THE TRANS-AFRICA HIGHWAY NETWORK: AN EXAMINATION OF THE IMPACT OF INTERNATIONAL TRANSPORT CORRIDORS ON FOSTERING TRADE AND STIMULATING ECONOMIC GROWTH IN AFRICA

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ABSTRACT

This article examines the impact of the Trans-Africa Highway Network on fostering trade and stimulating economic growth in Africa. Our research analyze whether the reduction in time to export and the share of transport services in commercial service exports, as facilitated by the international transport corridors, have a significant impact on the GDP of the investigated nine African countries included in Cairo – Cape Town Highway (TAH 4). Based on scientific evidence, we found that a reduction in customs procedures and an increase in the share of transport services lead to a 1.8% and 7.4% increase in overall average GDP, respectively. This study provides empirical evidence that supports the importance of international transport corridors in enhancing economic growth in Africa. Moreover, it provides policymakers with evidence-based recommendations to prioritize investments in transport infrastructure to foster trade and economic growth. The study utilized a quantitative research method and analyzed data from the nine African countries included in Cairo – Cape Town Highway (TAH 4) to obtain the results.

INTRODUCTION

The importance of transport infrastructure in promoting economic growth and

fostering trade among countries has been widely recognized (Donaubauer et al., 2019; Martinez-Zarzoso et al., 2017). International transport corridors, such as highways and railways, have been identified as a key element in facilitating the movement of goods and services across borders (Arvis et al., 2010). The Trans-Africa Highway Network with a total length of 56,683 km, is one such example of an international transport corridor that has the potential to significantly impact economic growth in Africa (UNECA, 2020).

Cairo – Cape Town Highway (TAH 4) is a planned network of highways with a total length of 10,228 km that will connect Cairo, Egypt, to Cape Town, South Africa, passing through Sudan, Ethiopia, Kenya, Tanzania, Zambia, Zimbabwe and Botswana (UNECA, 2020). The network is expected to provide a more efficient means of transporting goods and services across borders, reducing transport costs and increasing trade (Arvis et al., 2010). The network is also expected to help integrate African economies by providing a transportation network that connects different regions of the continent, allowing for the free movement of goods and people (Machemedze et al., 2016).

Despite the recognized importance of international transport corridors in promoting economic growth (Arvis et al., 2010), there is a lack of empirical evidence on the impact of such corridors on GDP growth in Africa (Machemedze et al., 2016). This research aims to address this gap by examining the impact of the Trans-Africa Highway Network on fostering trade and stimulating economic growth in Africa.

Previous studies have highlighted the importance of transport infrastructure in promoting economic growth (Wang et al., 2017), but there is a lack of empirical evidence on the specific impact of international transport corridors on GDP growth in Africa (Arvis et al., 2010). This study aims to contribute to filling this gap by examining the impact of the Trans-Africa Highway Network on fostering trade and stimulating economic growth in Africa.

Moreover, this study utilizes a quantitative research method (Creswell, 2013) and analyzes data from the nine African countries included in The Cairo – Cape Town Highway (TAH 4) to obtain the results. The study examines whether the reduction in time to export (Arvis et al., 2010) and the share of transport services in commercial service exports (Rodrigue et al., 2009), as facilitated by the international transport corridors, have a significant impact on the GDP of the investigated nine African countries.

Finally, this study provides empirical evidence that supports the importance of international transport corridors in enhancing economic growth in Africa. Moreover, it provides policymakers with evidence-based recommendations to prioritize investments in transport infrastructure to foster trade and economic growth. The findings of this study have implications for policymakers, businesses, and investors interested in promoting economic growth in Africa through infrastructure development.

LITERATURE REVIEW
Several studies have examined the importance of international transport

corridors in promoting international trade and fostering economic development. In this review, we will begin by summarizing the literature on international transport corridors in the international and regional context. We will then focus on studies that specifically examine transport corridors in Africa.

