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Transport as a catalyst for regional trade and economic development

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Abstract

This study examined the role of transport as a catalyst for export performance. Using a fixed-effects panel estimator with robust clustered standard errors, we analysed data from 31 countries over the 2022-2024 period. The major findings revealed that the transport and logistics performance index was a strong, positive predictor of export volumes, whereas import costs significantly reduced export growth. Remarkably, the direct cost of export was positive but not statistically significant, suggesting that higher export volumes may lead to greater procedural complexity, which increases the cost of exports. Regional integration through ECOWAS and SADC was associated with lower export performance, indicating the possible existence of non-tariff barriers among countries. The model also showed a substantial negative effect for landlocked countries, though at the margin of statistical significance. These findings emphasize the key role of trade facilitation, particularly efficient transport logistics and improved import procedures, in boosting export competitiveness, especially within the African region. The analysis suggests that policy efforts to reduce trade barriers should prioritize transport and logistics infrastructure and import facilitation to stimulate export growth.

1. Introduction

The complex web of roads, railways, ports, and digital connections that links the globe creates more than a simple physical infrastructure; it is the very lifeblood of today's economy. Efficient transport connectivity is widely recognized as the foundation of trade, investment, and broad-based economic growth (Rodrigue, 2024). By lowering the cost and time it takes to transport goods and people, transport infrastructure directly improves market access, enhances productivity, and enables the incorporation of regional economies into bigger, more competitive markets (Blanchard and Flint, 2017). This connectivity matters most in developing regions, where the lack of robust, integrated transport links is typically the single most important constraint on growth, perpetuating cycles of poverty and inequality (Henri, 2019). This paper argues that for transport to achieve its catalytic potential, especially within the divided regions, it must be planned and executed not as a collection of isolated projects, but as part of an all-inclusive, policy-driven framework designed to deeply connect regions and foster development that's both sustainable and benefits everyone.

Despite being rich in natural resources and blessed with a lively, youthful population, Africa's economic potential remains limited owing to a deep disintegration (Luke,2023). Intra-African trade stands at about 15% of global trade (World Bank, 2025). This divide is not an issue of tariff barriers but of disabling physical and administrative obstructions to movement. Transport costs are responsible for 40% of the purchase price of goods in some countries in Africa, excessively discouraging the competitiveness of local products and trapping landlocked countries in economic seclusion (World Bank,2024). The poor, small-scale traders, and women are the ones who disproportionately carry this weight, aggravating social inequalities while hampering the diversification and growth of economies away from raw material exports (Gutman and Malashenko,2025). The pursuit of trade growth through transport integration is disrupted by an intricate array of challenges that goes beyond the simple need for more roads or railways (Herrera et.al., 2021). These impediments are mutually reinforcing, forming a vicious cycle of high costs, low trade, and restricted growth. Understanding this landscape is key to policy planning.

The way academics and policymakers talk about transport has changed; it's no longer seen as a capital investment, but as a living, breathing system woven into the social and economic fabric (MacLeod et al., 2023). Despite the fact that Africa's network of ports and border posts is vast, only a few of them are true lifelines for feeding the continent (World Bank,2025). Thus, improving these specific hubs can strengthen vital trade corridors, lower prices,

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and boost trade by linking communities directly to the markets they depend on (World Bank,2025). Recent studies highlight that transport infrastructure investments are maximized only when paired with supportive "soft" infrastructure, harmonised guidelines, efficient supply chains, and policies that encourage fair competition (Bu et al., 2024). A study within the Southern African Development Community (SADC) found that while road quality influences trade openness, its effect is much stronger when paired with factors like sound macroeconomic policy and foreign direct investment (Morolo and Kambidima,2025). This shows that physical assets are an especially important but insufficient condition for development (Gutman and Malashenko,2025). Furthermore, there is a crucial need to think about sustainability. The transport sector is a major contributor to emissions; thus, its growth must find a balance, enhancing economic growth while protecting the environment (Morolo and Kambidima,2025).

The continuous gap between the recognised significance of transport infrastructure as a catalyst for trade and the unacceptable results of many infrastructure projects in Africa creates a critical academic and policy dilemma. While extensive investments continue to be made in roads, railways, and ports, the expected surge in regional trade and broad-based economic growth generally doesn't occur. Despite robust political agendas like the African Continental Free Trade Area (AfCFTA), among others, Africa's intra-regional trade remains at only 15%, a stark underperformance compared to Europe (67%) and Asia (61%). This glaring gap points not to an absence of determination but to deep failures in translating policy into practice.

