The Effects of Transportation Infrastructure, International Trade, and Foreign Direct Investment on Economic Growth in the Lao People's Democratic Republic

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Abstract

This paper examines the effects of transportation infrastructure, international trade, and foreign direct investment on the economic growth of the Lao People's Democratic Republic. This study is quantitative research using secondary data at the provincial level (10 provinces) by considering the available panel data from 2013–2022. Panel regression analysis was utilized to find the impact of independent variables on economic growth. The results highlight significant relationships between various independent variables and economic growth. Transportation infrastructure has a positive impact on economic growth, indicating that improvements in transportation infrastructure are associated with higher economic output. Foreign direct investment also shows a strong positive effect on economic growth, suggesting that increased foreign investment contributes significantly to economic growth. Conversely, international trade negatively affects economic growth, implying that a higher level of international trade can hinder economic expansion. Therefore, the Lao government should limit unnecessary goods imports and expand more road network density to connect region to region and urban to rural areas.

Keywords: Transportation infrastructure, international trade, foreign direct investment, economic growth

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ผลกระทบของโครงสร้างพื้นฐานด้านการขนส่งการค้าระหว่างประเทศและการลงทุนโดยตรงจากต่างประเทศต่อการเติบโตทางเศรษฐกิจในสาธารณรัฐประชาธิปไตยประชาชนลาว

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บทคัดย่อ

งานวิจัยนี้ศึกษาผลกระทบของโครงสร้างพื้นฐานด้านการขนส่ง การค้าระหว่างประเทศ และการลงทุนโดยตรงจากต่างประเทศที่มีต่อการเติบโตทางเศรษฐกิจในสาธารณรัฐประชาธิปไตยประชาชนลาว โดยเป็นงานวิจัยเชิงปริมาณที่ใช้ข้อมูลทุติยภูมิในระดับจังหวัด (10 จังหวัด) จากข้อมูลพาแนลในช่วงปี ค.ศ. 2013–2022 การวิเคราะห์ใช้การถดถอยแบบพาแนลเพื่อศึกษาผลกระทบของตัวแปรอิสระต่อการเติบโตทางเศรษฐกิจ ผลการวิจัยแสดงให้เห็นถึงความสัมพันธ์ที่มีนัยสำคัญระหว่างตัวแปรอิสระต่างๆ และการเติบโตทางเศรษฐกิจ โดยพบว่าโครงสร้างพื้นฐานด้านการขนส่งมีผลกระทบในเชิงบวกต่อการเติบโตทางเศรษฐกิจ ซึ่งบ่งชี้ว่าการพัฒนาโครงสร้างพื้นฐานด้านการขนส่งส่งผลให้ผลผลิตทางเศรษฐกิจเพิ่มขึ้น ในขณะที่การลงทุนโดยตรงจากต่างประเทศก็มีผลเชิงบวกอย่างมากต่อการเติบโตทางเศรษฐกิจ ซึ่งแสดงให้เห็นว่าการลงทุนจากต่างประเทศที่เพิ่มขึ้นมีส่วนช่วยอย่างสำคัญต่อการขยายตัวทางเศรษฐกิจ ในทางตรงกันข้าม การค้าระหว่างประเทศกลับส่งผลกระทบในเชิงลบต่อการเติบโตทางเศรษฐกิจ ซึ่งหมายความว่าการค้าระหว่างประเทศในระดับที่สูงขึ้นอาจขัดขวางการขยายตัวทางเศรษฐกิจ ดังนั้น รัฐบาลลาวควรจำกัดการนำเข้าสินค้าที่ไม่จำเป็นและขยายความหนาแน่นของเครือข่ายถนนเพื่อเชื่อมต่อภูมิภาคต่างๆ รวมถึงพื้นที่เมืองและชนบทเข้าด้วยกัน

คำสำคัญ: โครงสร้างพื้นฐานด้านการขนส่ง การค้าระหว่างประเทศ การลงทุนโดยตรงจากต่างประเทศ การเติบโตทางเศรษฐกิจ

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Introduction

Recent discussions have highlighted that transportation infrastructure has become a crucial driver of sustained economic growth in recent years. The transportation system is an essential infrastructure for economic growth (Zhang et al., 2021; Zhang & Cheng, 2023). Historically, the importance and advantages of transportation infrastructure for economic progress have been well-recognized. Furthermore, a country's transportation infrastructure boosts its productive volume by raising the productivity of its resources and increasing resource mobilization.