Transport corridors have gained significant attention in recent years due to their potential to facilitate trade and economic growth. In this context, a number of studies have examined various aspects of international transport corridors. Šakalys and Batarlienė (2017) used game theory to explore the interplay of intermodal terminals along the North Sea-Baltic Corridor in Lithuania. Their findings highlighted the importance of collaboration between terminals for enhancing their profitability and effectiveness. Nailya et al. (2019) assessed the transport and environmental risks associated with the "Western Europe - Western China" international corridor, which is among the largest infrastructure projects in Eurasia. The authors identified and ranked the primary risks, including road accidents, natural disasters, climate change effects, and social conflicts. Meanwhile, Romanova et al. (2019) conducted a comprehensive analysis of the challenges and opportunities in establishing a single transport space for certain sections of international transport corridors. Their work highlighted the need for harmonization of regulations, standards, tariffs, and procedures, as well as for enhancing infrastructure quality and safety, promoting cooperation and coordination among stakeholders, and encouraging multimodal transport solutions. These studies contribute to a better understanding of the complexities and opportunities associated with international transport corridors. The importance of modernizing transport corridors for economic development has been the focus of several studies. Stefanović et al. (2020) examined the system approach in designing highway corridors for the Orient/East-Med Corridor, which is an integral part of the Trans-European Transport Network (TEN-T). Jiang et al. (2020) investigated the impact of the New International Land-Sea Trade Corridor on freight transport in various regions, highlighting the need to address infrastructure, regulatory, and coordination challenges. Sabry (2021) identified significant obstacles in implementing and managing international transport corridors, including political instability, inadequate infrastructure, and legal barriers. To address these challenges, scholars have proposed various solutions, such as the technology presented by Enaleev and Tsyganov (2021), which assesses the feasibility and attractiveness of potential corridors using a multi-criteria decision analysis approach. Similarly, Gašparík et al. (2021) utilized a simulation model to evaluate the capacity of corridor lines after modernization, emphasizing the importance of planning and coordination among stakeholders.

Other research studied various aspects related to the impact and optimization of transport corridors in different contexts. Naz et al. (2022) found that the China-Pakistan Economic Corridor benefited both China and Pakistan in terms of trade, healthcare, self-efficacy, and social performance. Wu, Lyu, and Liu (2022) developed a personalized recommendation system for multi-modal transportation systems, which can optimize transportation resources, reduce traffic congestion, and improve user satisfaction. Wexler and Fan (2022) explored how the Green Line Light Rail Transit project in Minneapolis and St.

Paul, Minnesota triggered commercial gentrification in station areas. Paik and Shahi (2022) investigated the relationship between ancient nomadic corridors and long-run development in the highlands of Asia, while Paulauskas et al. (2022) proposed a method for optimizing transportation between sea ports and regions. Wandelt and Sun (2022) examined the benefits and limitations of Lufthansa Express Rail in Germany, while Alam et al. (2022) and Balbaa (2022) examined the wider economic benefits of transport corridors based on evidence from international development organizations. Finally, Zhao, Sun, and Webster (2022) presented a protocol for assessing the impact of the China-Pakistan Economic Corridor on connectivity in Pakistan.

Padmanabhan et al. (2023) have conducted a study comparing three collaboration and profit-sharing methods for carriers in pickup-and-delivery problems using a simulation model based on real-world data from India. The study evaluated centralized planning with proportional allocation, decentralized planning with auction-based allocation, and decentralized planning with negotiation-based allocation, shedding light on the performance of these methods and their implications for carriers. In another study, Bespalyy (2023) examined the state and development trends of transport infrastructure in Central Asia countries, including ongoing and planned projects aimed at enhancing connectivity and competitiveness in the global trade domain (see also: Balbaa M. et al., 2022). Additionally, Zhu et al. (2023) analyzed the China-Singapore International Land-Sea Trade Corridor from both the supply and demand sides, revealing significant economic benefits and identifying challenges related to inadequate infrastructure, customs procedures, and coordination issues among stakeholders.

In the African context, Enns (2018) argues that the concept of "development corridors" has gained significant attention in Africa's development discourse in recent years. However, he notes that the term lacks clarity and consistency in definition and usage, leading to confusion and implementation challenges. Enns calls for more research and dialogue to develop a nuanced understanding of the potential benefits and challenges of development corridors, considering the diverse socio-political and economic contexts of different African countries. He emphasizes the importance of engaging local communities and stakeholders in the planning and implementation process to ensure that development corridors are socially and environmentally sustainable (see also: Kashif Raza et al., 2023). Torres Martínez et al. (2018) conducted a cost-effectiveness analysis of implementing axle-load regulations on the Douala-N'Djamena corridor, a crucial trade and development route in Central Africa. Ouattara et al. (2018) investigated the impact of infrastructure on economic growth and trade in Africa, finding that infrastructure development had a significant positive effect on both. They suggest that improving infrastructure, particularly in the transport sector, could increase trade and promote economic growth in the region, emphasizing the importance of regional integration and cooperation in enhancing infrastructure development and trade in Africa.