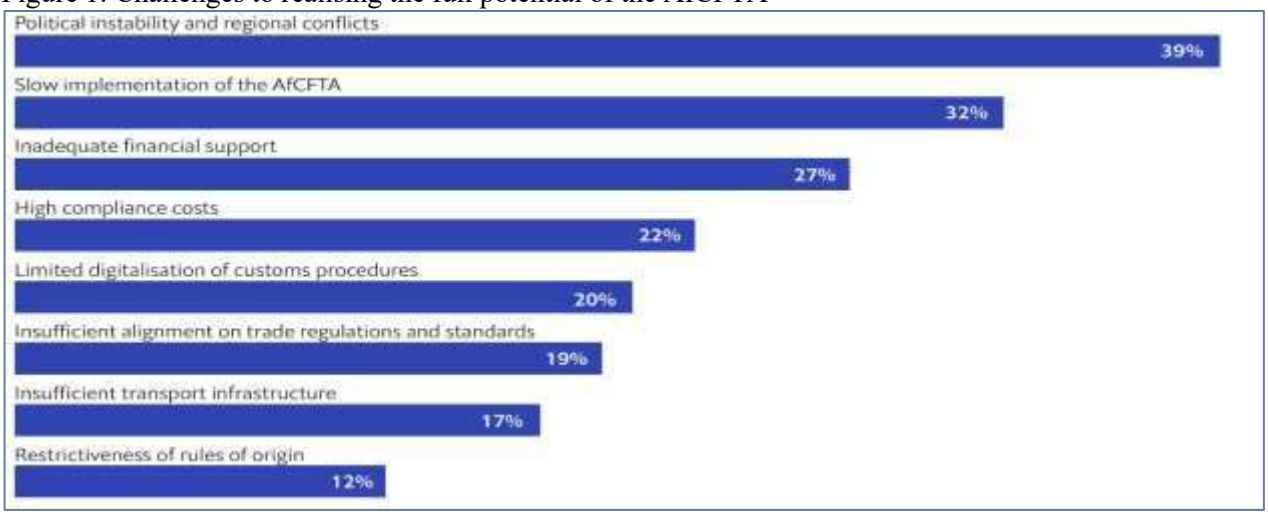
The implementation of automated systems such as ASYCUDA aimed to tackle border delays and improve the movement of goods and services across borders. However, a primary failure persists: the continued prioritisation of physical infrastructure over the necessary regulatory, procedural, and policy frameworks that should govern its operation. This misplaced priority is the key reason transport costs consume up to 40% of product prices in Africa, as inefficiencies at borders and in logistics prove as detrimental to trade as degraded road networks. Additionally, transport planning is often conducted in isolation, overlooking its intrinsic connection to trade policy, industrial strategy, and the pursuit of spatial equity. This siloed approach yields infrastructure that is technically complete but economically and socially deficient; it connects points without creating meaningful trade, stimulating local economies, or ensuring equitable benefits, thereby strengthening the disadvantages encountered by marginalized communities. Consequently, this paper seeks to address the consistent underperformance of transport infrastructure as a trade catalyst. Its central questions are: Why do transport investments persistently under-deliver on regional trade promises, and what are the essential components of a holistic framework to translate this persistent bottleneck into a reliable catalyst for integrated and sustainable growth? The main goal is to create a sustainable transport infrastructure. This paper aims to deepen our understanding by examining transport as an engine for trade development. The specific objectives are to assess the Impact of Transport Infrastructure on Regional Trade Patterns, with special focus on exports and to provide Integrated Policy Solutions for addressing Systemic Bottlenecks Identified in Regional Trade.

The rest of the paper is organised as follows. Section 2 presents an overview of the dynamics of transport infrastructure and trade performance in Africa. Section 3 reviews the relevant theoretical and empirical literature, while Section 4 outlines the methodology and discusses the empirical analysis and results. Finally, Section 5 concludes the study.

2. The Dynamics of transport infrastructure and/or trade performance in Africa

Insufficient physical infrastructure, including degraded roads, unavailable rail connections, and congested ports, directly doubles shipping costs, extends delivery times, and increases cargo loss, especially for perishable goods (Akinshipe and Aigbavboa, 2020). The continent's drive for economic integration through the African Continental Free Trade Area (AfCFTA) cannot be achieved without a matching transformation in the transportation network (MacLeod et al., 2023). Figure 1 shows insufficient transport infrastructure, limited digitalisation, insufficient regulation, and procedures as major factors in why Africa is failing to realize the full potential of AFCFTA.

Figure 1: Challenges to realising the full potential of the AfCFTA



Source: *Economist Impact Trade in Transition survey, August-November 2024*

This inadequacy is mirrored in a specific system of measurement for road access. OECD (2025) revealed that the percentage of road access in Africa is around 34%, which is low compared to the 50% global average. Subsequently, Jedwab and Storeygard (2021) discovered that, compared to the rest of the world, Africa is characterized by insufficient road access infrastructure, owning an average of 204 km per 1000 km² compared to the world average of 944 km per 1000 km². He further highlighted that road density in Africa is less than one-third of that of South Asia. Moreover, the quality of the network is also inadequate, as only 25% of roads in Africa are paved, relative to over 60% in India and 67% in China. Likewise, in terms of high-capacity corridors, Sub-Saharan Africa has only 3,700 km of highways, against 24,000 km in India and 111,900 km in China (Jedwab and Storeygard, 2021).