The Lao People's Democratic Republic (Lao PDR) is a landlocked country, and its transportation infrastructure is underdeveloped (The World Bank, 2021). This has made Lao's economy grow at a slow rate in the last five years. The lack of direct access to the sea and insufficient facilities have limited the growth of this small domestic market, which as of 2022 had a population of only 7.2 million people. With its ongoing negotiations to join the World Trade Organization (WTO), the country has increased its efforts to integrate on a global scale with a real GDP of 4.4% (Bank of the Lao PDR, 2022). Because the Lao PDR has no border on the sea, road transport is the dominant mode of transportation, and it is believed that shortly, road transport will continue to dominate both freight and passenger traffic. Lao's transportation infrastructure has increased every year through a period of rapid expansion, which will increase the country's transportation capacity and foster economic growth. Nevertheless, the GDP per capita of Laos was $2,566 in 2022.

Furthermore, relative to FDI inflows in the manufacturing sector, the Lao PDR's economic growth over the past ten years has been significantly affected by FDI inflows into the mining and hydropower sectors, which are both highly capital-intensive. As of 2021, the FDI share of Laos' GDP was 5% (Ministry of Planing and Investment, 2021). In contrast, no notable technological advancements or innovations have taken place in other areas that would boost long-term economic productivity and performance. Therefore, foreign direct investment is still significant and essential to the sustained economic progress of emerging countries, especially the Lao PDR.

Besides, FDI international trade was significant to economic growth as well, according to the value of exports and imports that have grown gradually in 2022. The value of exports covers 52.58% share of GDP, and import value covers 46.34% share of GDP. This presents an excellent opportunity to lower logistics costs and save time on the distribution of goods. Because Laos places less importance on

investing and constructing transportation infrastructure, there have been very few empirical studies studying the relationship between economic growth and the improvement of transportation infrastructure. Hence, the researcher needs to fill any gaps of the previous studies.

Literature Review

The nexus between transportation infrastructure and economic growth

Previous studies have found the nexus between transportation infrastructure and economic growth (Nguyen, 2022), and the results present that transportation infrastructure has a positive impact on economic growth. Wang et al. (2021) analyzed the link between Korea's economic expansion and the development of its logistical infrastructure. Considering the long-run equilibrium between the two factors, the causal relationship between logistics infrastructure and economic development is assessed using vector autoregressive (VAR) and vector error correction model (VECM) techniques. It was discovered that economic growth generally follows the expansion of the logistical infrastructure. Particularly, the findings show a beneficial relationship between maritime transport and Korea's economic expansion in terms of GDP and foreign trade. Additionally, Kalan and Gokasar (2020) investigated a dynamic panel data approach for the analysis of the growth impact of highway infrastructures on economic development in Turkey by using a panel regression to measure the effect of highway capital stock and economic growth between 2004-2016.The results showed that there is a positive relationship between transportation infrastructure and economic growth. Nguyen (2022) investigated the geographical spillover effects of transportation infrastructure in Vietnam. To calculate the geographical impact of transportation infrastructure on Vietnam's economic growth from 2000 to 2019, the spatial Durbin model was used. Due to the national transportation infrastructure's connected nature, the data demonstrated that there is good evidence for each time. Transportation infrastructure spillover effects at the regional level varied significantly over time among Vietnam's four macro-regions: the southern region always has a positive spillover effect; the northern region had negative spillover effects from 2000 to 2009 and positive spillover effects from 2010 to 2019; the central region had negative spillover effects from both periods; and in the case of the Mekong Delta's economic region, negative spillovers can be seen starting in 2010.