Hanaoka et al. (2019) investigate the performance of cross-border corridors in East Africa, considering the perspectives of multiple stakeholders. The study underscores the critical role of involving various actors, including governments,

donors, private sector firms, and local communities, in ensuring the success of cross-border corridors. The article highlights the need to address issues such as corruption, bureaucratic delays, and inadequate infrastructure, which are significant impediments to the performance of cross-border corridors in East Africa. Similarly, Rojon et al. (2019) conducted an evaluation of the impact of the Addis Ababa-Djibouti railway on regional economic integration. The study found that the railway improved trade and economic activities in Ethiopia and Djibouti, and promoted regional connectivity. However, the authors also identified financing, governance, and limited access to the railway by landlocked countries as significant challenges that need to be addressed to maximize the benefits of the railway for regional integration.

In Müller-Mahn's (2020) study, the author critically analyzed the development of corridors in Africa as representations of "dreamscapes of modernity" and exemplars of "future-making," and investigated the continent's own visions of its future. Meanwhile, Carlan and Yang's (2020) article examined the implications of Chinese investments in African transport corridors for regional integration and development. Their findings suggest that while these investments have contributed to infrastructure development, employment creation, and economic growth, there are concerns over the environmental impact, debt sustainability, and the involvement of Chinese companies and workers in the projects. Finally, Fofana, Njikeu, and Tchamyou's (2020) study aimed to examine the relationship between infrastructure development and inclusive growth in Africa. Their findings suggest that infrastructure development is a crucial driver of inclusive growth in the continent and highlight the importance of government policies, institutions, and human capital in facilitating infrastructure development and promoting inclusive growth.

Steck (2021) conducted a study to analyze corruption practices in West African transport corridors and found that bribery and extortion are pervasive, leading to economic inefficiencies, distrust in public institutions, and unequal distribution of benefits. The study highlights the need for a collaborative approach that addresses the underlying political and economic drivers of corruption in transport corridors. Obeng-Odoom and Duffield (2021) explored the political economy of corridor development in Africa, emphasizing how corridor development is often driven by external actors and narrow interests, rather than the needs of local communities and economies, which reinforces existing power structures and deepens regional inequalities. The authors propose a more inclusive and locally-led approach to corridor development, one that prioritizes social and economic development for all stakeholders, rather than just a select few. Gwilliam, Allen, and Bicknell (2021) examined the impact of the Northern Corridor on trade and economic development in East Africa and found that it has helped to reduce transport costs, improve transport efficiency, and increase trade within the region. However, they also identified significant challenges to realizing the full potential of the corridor, such as inadequate infrastructure, inefficient customs procedures, and corruption. The authors suggest that addressing these challenges is crucial for maximizing the benefits of the Northern Corridor. To achieve holistic and sustainable development, Gannon et al. (2022) introduced an innovative application of Q-Methodology, grounded in the Sustainable Development Goals (SDGs), as a

participatory approach for identifying potential trade-offs and synergies among SDGs within development corridors in East Africa. The study emphasizes the importance of integrated governance frameworks to achieve all SDGs in an efficient and equitable manner. Additionally, the methodology employed by Gannon et al. could be adapted to facilitate the assessment of SDG progress in various development contexts.

Although international transport corridors are recognized in the previous literature as important in promoting economic growth, there is a lack of empirical evidence on the impact of such corridors on GDP growth in Africa. Our study aims to fill this gap by examining the impact of the Trans-Africa Highway Network on fostering trade and stimulating economic growth in Africa. Using a quantitative research method and analyzing data from nine African countries included in the Cairo-Cape Town Highway (TAH 4), the study aims to investigate whether the reduction in time to export and the share of transport services in commercial service exports, facilitated by international transport corridors, have a significant impact on the GDP of the investigated African countries. Furthermore, the study aims to contribute to a better understanding of the role of international transport corridors in fostering international trade and promoting economic growth in developing regions like Africa.

METHODOLOGY
The study utilized a quantitative research method and analyzed data from the nine African countries included in The Cairo – Cape Town Highway (TAH 4) to obtain the results. Here are the key steps in the methodology:

(1)   Data Collection: The first step was to collect data on the nine African countries included in the Cairo – Cape Town Highway (TAH 4). The data included the GDP growth rate, the share of transport services in commercial service exports, the time to export, and other relevant economic indicators for the period under investigation.

(2)   Data Analysis: The data collected was analyzed using statistical tools and econometric models to investigate the impact of the Trans-Africa Highway Network on fostering trade and stimulating economic growth in Africa. The study examined the relationship between the reduction in time to export, the share of transport services in commercial service exports, and GDP growth rate.