The disparity in road infrastructure has, on average, doubled the cost of transportation in Africa. Consequently, transport and logistics account for nearly half (up to 45%) of the final consumer price for staples like rice and cassava in Africa, a cost burden heightened by supply chains that are, on average, four times longer than their European counterparts (World Bank,2024). This highlights the huge potential for enhancement of transport and logistics in the Continent. According to (Gorgulu et al., 2023), improving road networks to increase connectivity between urban centres in Africa can catalyse around USD 250 billion in trade over 15 years. The magnitude of this opportunity is clearly revealed in regional comparison, as Latin America's intra-regional trade is 53% higher than Africa's, a difference resulting from superior transport infrastructure and greater regional integration, which make border crossings easier and logistics less costly (Takele, 2019).

Market structure deficiencies in Africa further hamper trade, with various transport conditions creating systemic bottlenecks. Thus, inadequate rail and road conditions combined with logistical tailbacks directly increase shipping costs, restrict entry to neighbouring markets, and reduce trade efficiency. Focusing on railways, accessibility is excessively lacking relative to the region's demographic and economic needs (Pagliara et al., 2022). This shortage is highlighted by Vilardell and Mateo (2023), who disclosed that only six African countries have reliable rail infrastructure above the world average (Morocco, Tunisia, and Egypt in North Africa, and Namibia, South Africa, and Swaziland in Southern Africa). The challenges spread to maritime gateways. Likewise, Mlambo (2021) disclosed that most seaports in Africa are affected by substantial incompetence and incapability, which hamper their smooth and efficient operations. Addressing these pervasive physical barriers through strategic infrastructure investment is therefore essential for unlocking economic growth and achieving meaningful regional integration (United Nations, 2025).

To address this critical situation at a regional level, the Programme for Infrastructure Development in Africa (PIDA) was established to encourage Africa’s regional economic integration through building infrastructure and strengthening trade. Within this framework, the African Development Bank (AfDB), as PIDA's implementing agency, created the dedicated infrastructure fund Africa 50 to influence private investments for high-impact infrastructure projects (Africa 50 Annual Report, 2018). Despite these efforts, a critical challenge such projects must address is market concentration (Notteboom et al., 2022). This matches a global trend, where nearly 40 percent of trade demonstrates high concentration, a phenomenon largely explained by the heterogeneity of operational economic factors across countries (Arriola et al., 2024).

It is imperative that improving transport connectivity infrastructure in Africa enhances the productivity of companies, thus improving their integration into global value chains. Inadequate infrastructure is often cited as the most significant trade barrier by firms in Africa to their global value chain participation (UNCTAD, 2024). Precisely, Transport connectivity was found to have more of an effect on global value chains than on aggregate trade flows (Arriola et al., 2024). This is because intermediate goods are more sensitive to transport costs than finished products (UNICTAD, 2024). This is very important as developing countries increasingly import raw materials and intermediate goods to produce manufactured products for export. To improve Africa's trade competitiveness, it is critical to bolster the reliability of trans-shipments and certainty of supply chain operations in transport connectivity (Chen, 2025).

Outside physical infrastructure, bureaucratic hurdles present some of the most significant obstructions to trade. In many developing regions, cross-border trade is severely inhibited by an intricate array of non-tariff barriers (Kuteyi and Winkler, 2022). These bureaucratic obstacles are evident in several interconnected ways that suffocate cross-border trade. Traders generally encounter cumbersome customs procedures characterised by excessive paperwork, manual processing, and a serious lack of automation, which produces long and unpredictable delays (Drinkwater and Robinson, 2023). Further complications emanate from fragmented standards between neighbouring countries, where different procedures on vehicles, axle loads, and product safety force transporters and manufacturers to navigate a perplexing and often inconsistent patchwork of rules (Drinkwater and Robinson, 2023).

The journey itself is often interrupted by paralysing checkpoints and unauthorized roadblocks, where numerous stops by police, immigration, and other agencies lead not only to chronic delays but also to demands for bribes (Kuteyi and Winkler, 2022). Collectively, this "thicket" of non-tariff barriers functions as a severe invisible tax on trade (Wahab, 2024). Research shows that such procedural inefficiencies can inflate the final cost of goods moving across regions by 25% or more, severely undermining competitiveness and stalling market integration (World Bank, 2025).