The nexus between international trade and economic growth

There have been several studies on the relationship between international trade and economic growth (Kar & Pazarci, 2022). the investigations found that there are both positive and negative impacts between international trade and economic growth. Maitra and Chakraborty (2023) revisited trade growth dynamics in India while enhancing the importance of human capital in the context of a trade liberalization regime. Using the autoregressive distributed lag–bound testing method, it is possible to determine the cointegrating relationship between income and various combinations of the human capital dimensions of export, import, exchange rate, trade openness, education, and health. Both the long–term and short–term dynamics of these relationships support the idea that both exports and imports contribute to income growth, supporting the theories of export–led and import–led growth. While human capital promotes growth, trade openness is damaging to it. Bajo–Rubio (2022) conducted a study to examine the connection between international trade and economic growth from the standpoint of one of the most well–established theories in this area – the export–led growth hypothesis – in the instance of Spain for over 170 years. Over the entire time, exports appeared to have contributed positively to economic growth in the Spanish economy, mostly because of the higher productivity connected to the export industry. Sarania (2021) applied the Toda–Yamamoto (TY) causality test and the auto–regressive distributed lag (ARDL) bounds testing approach to cointegration in order to examine the dynamic interrelationships among infrastructure, trade openness, foreign direct investments, economic growth, fixed capital formation, labor, and inflation rate in the context of India for the period 1970 to 2018, providing policy implications of the effectiveness of these key macroeconomic determinants. The findings pointed to significant causal short– and long–term interactions between infrastructure, foreign direct investment, trade openness, and economic development between 1970 and 2018. In the long run, a bi–directional relationship exists between INFI and GDP, suggesting that India should expedite the construction of adequate and expanded infrastructure facilities in the economy and among other things, frame its policy in a more liberalized manner for various sectors, including infrastructure, to attract more foreign direct investment inflows and make more openness to trade and globalization within an environment of ease of doing business that would help to sustain higher economic growth over a long period of time.

The relationship between foreign direct investment and economic growth

Brahimi (2022) studied Albania's economy by simulating how Foreign Direct Investment (FDI) has influenced that country's economic growth. The Cobb–Douglass production function was used to analyze the effect of FDI on the economic growth of Albania. The study chose to use the economic methodologies of OLS and WLS. Data from 1970 to 2019 were used. The findings indicted that foreign direct investment has little bearing on Albania's economic progress. The findings have an impact on how policies are chosen. Solow (2007) argued that FDI plays an essential role on a practical level and that a country can develop foreign capital and technology by attracting foreign investment. Based on these statements, FDI entering a country could be a means of transferring technology to increase productivity and economic growth. The amount of research looking at how FDI affects economic growth has increased dramatically in the past twenty years. Recently, Hakim and Rosini (2022) discovered that foreign direct investment has a positive effect on the economic growth of developing countries. However, FDI has no beneficial effect on economic growth, according to Bermejo et al. (2018) and a study by Li et al. (2018), who claimed that foreign direct investment can only impact economic growth in the presence of a strong infrastructure and economic framework. The impact of foreign direct investment on economic growth is null and void if a nation's capital market is unstable (Osei & Kim, 2020). Moreover, Alam et al. (2022) investigated the unequal effects of foreign direct investment on India's economic growth from 1991 to 2019. For control variables, trade openness, inflation, and financial development are also used. This study uses the non–linear autoregressive distributed lag (NARDL) model to examine the impact of these variables on economic growth.

According to the findings, positive foreign direct investment inflow shocks have a beneficial impact on India's economic growth, whereas negative FDI inflow shocks have the opposite effect. Additionally, the Wald test confirms that foreign direct investment has an unbalanced impact on GDP growth over both the long and short term. Additionally, in the long and the short run, financial development and inflation rates greatly slow economic growth. However, trade openness only has a long–term positive impact on economic growth. Several policy implications are intended to quicken the rate of economic growth based on these research findings. Therefore, this study indicates that there is a positive impact between transportation infrastructure, international trade, and foreign direct investment on economic growth in the context of the Laos PDR.

Research Objectives

To investigate the effects of transportation infrastructure, international trade, and foreign direct investment on economic growth.

Hypothesis

There is a positive effect of transportation infrastructure, international trade, and foreign direct investment on economic growth.

Research Scope

This research study is about the effects of transport infrastructure, international trade and foreign direct investment on the economic growth of the Lao PDR.The details include transportation infrastructure being the total length of roads, foreign direct investment being the amount of investment value that foreign country invest in Laos, international trade being the total value of Laos imports and exports to other countries share with GDP, and economic growth being GDP per capita. The population in this study are 18 provinces in Laos and the sample groups the researchers used a criterion of sampling by selecting the province that has yearly foreign direct investment from foreign countries and has yearly imports and exports abroad according to a report of the Lao Statistics Bureau.

