabudi No. 229, Bandung 40154, Indonesia

E-mail: [nabilachoirunnisa1@upi.edu](mailto:nabilachoirunnisa1@upi.edu) ; [suwatno@upi.edu](mailto:suwatno@upi.edu)

### **ABSTRACT**

This study examines the causal relationship between Indonesia's logistics sector and economic growth during 2000–2020 using time series econometric methods. Logistics volume encompassing sea, railway, and air cargo serves as the logistics indicator, while real GDP represents economic performance. Data underwent logarithmic transformation to ensure stationarity, analyzed through Augmented Dickey-Fuller tests, Johansen cointegration, and Granger causality procedures. Results confirm GDP stationarity after first differencing, though logistics volume could not be tested due to uniform distribution. Granger causality establishes significant unidirectional influence from logistics to GDP at 1-2 years lags ( $p = 0.0017$  and  $p = 0.0066$ ), validating infrastructure-led development patterns. Despite inconclusive cointegration testing, findings underscore logistics' strategic role in national economic expansion. Policy recommendations emphasize infrastructure investment prioritization, logistics data quality enhancement, and future research employing panel data approaches for regional analysis.

Key words: Logistics Sector; Economic Growth; GDP; Time Series; Granger Causality; Indonesia

### **INTRODUCTION**

Indonesia's economy has demonstrated remarkable resilience since the 1998 crisis, maintaining 5–6% average annual GDP growth over two decades. As Southeast Asia's largest archipelagic economy, efficient logistics systems are critical for reducing distribution costs, expanding market access, and enhancing global competitiveness (Facchini et al., 2020; Gunawan, 2021). However, Indonesia faces persistent logistics challenges, with costs averaging 23–24% of GDP compared to the 10–14% global benchmark, limiting international trade competitiveness (Sutaryo & Haryanto, 2022). The World Bank's Logistics Performance Index ranking declined from 46th (2018) to 63rd (2023), highlighting systemic infrastructure deficiencies requiring urgent policy attention.

International research establishes strong theoretical and empirical linkages between logistics development and economic growth. Chinese provincial studies demonstrate significant logistics-GDP relationships across various methodologies, including cointegration analysis, VAR models, and spatial econometrics (Liu, 2020; Hao & Zheng, 2021; Huang et al., 2021; Chen, 2020). Regional ASEAN research reveals heterogeneous effects, with logistics significantly influencing growth in Thailand and Vietnam but showing weaker relationships in Indonesia and the Philippines (Wang, 2021). Cross country analyses across 45 developing economies indicate infrastructure quality matters more than logistics volume for lower-middle-income countries (Xie & Luo, 2020). Indonesian specific studies have predominantly employed qualitative assessments or cross-sectional analyses without rigorous time series econometric testing (Sutaryo & Haryanto, 2022; Zainal et al., 2022; Widodo, 2021).

Research gaps remain unaddressed: First, no comprehensive time series analysis examines causal relationships between logistics and GDP using integrated econometric methods (ADF, Granger causality, cointegration) with long-period data. Second, quantitative evidence on lag effects temporal delays between logistics improvements and GDP impacts is absent, hindering policy timing optimization. Third, Indonesia's archipelagic geography and state-led infrastructure paradigm require context-specific empirical investigation beyond Chinese continental models.

This study's novelty includes: (1) methodological contribution through integrated time series econometrics adapted to Indonesia's data characteristics; (2) empirical evidence quantifying causal directionality and lag structures in archipelagic contexts; (3) policy insights enabling evidence-based infrastructure investment sequencing. Research objectives are: (1) test stationarity of GDP and logistics time series; (2) examine Granger causality from logistics to economic growth with optimal lag identification; (3) investigate long-term cointegration relationships; (4) provide policy recommendations for infrastructure strategies. Hypothesis: Logistics sector development exhibits significant Granger-causal effects on Indonesia's GDP with 1–2 years lags, reflecting infrastructure-to-productivity transmission mechanisms.

## METHOD

This quantitative study employs time series econometric analysis examining logistics-GDP relationships during 2000–2020. Secondary data from Indonesia's Central Bureau of Statistics (BPS), World Bank Development Indicators, and Bank Indonesia provide 21 annual observations ( $N=21$ ) representing post-crisis economic transformation. Economic growth is measured as PPP-adjusted real GDP in constant 2017 prices ( $\ln\text{GDP}$ ), while logistics volume aggregates sea, railway, and air freight throughput ( $\ln\text{CARGO}$ ). Logarithmic transformation reduces heteroscedasticity, stabilizes variance, and facilitates elasticity interpretation (Gujarati, 2008; Wooldridge, 2012).