Ultimately, these persistent soft barriers signify regional governance failure. They expose how an absence of coordinated governance challenges political pledges for integration, leaving initiatives by SADC and ECOWAS elusive (Mutoya, 2020). According to the World Bank (2025), effective integration requires going beyond scrapping tariffs to addressing practical constraints that incapacitate the daily operations of ordinary producers and traders. In addition, the Feed Africa strategy underscores the requirement to increase investment in hard and soft transport infrastructure and to alleviate logistical issues in agro-processing zones and corridors. Similarly, it underlines the importance of African

governments to track transport policies intended to foster Africa's involvement in global value chains, while stressing the need to add value to exports through agricultural industrialisation (AFDB, 2016).

The issue of inefficient transport is regressive, falling excessively on those least able to carry it. Women, who include most informal cross-border traders, experience heightened vulnerability, while the poor are extremely affected as they allocate a larger portion of their income to high-cost transport and inflated prices for basic goods (Tucho, 2022). Additionally, the historical legacy of certain regions shapes their transport challenges.

This study has shown that the continuous failure of transport infrastructure to catalyse meaningful regional trade and development is not an issue of funding, but a systemic design failure. This research shows that the traditional hardware-oriented solution paradigm of investment in infrastructure policy remains suboptimal overall. The proposed fixed effects approach aims precisely at distinguishing and isolating this complex reality. It moves beyond proving correlation to diagnosing the specific points of policy failure. In essence, transport must be re-conceptualised from a sectoral expenditure into a foundational platform for integrated regional development. The catalytic influence of transport is not automatic; it is unlocked only through policies that have clear goals of trade facilitation, market integration, and equitable access.

3. Literature review

This section focuses on both theoretical and empirical literature underpinnings of the study.

3.1 Theoretical literature

Transport functions as an enabling infrastructure that reduces trade costs, reshapes spatial economic patterns, and unlocks agglomeration and productivity gains, thereby acting as a catalyst for regional trade and economic development. Theoretical work in transport economics, trade theory and regional science converges on the view that improved transport networks expand market access, deepen regional integration and generate dynamic growth effects, although the magnitude and distribution of these gains depend on policy, geography, and complementary institutions.

The phrase "three theories of trade and transport" most commonly refers to Edward Ullman's (1956) three bases of spatial interaction, which are widely used in economic geography and transport studies to explain why regions trade and how transport enables that trade. Edward Ullman proposed that spatial interaction (including trade flows) occurs when three conditions are met, which are: complementarity, where one region has a surplus of a good or service, while another has a deficit or demand for it. Trade arises because regions differ in what they produce and need. Even if complementarity exists, trade may be reduced or redirected if a closer or cheaper alternative source (or market) appears between the two regions, thus presenting an intervening opportunity. To enable trade to take place, the theory proposes that the good or service must be transferable.

The good or service must be movable at an acceptable cost and within a feasible time, given available transport technology, infrastructure, and regulations. Transferability captures the role of transport costs, distance, and logistics in enabling or constraining trade. Together, these three conditions form a compact theoretical framework linking trade patterns directly to transport; without sufficient transferability (effective, affordable transport), complementarity alone will not generate significant trade flows.

Transport is a form of economic infrastructure that provides connectivity between firms, households, and markets, and its main economic role is to lower generalised transport costs in time, money, and reliability. When transport systems are efficient, they increase accessibility, reduce input and transaction costs and create positive multiplier effects through expanded production, employment, and income (Rodrigue and Theo, 2024).

From a regional development perspective, transport infrastructure can be viewed as a spatial network that links regions and nodes, where improvements alter distance, travel times, and connectivity, thereby modifying patterns of specialisation and inter-regional interaction. These network properties mean that the benefits of transport investment can extend beyond the immediate corridor or locality through spillovers to connected regions (Gabriel and Tarasov, 2022).

In classical and neoclassical growth frameworks, transport enters as part of the capital stock that enhances the productivity of labour and private capital, supporting higher output and convergence across regions. Endogenous growth models extend this logic by treating transport and associated logistics services as knowledge- and service-intensive activities that generate increasing returns and facilitate the diffusion of technology and human capital across space (OECD, 2001).

However, these models also highlight potential diminishing returns and the risk that poorly selected projects simply reallocate activity rather than create net growth, implying that transport investment must be aligned with broader industrial and regional development strategies. Theoretical contributions note two difficulties: isolating pure transport effects from other factors and distinguishing between short-run construction impacts and long-run productivity and structural change (Heling, 1997).

Current trade theories explicitly integrate transport considerations through trade costs. In various models, bilateral trade is regarded as a function of the economic size of the trading partners and negatively on the distance or generalised transport cost between them. Structural fixed effects models of trade posit that decreases in transport costs between regions boost bilateral exports, modify multilateral resistance terms, and can increase real GDP. These gains

accrue not only in the directly connected regions but also in third-party regions through general equilibrium effects (Khatabi et al., 2025).

In these frameworks, transport acts as a trade facilitation mechanism: improved roads, ports, railways, and border procedures reduce iceberg transport and transaction costs, increasing the intensive margin (higher trade volumes on existing routes) and extensive margin (new trade links and products). At the regional bloc level, such as SADC, COMESA, and SACU, trade and transport agendas are explicitly linked through corridor development and customs transit arrangements that aim to integrate landlocked and coastal economies and support regional value chains (Anna at al., 2022).