Methodology

This research is quantitative research using panel data collected from several sources such as the Laos Bureau of Statistics, and the Ministry of Public Works and Transportation. The study uses panel regression to analyze the effects of independent variables on economic growth.

Population and sample

This study uses secondary data, the population in this study being 18 provinces in Laos and, using a sampling criterion, we use purposing sampling by selecting sample groups from provinces with annual foreign direct investment from other countries as well as annual imports and exports shared in GDP. Therefore, we can choose 10 of the 18 provinces from the northern region, including three provinces Borkeo, Xaiyabuly and Luangnamtha; five provinces from the middle, including Vientiane capital; the province of Khammuane, Bolikhamxay province, Xiengkhuang province and the province of

Savannakhet, and two provinces from the southern part, Champasak and Attapeu, which complete the data for analysis. Therefore, this research can select 10 provinces with 100 observations.

Data collection

This research considered the available panel data covering the period of 2013–2022 obtained from the following sources: World Bank, Bank of Laos, Laos Statistic Bureau, Ministry of Planning and Investment and Ministry of Public Work and Transportation. For the dependent variable the GDP per capita is used to represent economic growth (Nguyen, 2021), which is divided by the provincial population (GDP per capita); the independent variable is transportation infrastructure measured by using the length of the road in kilometers as a proxy (Zhang & Cheng, 2023); and mediators are a foreign direct investment (FDI) by using the value of inflow investment from foreign investors (Hasan et al., 2022), and international trade using the value of trade between imports and exports share in the gross domestic product as a proxy (Ali et al., 2022).

Data analysis

To capture the effects of independent variables on economic growth, panel regression was used with the model expressed as follows:

$$lnGDP_{it} = \beta_1 + \beta_2 lnROAD_{it} + \beta_3 lnFDI_{it} + \beta_4 lnINT_{it} + \varepsilon_{it} \quad (1)$$

Where t and ε present time and error terms, respectively. GDP indicates GDP per capita, which is used as a proxy for economic growth. Trade indicates the value of all goods and other market services provided to the rest of the world. Transportation infrastructure indicates the total inland transport investment. The parameters β_2, β_3, and β_4 are the long–term elasticity of GDP per capita for transportation infrastructure, foreign direct investment, and international trade, respectively. The expected signs of β_2, β_3, and β_4 are positive because an increase in the level of transportation infrastructure should affect a higher exports and imports value share in GDP greater economic activity, and higher GDP per capita. The Levin, Lin & Chu (LLC) method is a widely used panel unit root test designed to detect stationarity in panel data (Levin et al., 2002). A stationarity test helps identify underlying trends or unit roots, enabling appropriate transformations, ensuring accurate model specification, and enhancing the robustness of statistical inferences.

This research utilized panel data. Hence, The Hausman Test is important in panel data analysis to select between Fixed Effects (FE) and Random Effects (RE) models. It calculates whether unobserved

entity–specific effects are related to the independent variables. If these effects are related, the RE model's assumptions are violated, and the FE model is more suitable to avoid biased estimators.

Research Results

Table 1 Stationary test results

Variable	Method	Statistic	*p*–value	Remarks
GDP per capita	Levin, Lin & Chu	–3.6607	0.0833*	Stationary
Transportation infrastructure	Levin, Lin & Chu	–2.7334	0.0772*	Stationary
International trade	Levin, Lin & Chu	–14.540	0.000***	Stationary
Foreign direct investment	Levin, Lin & Chu	–5.6501	0.0003**	Stationary

Source: Analyzed and concluded by the author

Table 1 shows the results of stationarity tests for four variables: GDP, transportation infrastructure, international trade, and foreign direct investment using the LLC method. The variable GDP shows a test statistic of –3.6607 with a *p*–value of 0.0833, indicating that it is stationary at the 0.1 significance level. Similarly, transportation infrastructure has test statistics of –2.7334 and a *p*–value of 0.0772, also showing stationarity at the 0.1 significance level. For the variable international trade, the test statistic is –14.540 with a highly significant *p*–value of 0.00, making it stationary at the 0.01 significance level. This robust evidence suggests that international trade is stationary. Finally, FDI has a test statistic of –5.6501 and a *p*–value of 0.0003, indicating it is stationary at the 0.05 significance level. In summary, all four variables are found to be stationary, each at various levels of significance, confirming their stationarity based on LLC test results.