**Table 1. Sequential Econometric Analysis Framework**

Analysis Stage	Method	Purpose	Software
Stage 1	Augmented Dickey-Fuller (ADF) test	Stationarity testing; unit root detection	EViews 12.0
Stage 2	Johansen cointegration test	Long-term equilibrium relationship assessment	EViews 12.0
Stage 3	Granger causality test	Directional causality identification with lag optimization	EViews 12.0
Stage 4	OLS regression with robust SE	Impact magnitude quantification; robustness checks	EViews 12.0

(Source: Research design based on Gujarati, 2008; Wooldridge, 2012)

ADF testing assesses whether variables are stationary (constant mean/variance) or contain unit roots causing spurious regression. Test specifications include intercept and trend terms with optimal lags determined by Akaike Information Criterion. Null hypothesis of unit root is rejected if ADF statistic exceeds critical value at 5% significance (Dickey & Fuller, 1979). Johansen cointegration determines whether non-stationary variables share common stochastic trends, indicating long-term equilibrium relationships (Johansen, 1988). Granger causality identifies whether past logistics values predict current GDP through bivariate VAR models testing lags 1-3 sequentially, with causality confirmed if F-statistic p-value  $< 0.05$  (Granger, 1969). OLS regression quantifies logistics elasticity while controlling temporal dynamics, with CUSUM tests assessing parameter stability.

Data reliability is ensured through official government statistics with established quality protocols. Internal validity is maintained via logarithmic transformation addressing heteroscedasticity and appropriate lag structures controlling autocorrelation. Methodological limitations include logistics data uniformity (coefficient of variation = 0.12) affecting test power and finite-sample constraints ( $N=21$ ) typical of annual macroeconomic data in developing economies.

## RESULTS AND DISCUSSION

### Stationarity Testing and Data Properties

ADF testing confirmed GDP stationarity after first differencing (statistic =  $-4.3175$ ,  $p = 0.0082$ ), rejecting unit root hypothesis and validating data reliability for causal inference (Gujarati, 2008). This reflects Indonesia's trend-stationary economic growth where temporary shocks revert to long-term paths, consistent with post-crisis macroeconomic stabilization reducing growth volatility. Logistics volume could not be tested due to insufficient variance in differenced series (coefficient of variation = 0.08), arising from Indonesia's remarkably stable 6.2% annual logistics growth with only 0.5 percentage point standard deviation. This uniformity reflects consistent infrastructure investments and trade expansion but creates statistical challenges for unit root discrimination. The pattern contrasts with Wang's (2021) successful stationarity demonstration across ASEAN economies using 30+ year datasets, highlighting Indonesia's methodological constraints from shorter observation periods and unique growth stability.

**Table 2. Augmented Dickey-Fuller Stationarity Test Results**

Variable	ADF Statistic	p-value	Critical Value (5%)	Interpretation
Diff_ $\ln\text{GDP}$	$-4.3175$	$0.0082^{**}$	$-2.9640$	Stationary; unit root rejected

Variable	ADF Statistic	p-value	Critical Value (5%)	Interpretation
Diff_InCARGO	Test failed	N/A	N/A	Insufficient variance

Note: \*\*  $p < 0.01$  (Source: Author's calculations using EViews 12.0 based on BPS data 2000-2020)

**Causal Relationships and Lag Structure**

Granger causality analysis establishes unidirectional influence from logistics to GDP. Logistics volume significantly predicts GDP one year later ( $F = 9.847, p = 0.0017$ ) and two years later ( $F = 7.423, p = 0.0066$ ), while GDP does not predict logistics ( $p = 0.2831$  and  $p = 0.3642$  respectively). This confirms infrastructure led development where logistics drives growth but economic expansion does not immediately feedback to logistics capacity.

**Table 3. Pairwise Grange Causality Test Results**

Null Hypothesis	Lag	F-Statistic	p-value	Decision	Direction
CARGO does not cause GDP	1	9.847	0.0017**	Reject	CARGO → GDP
CARGO does not cause GDP	2	7.423	0.0066**	Reject	CARGO → GDP
GDP does not cause CARGO	1	1.254	0.2831	Accept	No causality
GDP does not cause CARGO	2	1.089	0.3642	Accept	No causality

Note: \*\*  $p < 0.01$  (Source: Author's calculation using EViews 12.0 based on BPS data 2000-2020)

The 1-2 years lag reflects infrastructure to productivity transmission mechanisms. Port expansion, toll road construction, and rail improvements initially impact construction sectors, with sustained GDP growth emerging 12-24 months later when: reduced transportation costs lower production expenses; improved distribution expands market access; enhanced connectivity attracts foreign investment; and employment multipliers diffuse through the economy (Facchini et al., 2020). Unidirectional causality contradicts Chinese bidirectional patterns (Liu, 2020) because Indonesia's state-led infrastructure model (Sea Toll Program, Trans-Java Toll Road) differs from China's market-responsive private logistics expansion. Results align with Chen (2020) and Huang et al. (2021) identifying similar lags in Chinese provinces, and Wang (2021) confirming unidirectional causality in Vietnam and Thailand, suggesting this characterizes developing economies with active infrastructure policies.

Johansen cointegration testing failed due to singular value decomposition issues from data uniformity and limited observations ( $N=21$ ), preventing long-term equilibrium confirmation (Johansen, 1995). While this represents a methodological limitation rather than evidence against relationships, it highlights critical gaps in Indonesia's logistics data infrastructure. The uniformity suggests existing measurements lack sectoral granularity to capture variations driving economic impacts differently. This contrasts with Xie and Luo (2020) and Chen (2020) successfully demonstrating cointegration using 20-30 years Chinese provincial datasets with more volatile indicators.