New economic geography formalises the idea that declining transport costs interact with increasing returns and factor mobility to shape the spatial distribution of economic activity. When transport costs are high, production tends to be dispersed, but as costs fall, centripetal forces such as market access, input linkages and knowledge spillovers can lead to agglomeration of firms and workers in core regions, generating higher productivity and wages (Gabriel et al., 2015).

These models imply that transport improvements can both stimulate regional development and exacerbate core-periphery disparities, depending on initial conditions, the direction of investment and complementary regional policies. From a policy standpoint, corridor-based strategies attempt to harness agglomeration along key routes while extending feeder links and trade facilitation measures to ensure that landlocked or lagging regions capture benefits from expanded trade.

The literature identifies various mechanisms through which transport facilitates regional trade and economic development: reduced direct transport costs, improved reliability, enlarged market areas, labour mobility and attraction of investment. At the regional level, integrated transport networks underpin common markets by enabling free movement of goods and people, supporting the emergence of cross-border clusters and regional value chains in manufacturing, agriculture, and services (SAIIA, 2011).

Transport's developmental impact is mediated by governance, regulation, and trade facilitation; protocols on transport and trade, one-stop border posts, and regional customs transit guarantees can significantly magnify the gains from physical infrastructure by addressing "behind-the-border" and "at-the-border" barriers. Overall, the theoretical literature suggests that transport is a necessary but not sufficient catalyst; its capacity to drive regional trade and development depends on strategic network design, complementary industrial and integration policies, and institutions that ensure inclusive and sustainable spatial outcomes (SADC, 2025).

3.2 Empirical evidence

The nexus between transport and trade has long been the foundation of international economics, with current literature shifting from recognising transport as a mere trade enabler to a principal catalyst_for trade growth and facilitation. Existing studies strongly support the hypothesis that efficient transport infrastructure and logistics performance are key catalysts, reducing trade costs, improving competitiveness, and integrating economies into worldwide networks. This review not only synthesizes the prevailing evidence but also critically examines the nuances and critiques present within the literature. Central to this dynamic is the role of road infrastructure, where quality enhancements directly boost trade volume by lowering costs and increasing logistical effectiveness.

The transformative potential of such investments is evidenced by large-scale programs such as China's Belt and Road Initiative, where targeted road developments have supported international trade, spurred economic growth, and improved welfare via enhanced regional connectivity (Morten and Oliveira, 2024; Zhang, 2025; Cui et al., 2022; Maliszewska and van der Mensbrugghe, 2019).

At its core, trade needs the physical movement of goods, making the quality of transport infrastructure- roads, ports, railways, and airports- the chief determining factor of trade volume (Gbahabo et al., 2024; Sénquiz-Díaz, 2021; Bifou, et al., 2025. Recent empirical literature consistently confirms a strong, direct positive association. For example, a partial least squares structural equation modelling (PLS-SEM) analysis across 80 countries recognized a huge direct effect of transportation infrastructure on trade facilitation (Senquiz-Diaz, 2021).

Correspondingly, Senquiz-Diaz (2021) analysed 29 developing countries and discovered that the quality of roads and ports contributes significantly to higher exports. This direct catalytic impact is further measured in micro-level studies; for instance, in Colombia, domestic transport costs from the industry to port proved to be a significant friction, with regions in the lower cost percentile exporting 2.3 times more than those in the higher percentile (Baldomero-Quintana,2025). While robust road infrastructure improves trade by enhancing efficiency and accessibility, its full catalytic potential is dependent on supportive complementary policies and specific regional backgrounds (Morten and Oliveira, 2024; OECD, 2022; Han et al., 2025; Li et al., 2025).

This conditional relationship underlines the view that poor infrastructure acts as a prohibitive tax on trade, while improvements, specifically in poorly connected areas, can produce higher export gains (Mao et al., 2024). While infrastructure offers the physical base, logistics performance, encompassing customs competence, tracking, timeliness, and service quality, functions as the operational core that unlocks its full potential (Oğuz, 2023) The literature overwhelmingly recognizes logistics as a chief catalyst that increases the benefits of physical infrastructure (Long, 2025) The Logistics Performance Index (LPI) is widely used as the major proxy for trade facilitation, with studies proclaiming that, improved logistics improves trade flows across various global regions (Marti et al., 2014; Sharawi et al., 2025).

Likewise, Bhukiya et al. (2023) and Huong et al. (2026) identified a strong positive effect of logistics performance on trade volumes. Extending this analysis, Barakat et al. (2023) present evidence that logistics improvements are key determinants of trade and lower trade costs. Extending this analysis, Jayathilaka et al. (2022) assessed the effect of Gross Domestic Product (GDP) and the Logistics Performance Index (LPI) on international trade across 142 countries. Their findings validate the positive role of logistics performance, while also revealing that its catalytic effect is more noticeable in Asia, Europe, and Oceania.