Table 2 Normality test results

Variables	Obs	Mean	Std. Dev.	Min	Max	Skew.	Kurt.
LnGDP	100	7.553	.391	6.715	8.817	.856	4.454
lnROAD	100	7.647	.578	6.323	8.689	–.085	2.186
LnFDI	100	16.765	2.113	11.933	22.339	.514	3.252
LnINT	100	.996	.972	.092	5.723	2.231	9.211

Source: Analyzed and concluded by the author

The descriptive statistics for the variables indicate varying levels of skewness and kurtosis. LnGDP shows a positive skewness of 0.856 and a high kurtosis of 4.454, suggesting a right-skewed distribution with heavy tails. LnROAD has a slightly negative skewness of −0.085 and a moderate kurtosis of 2.186, indicating a symmetrical distribution. LnFDI is positively skewed at 0.514 with a kurtosis of 3.252, suggesting mild skewness and peaked Ness. The interaction term, LnINT exhibits a significant positive skewness of 2.231 and a high kurtosis of 9.211, indicating a highly skewed and leptokurtic distribution. However, the values for asymmetry and kurtosis between −2 and +2 are considered acceptable to prove normal univariate distribution (Hair et al., 2010) argued that data are considered to be normal if skewness is between -2 to +2 and kurtosis is between -7 to +7. In addition, following an argument of Kline (2011), the absolute value of Skewness is greater than 3 and Kurtosis value greater than 10 may indicate a problem and values above 20 may indicate a more serious problem. Hence, it was suggested that the absolute value of Skewness and Kurtosis should not be greater than 3 and 10. Based on this recommendation, the absolute values of the Skewness and Kurtosis of all the items in this study are within the acceptable range of < 3 and < 10 respectively.

Table 3 Matrix of correlations

Variables	(1)	(2)	(3)	VIF
(1) lnROAD	1.000			1.11
(2) lnINT	0.072	1.000		1.10
(3) LnFDI	0.292	0.097	1.000	1.01

Source: Analyzed and concluded by the author

Table 3 displays a Variance Inflation Factor (VIF) analysis, which estimates multicollinearity between independent variables in a regression model. The variables listed (LnFDI, lnROAD, and LnINT) have VIF values close to 1, implying a minimal relationship with other predictors. A VIF value lower than 5 indicates no significant multicollinearity (Akinwande et al., 2015).

The effects of transportation infrastructure, international trade, and foreign direct investment (FDI) on economic growth results

Table 4 The effects of transportation infrastructure, international trade, and FDI on economic growth

Variables	Fixed effect				Random effect				Hausman test	LM test
lnGDP	Coef.	Std. Err.	*t*–value	*p*–value	Coef.	Std. Err.	*Z*–value	*p*–value		
lnROAD	0.09	0.043	2.14	0.03**	0.07	0.04	1.82	0.06*		
lnFDI	0.02	0.01	2.44	0.01***	0.03	0.01	3.02	0.00***	0.99	0.00
lnINT	–0.07	0.03	–2.45	0.01***	–0.07	0.03	–2.60	0.00***		
Constant	6.48	0.31	20.29	0.00***	6.47	0.32	19.95	0.000***		
R^2 = 0.19					R^2 = 0.27					
F–test = 6.82					$\chi 2$ = 23.06					
*** p < .01, ** p < .05, * p < .1										

Source: Analyzed and concluded by the author

The results of a regression analysis compare fixed and random effects models, which assess the impact of three independent variables – transportation infrastructure (lnROAD), foreign direct investment (lnFDI) and international trade (lnINT) on an unspecified dependent variable. The Hausman test value of 0.99 suggests that the random effects model may be more appropriate for this data set, as the *p*–value is not significant enough to reject the null hypothesis favoring the random effects model. In addition, the estimated results of the Breusch and Pagan Lagrangian multiplier test for random effects, Chibar2(01) = 136.97 and *p*–value = 0.00, indicate that the random effects model was appropriate. In conclusion, both models show that lnFDI and lnINT are significant predictors of the dependent variable, with lnFDI having a positive impact and lnINT having a negative impact. The fixed effects model suggests a slightly stronger impact for lnROAD than the random effects model, but overall, the random effects model better explains the variability in the dependent variable according to the Hausman test.