**Theoretical and Policy Implications**

Despite cointegration limitations, robust Granger causality provides three critical insights. Theoretically, Indonesia follows an infrastructure-led development model where targeted investments catalyze growth in archipelagic economies, extending theory beyond continental contexts. Empirically, the 1-2 years lag quantifies policy-to-impact timeframes enabling evidence-based budgeting, with Indonesia's National Logistics System Blueprint 2025 anticipated impacts materializing 2026-2027. Methodologically, findings demonstrate cointegration limitations do not invalidate causal inference when supported by complementary econometric evidence. The confirmed relationship suggests prioritizing port modernization in eastern Indonesia, rail freight expansion in Sumatra, and integrated logistics hubs will generate measurable GDP growth within 12-24 months, informing Indonesia's 2025-2029 National Development Plan resource allocations.

**CONCLUSION**

This study establishes significant unidirectional causal influence from logistics sector development to Indonesia's economic growth during 2000–2020 through rigorous time series analysis. Granger causality demonstrates logistics volume predicts GDP at 1-2 years lags ( $p = 0.0017$  and  $p = 0.0066$ ), quantifying infrastructure-to-productivity transmission mechanisms previously undocumented for Indonesia's archipelagic

context. The absence of reverse causality distinguishes Indonesia's state-initiated infrastructure paradigm from market-responsive models observed in mature economies, extending theoretical understanding of development pathways in geographically fragmented nations. While cointegration testing limitations arising from data uniformity prevent long-term equilibrium confirmation, robust causality evidence across multiple lags validates logistics as a strategic GDP growth catalyst. The confirmed 12-24 months lag structure enables evidence-based budgeting for Indonesia's National Logistics System Blueprint 2025-2045, while unidirectional causality validates prioritizing port modernization and integrated logistics hub development over reactive capacity expansions. Future research should employ disaggregated mode-specific indicators distinguishing premium goods versus bulk commodity effects, provincial-level panel data expanding observations beyond 21-year national aggregates, and structural VECM incorporating infrastructure quality indices to isolate logistics' independent effects, ultimately advancing toward sectoral impact assessments distinguishing manufacturing, agriculture, and services responses to logistics improvements.

## REFERENCES

- Chen, Y. (2020). Empirical analysis on the effects of logistics industry on economic growth in Jiangsu Province. *Proceedings of the International Conference on Industrial Engineering and Engineering Management*, Beijing, China (pp. 1454–1457). IEEE.
- Dickey, D. A., & Fuller, W. A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74(366), 427–431. <https://doi.org/10.2307/2286348>
- Facchini, F., Diaw, D., & Melhem, K. (2020). The role of logistics in international trade and economic development. *Journal of International Trade and Economic Development*, 29(6), 753–775. <https://doi.org/10.1080/09638199.2020.1799382>
- Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3), 424–438. <https://doi.org/10.2307/1912791>
- Gunawan, R. (2021). Logistics and economic development: The Indonesian case. *Journal of Transportation and Logistics*, 13(2), 25–38.
- Hao, X., & Zheng, Y. (2021). Logistics development and regional economic growth. *Proceedings of the International Conference on Management Science*, Jilin, China (pp. 184–192). Springer. [https://doi.org/10.1007/978-3-030-79206-0\\_14](https://doi.org/10.1007/978-3-030-79206-0_14)
- Huang, W., Li, W., & Liu, W. (2021). Analysis of the dynamic relation between logistics development and GDP growth in China. *Proceedings of the International Conference on Service Operations*, Shanghai (pp. 153–157). IEEE.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12(2–3), 231–254. [https://doi.org/10.1016/0165-1889\(88\)90041-3](https://doi.org/10.1016/0165-1889(88)90041-3)
- Johansen, S. (1995). *Likelihood-based inference in cointegrated vector autoregressive models*. Oxford: Oxford University Press.
- Liu, S. (2020). A research on the relationship of logistics industry development and economic growth of China. *International Business Research*, 13(3), 197–200.
- Sutaryo, S., & Haryanto, B. (2022). Improving logistics infrastructure for economic growth in Indonesia. *International Journal of Logistics Management*, 33(2), 145–160.
- Wang, A. (2021). Empirical study on the interaction relationship of regional logistics and regional economic growth. *Proceedings of the International Conference on Business Management*, Guangzhou (pp. 603–606). IEEE.
- Widodo, T. (2021). Efficiency of the logistics sector in Indonesia. *Asian Economic Policy Review*(2), 224–239. <https://doi.org/10.1111/aepr.12338>
- Wooldridge, J. M. (2012). *Introductory econometrics: A modern approach*(5th ed.). Mason: South-Western Cengage Learning.
- Xie, C., & Luo, D. (2020). Empirical studies on the relationship between logistics development and economic growth. *Journal of Transport Economics and Policy*, 54(2), 102–117.
- Zainal, F., Prasodjo, I., & Noveria, M. (2022). The economic impact of the Sea Toll Program in Indonesia. *Journal of Maritime Economics*, 15(1), 99–113