For landlocked countries, poor logistics and infrastructure are a severe problem that affects trade flows compared to their coastal neighbours (AFDB, 2026). Most importantly, logistics performance frequently displays a more noticeable effect on trade than infrastructure alone. Adding to this comparative analysis, Senquiz-Diaz (2021) further confirmed that the effect of logistics on trade, mediated through trade facilitation, exceeds the direct impact of transportation infrastructure quality alone. In support, Cantoni et al. (2024) proposed that strategic investments in soft logistical proficiencies, such as customs modernisation, digital tracking (ASYCUDA system), and procedural effectiveness, can potentially result in higher trade flows than investments in hard infrastructure. This is particularly prominent in situations where existing physical assets are underutilized due to procedural inadequacies, a point underscored by Cantoni et al. (2024).

The catalytic role of logistics is predominantly effective in complex trade procedures (World Bank, 2025). Studies such as Alamsyah et al. (2023), World Bank (2025) and UNCTAD (2024) revealed that the flow of raw materials is more sensitive to the importer's logistics performance than final goods trade by over 45%. This underlines logistics as a significant enabler of modern global value chains. Additionally, logistics performance significantly affects export diversification, with evidence from Turkey showing it has a larger effect on the variety of exported goods than on the volume of existing exports (Tongur et al., 2020).

The most captivating argument for transport as a catalyst arises from the synergistic and facilitated relationships between infrastructure, logistics, and trade. World Bank (2023) and kechukwu et al. (2020) emphasised that transport infrastructure growth directly enhances logistics performance by offering the physical network that facilitates the connection between infrastructure and trade outcomes, unlocking the full economic potential of physical assets. This integrated system is critical for sustainable development, as infrastructure and logistics performance enhancements may boost international trade volume (Yeo et al., 2020).

The literature critiques siloed methodologies, which might be inadequate without integrating logistics stakeholders from the private sector (Senquiz-Diaz, 2021). This underlines a key policy implication: the catalytic purpose is heightened only when public infrastructure investment is combined with policies that allow efficient private logistics services, competitive markets, and modernized border procedures. While the catalytic role is well-established, the literature presents important contextual critiques. This catalytic effect, however, is not identical and can vary significantly by infrastructure type and environment. For instance, Ukoha (2025) highlighted that Africa's limited superior airport infrastructure and logistics services may, counterintuitively, display a negative effect on exports. This inconsistency is often caused by misallocation of scarce resources or operational costs that exceed the derived economic benefits in those specific environments (Sénquiz-Díaz, 2021). This advocates that the catalytic effect is subject to suitable, context-sensitive asset prioritization.

Current studies also expand the context to include sustainability, bringing in the concept of green logistics. Studies on Vietnam suggest that while carbon dioxide emissions from transport hamper exports, integrating green practices can positively affect trade, showing that the forthcoming catalytic role of transport must be merged with environmental objectives (Huong et al., 2026). The body of literature undeniably positions transport, comprising both its physical infrastructure and logistical efficiency, as a critical catalyst for trade. It directly decreases the primary cost of trade, permits participation in cultured global production webs, and is vital for export diversification and competitiveness. Yet, its catalytic potency is not automatic; it is capitalized through the harmonious integration of hard infrastructure with soft logistics efficiencies, custom-made to regional and sectoral specificities. Thus, the study aims to evaluate the catalytic potential of transportation in promoting trade.

4. Methodology and data

The paper utilised the robust fixed effects model, an econometric panel data technique that controls for unobserved time-invariant heterogeneity across entities, such as countries, firms, or individuals, through demeaning the data within each unit, thus removing bias from omitted variables that are constant over time. This method separates the within variation, permitting the researcher to estimate how changes in independent variables affect changes in the dependent variable over time, while holding constant all unobserved, time-invariant characteristics (Wooldridge, 2010).

In studies that focused on trade, research like Anderson and van Wincoop (2003) utilized fixed effects to account for multidimensional resistance terms in gravity models, while Feyrer (2021) employed country-pair fixed effects to assess the causal impact of air pollution on trade flows. By grouping standard errors at the country level, as in the study's model, fixed effects further address potential heteroskedasticity and within-panel serial correlation, yielding more reliable inference in macro-econometric applications.

This study utilises a panel dataset spanning the period 2022–2024 obtained from the World Bank and CEPII databases. The data included a wide-ranging set of variables categorized into economic performance indicators, bilateral agreements, trading blocks, distance measures, and explicit transport and logistics cost indices for import and export activities. To empirically investigate the impact of transportation costs on international trade, a fixed-effects model was

used. The econometric model accounts for potential confounding factors by incorporating a vector of macroeconomic controls and applying time-fixed effects to absorb global shocks. Standard errors were clustered at the country-pair level to ensure robustness against serial correlation and heteroskedasticity. The summary of the key variables used in the analysis is tabulated in Table 1.