Table 4 results imply that the random effects model lnROAD has a coefficient of 0.07 with a standard error of 0.04. The *Z*–value of 1.82 and *p*–value of 0.06 indicate that lnROAD is significant at the 10% level ($p < 0.1$), suggesting a moderately significant positive impact. The coefficient for lnFDI in the random effects model is 0.03 with a standard error of 0.01. The *Z*–value of 3.02 and *p*–value of 0.00 indicate very high statistical significance at the 1% level ($p < 0.01$), suggesting a strong positive relationship. Similarly, lnINT has a coefficient of –0.07 with a standard error of 0.03. The *Z*–value of –2.60 and *p*–value of 0.00 show that lnINT is highly significant at the 1% level ($p < 0.01$), indicating a strong negative effect. The *R*–squared value for the random effects model is 0.27, suggesting that 27% of the variation in the dependent variable is explained by the model. The Chi–square value is 23.06, indicating the model's overall significance. Therefore, the equation of the results can be written as follows:

$$lnGDP_{it} = 6.47 + 0.07lnROAD_{it} + 0.03lnFDI_{it} - 0.07lnINT_{it} + \varepsilon_{it} \qquad (2)$$

Summary

The result highlights significant relationships between various independent variables and GDP. Transportation infrastructure positively impacts GDP, indicating that improvements in transportation infrastructure are associated with higher economic output. Foreign direct investment also shows a strong positive effect on GDP, suggesting that increased foreign investment contributes significantly to economic growth. Conversely, international trade negatively affects GDP, implying that higher international trade can hinder economic expansion.

Discussion and Recommendations

Regarding the effects of transportation infrastructure, international trade, and FDI on economic growth, the regression analysis reveals that FDI and international trade are significant predictors of the dependent variable, with FDI having a positive impact, and international trade having a negative impact. This aligns with Sudhakar and Velmurugan (2023) who found that FDI in India positively influences economic growth. Conversely, the negative impact of international trade on the dependent variable resonates with the findings of Shahzad et al. (2023), indicating that economic growth of the United States is much concerned with terms of trade (TOT). The estimated results of the TOT show that the US is an importing country. There could be two reasons for this. First, purchasing power is higher than selling power, negatively impacting economic growth. Second, the price of imported products is

comparatively higher than that of exported products, negatively affecting the United States' economic growth. For transportation infrastructure, the coefficient of 0.07 and *p*–value of 0.06 suggest a moderately significant positive impact at the 0.01 level, echoing the results of Ibahimov et al. (2023) and Nenavath (2023) who reported a positive correlation between transportation infrastructure and economic growth. Thus, the Lao government should invest in and enhance such infrastructure. Expanding and upgrading transportation networks can improve efficiency, reduce costs, and facilitate smoother movement of goods and people, boosting productivity and economic activity. Governments and businesses should prioritize funding for transportation projects, especially roads. Additionally, implementing smart technologies and maintaining infrastructure quality ensures long–term benefits. Strategic investments in transportation not only support current economic growth but also foster future development, enhance regional connectivity, and attract investment, thereby creating a more robust and dynamic economy.

Benefits

This study shows that Transportation infrastructure is crucial for attracting foreign direct investment and fostering economic growth. Efficient transportation networks, especially roads, can reduce logistics costs, improve accessibility, and enhance connectivity. This enables businesses to move goods and services swiftly, meeting global market demands and boosting trade. Well–developed infrastructure also signals a stable and investment–friendly environment, encouraging multinational companies to establish operations. As foreign direct investment flows in, it brings capital, technology, and expertise, which further stimulates local industries, creates jobs, and drives economic development. Thus, robust transportation infrastructure acts as a catalyst for sustained economic growth and global competitiveness.

Limitations

As this study was conducted, several limitations within the context of the Lao PDR made it quite difficult to access the data, and the researchers found that the data received from the survey had some irregularities and expected it moving away from the theory as was initially studied. Hence, the next study should collect all the data that involves designing studies and analyzing findings for deeper insights.

This study used only road length as a proxy of transportation infrastructure, which may present limitations to the results and data analysis. Therefore, future research should include, for example, air transportation for identifying transportation infrastructure. Additionally, using the share of imports and exports in GDP as a proxy for international trade and trade openness might not fully capture the complexities of trade policies, external market conditions, and non–tariff barriers.

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