Table 1: Key Variables and Data Sources

Variable	Measure	Variable justification	Source
Trade Flows	exports/imports (USD)	These are a measure of trade performance of the country, which is facilitated by an efficient transport system.	World Bank
GDP	Nominal GDP (USD)	Trade performance is linked to economic performance, which is measured by the gross domestic product. There is a general positive relationship between GDP and export performance (Foellmi and Legge, 2026).	World Bank
Distance	Capital-to-capital distance (km)	Greater distance between trading partners systematically reduces trade volumes and raises trade costs, and this "distance penalty" is one of the most robust findings in international economics (Foellmi and Legge, 2026).	CEPII GeoDist
LPI	Overall Logistics Performance Index (transport and logistics performance)	Logistics Performance Index measures the overall performance of all the logistical issues that are related to trade, such as Efficiency of customs and border clearance Quality of trade- and transport-related infrastructure Ease of arranging competitively priced international shipments Competence and quality of logistics services Ability to track and trace consignments Frequency of on-time deliveries (Arvis et al., 2024).	World Bank LPI
Trade Costs	Cost to export/import ($US)	This relates to the direct cost of imports and exports. Neoclassical economics argues for a negative relationship between import/export cost and its volume.	World Bank
Regional Bloc	Dummy for ECOWAS, SADC, EAC, etc.	Regional trade blocs (regional trade agreements, RTAs) generally raise intra-regional trade and can improve members' overall trade performance, but the size and direction of effects depend on how deep the agreements are, how well they are implemented, and the structure of member economies (François de Soyres et al., 2021).	CEPII
Landlocked	Dummy for landlocked exporter/importer	Being landlocked with no direct access to the sea systematically raises trade costs, lengthens delivery times, and reduces competitiveness, especially for developing countries that depend on neighbours' ports and corridors to reach global markets (Nargiz et al., 2025).	CEPII

5. Model estimation

The use of country fixed effects is a commonly used empirical model in the trade literature to control for all unobserved, time-invariant heterogeneity across countries that may impact exports, such as persistent geographic features, historical institutions, or cultural factors (Baier and Bergstrand, 2007). This methodology assists in mitigating omitted variable bias by isolating the within-country variation over time (Djankov et al., 2010).

To assess whether transport and logistics performance enhances exports, the study estimates the following country fixed-effects model:

$$ln(Exports_{it}) = \beta_1 LPI_{it} + \beta_2 \ln(GDP_{it}) + \beta_3 CostImport_{it} + \beta_4 CostExport_{it} + \beta_5 Landlocked_i + \beta_6 ECOWAS_{it} + \beta_7 SADC_{it} + \alpha_i + \varepsilon_{it}$$

Where:

- $Ln(Exports)$ is the natural logarithm of total exports
- GDP_{it} captures the economic size, which has a direct effect on trade.
- $costtoImport_{it}$ and $costtoEmport_{it}$ shows transport-related costs
- LPI_{it} Logistics Performance Index used as a proxy for transport and logistics performance
- $landlocked_{it}$ is a time-invariant dummy equal to 1 for landlocked countries?

- $ECOWAS_{it}$ *and* $SADC_{it}$ are regional trade agreement dummies
- α_i denotes unobserved country-specific fixed effect
- ε_{it} is the error term
- $i = 1, \ldots . N$ indexes countries
- $t = 1, \ldots . . T$ indexes years

The utilisation of fixed effects models to analyse the determinants of trade, particularly infrastructure and logistics, was well-established. By adopting this methodology, the current study aligns with established econometric methods in international trade literature, ensuring that the estimated coefficients for the variables of interest (Logistics Performance Index (LPI), Import Cost, etc.), are detected from changes within countries over the sample period.

Results interpretation

Table 2 shows the multiple independent variables, whose estimated effects on exports are derived from a robust fixed-effects specification.

Table 2: Fixed-effects regression results

Dependent variable: Log of Exports (lnExports)

Variable	Coefficient	Robust Std. Error	t-statistic	p-value	Confidence Interval
LPI	1.734**	0.744	2.33	0.027	(0.215, 3.254)
lnGDP	0.530	0.429	1.24	0.225	(-0.345, 1.406)
Cost to Import	-2.354**	0.976	-2.41	0.022	(-4.348, -0.361)
Landlocked	-0.708*	0.361	-1.96	0.059	(-1.446, 0.030)
Cost to Export	1.391	1.059	1.31	0.199	(-0.771, 3.554)
ECOWAS membership	-1.022**	0.462	-2.21	0.035	(-1.966, -0.077)
SADC membership	-1.116**	0.472	-2.37	0.025	(-2.079, -0.153)
Constant	777.269	708.774	1.10	0.282	(-670.241, 2224.778)

Observations: 93 Countries: 31
Years: 3 Estimator: Fixed Effects (within)
Standard errors: Clustered at country level
Within R^2: 0.372 F-statistic: 4.97 (p = 0.0008)
rho | = 0.99999844

$$ln(Exports_{it}) = \beta_1 LPI_{it} + \beta_2 \ln(GDP_{it}) + \beta_3 CostImport_{it} + \beta_4 CostExport_{it} + \beta_5 Landlocked_i + \beta_6 ECOWAS_{it} + \beta_7 SADC_{it} + \alpha_i + \varepsilon_{it}$$

$$\ln(exports)_{it} = 1.734 LPI + 0.530 GDP - 2.354 CostImport + 1.391 CostExport - 0.708 Landlocked - 1.022 ECOWAS - 1.116 SADC$$

The empirical findings present clear and robust insights into the relationship between transport and trade. The analysis confirms the primary research hypothesis that transport infrastructure and logistics performance are significant drivers of trade flows. Specifically, a one-unit advancement in the Logistics Performance Index (LPI) is associated with exports increasing by 1.73 times. This positive and statistically significant effect at the 5% level indicates that improvement in the quality of transport-related infrastructure, customs efficiency, and logistics services has a strong, economically meaningful impact on a country's export performance. These findings were similar to the findings by Huong et al. (2024).

The findings further underline that transport costs are a key channel through which transport affects trade performance. Higher costs to import significantly reduce exports with a coefficient of -2.354, at the 5% level of significance, signifying that expensive import logistics raise production costs and erode the price competitiveness of exports. The cost to export was statistically insignificant, which may indicate that higher export volumes may lead to greater procedural complexity, for instance, additional certifications, quality controls, or customs procedures, thus

increasing measured costs, rather than costs driving export levels. The model also reveals important structural and regional patterns.

The economic size (GDP) of a country does not show a statistically significant effect. However, the disadvantage for landlocked countries is apparent, as shown by a negative coefficient, suggesting the trade-impeding effects of geographic remoteness from maritime networks. Remarkably, membership in ECOWAS or SADC regional blocs is associated with lower export performance after controlling for logistics, a result which may point to unsettled non-tariff barriers or infrastructure bottlenecks within these regions that weaken integration efforts. These results are a stark contrast to what is expected from theories and the theoretical benefits of being a member of a trading bloc (de Soyres et al., 2021).

The model diagnostics validate the selected empirical approach. A within R-squared of 0.372 indicates that the transport and logistics variables explain a large portion (37.2%) of the within-country variation in exports over time. Likewise, the estimated rho (ρ) value close to 1 confirms that nearly all unexplained variance is attributable to time-invariant country-pair characteristics, supporting the utilisation of the fixed-effects model to control for this heterogeneity. The use of clustered standard errors warrants that the reported significance levels are robust.

5. Conclusion and policy recommendations

The results provide strong empirical evidence that transport and logistics performance is a primary contributing factor to international trade. The results establish that improvements in overall logistics quality substantively boost exports, while increases in transport costs, specifically those associated with imports, can significantly constrain trade volumes. These findings strongly confirm that efficient transport systems and cost-effective logistics are central to improving trade competitiveness and integration into global markets. Though the study analysed the impact of transport on trade and provided policy recommendations, the challenges of comprehensive data and missing variables hindered a robust analysis of the complex relationship between trade variables. Based on the empirical findings, several targeted policy recommendations arise. First, prioritising investment in logistics infrastructure, such as ports, roads, railways, and digital customs systems, is very important. Given the strong positive effects of exports on logistics performance, targeted programmes to elevate a country's Logistics Performance Index score, potentially supported by the government, could yield large trade dividends. Second, policymakers should implement reforms to simplify import procedures, including reducing tariffs, streamlining customs clearance, and eliminating quotas. The significant negative effect of import costs on exports underscores the need for a strategic reconsideration of import policy; cheaper imports enhance export competitiveness by lowering input costs for domestic producers. Third, the negative association between regional blocs (ECOWAS and SADC) and exports, conditional on transport logistics, suggests a need to reassess regional integration frameworks. Efforts should shift from merely signing agreements to actively dismantling non-tariff barriers, improving implementation, and investing in cross-border infrastructure to connect members effectively. Fourth, special and targeted support is warranted for landlocked countries, which face a persistent structural disadvantage. This should include coordinated investment in transnational transit corridors and the negotiation of improved transit agreements with coastal neighbours to mitigate their geographic constraints. Finally, national export strategies should prioritise enhancing competitiveness beyond sheer economic size. The results indicate that within-country GDP growth alone is an insufficient driver; policies must therefore focus on raising productivity, improving product quality, and facilitating deeper integration into global value chains to sustainably boost trade performance.

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