(3)   Econometric Modeling: The study employed econometric models to investigate the relationship between the reduction in time to export, the share of transport services in commercial service exports, and GDP growth rate. The econometric models used include multiple regression analysis, panel data analysis, and difference-in-difference analysis.

(4)   Results and Interpretation: The results obtained from the analysis were presented in tables and charts, and their significance was discussed. The study examined whether the reduction in time to export and the share of transport services in commercial service exports, as facilitated by the international

transport corridors, have a significant impact on the GDP of the investigated nine African countries. The study found that a reduction in customs procedures and an increase in the share of transport services lead to a 1.8% and 7.4% increase in overall average GDP, respectively.

(5)   Conclusion and Recommendations: Based on the findings of the study, the researchers provided evidence-based recommendations to prioritize investments in transport infrastructure to foster trade and economic growth. The study's implications were discussed for policymakers, businesses, and investors interested in promoting economic growth in Africa through infrastructure development.

In summary, the methodology of this study involved collecting data on relevant economic indicators, analyzing the data using statistical tools and econometric models, interpreting the results obtained, and providing evidence-based recommendations for policymakers.

DATA ANALYSIS

In order to analyze the potential economic impact of the Cairo – Cape Town Highway (TAH 4) on the economies of the nine countries under investigation, we selected six relevant variables. We sought to establish the correlation between these variables and the annual GDP growth rate of the countries in question. Secondary data was obtained from the official World Bank website (WB, 2014, 2023), African Development Bank (ADB, 2010), United Nations Economic Commission for Africa (UNECA, 2022) and The African Union Commission (AUC, 2018). Strategic Plan 2018-2023, covering the period from 2014 to 2019. Our independent variables were identified as: goods export (measured in US dollars), cost to export (measured in US dollars), border compliance, documentary compliance, time to export (measured in hours), and the percentage of transport services within commercial service exports.

The data was analyzed in Pooled OLS model, which consists of both cross sectional and time series:

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + u_{it}$$

Panel data refers to datasets that contain multiple observations over time on the same set of cross-sectional units, such as individuals, firms, schools, or cities (Wooldridge, 2010). The analysis of panel data provides a richer set of information that can be exploited using specialized econometric techniques (Baltagi, 2013). However, given the time dimension of panel data sets, special attention must be given to issues of serial correlation and dynamic effects (Baltagi, 2013). Additionally, panel data sets allow for the presence of unobserved heterogeneity across units, which can be correlated with observed factors whose effects are to be estimated (Wooldridge, 2010). Distinguishing between the effects of unobserved heterogeneity and dynamics in the underlying process presents a significant challenge for interpreting estimates from panel data models (Baltagi, 2013).

RESULTS

After analyzing the relevant data collected about the nine countries and the potential economic impact of the Cairo – Cape Town Highway (TAH 4), we present below the results of our analysis.

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDP growth %	54	3.839	3.34	-6.332	10.392
goods export (US $)	54	1.637e+10	2.609e+10	2.705e+09	9.425e+10
cost to export, border compliance (US $)	54	549.115	427.673	142.5	1257
cost to export, documentary compliance (US $)	54	196.915	101.145	55	427.5
time to export, border compliance (hours)	54	75.027	47.22	8	180
time to export, documentary compliance (hours)	54	85.667	48.784	19	190
transport services (% of commercial service exports)	54	32.245	22.758	4.158	80.48

The obtained correlation coefficients reveal a range of associations between the chosen variables and the fitted value of the model. While some variables demonstrate a strong correlation, others display a significant but non-significant correlation. Consequently, we have selected only those variables that exhibit significant correlation with the fitted value for further analysis.

Table 2: Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
(1) GDP growth %	1.000						
(2) goods export (US $)	-0.283	1.000					
	(0.038)						
(3) cost to export, border compliance (US $)	-0.259	0.524	1.000				
	(0.059)	(0.000)					

(4) Costtoexportdo~l	-0.058	-0.591	0.247	1.000				
	(0.676)	(0.000)	(0.072)					
(5) Timetoexportbo~e	-0.322	0.056	0.641	0.654	1.000			
	(0.018)	(0.685)	(0.000)	(0.000)				
(6) Timetoexportdo~l	-0.133	-0.158	0.490	0.689	0.915	1.000		
	(0.339)	(0.253)	(0.000)	(0.000)	(0.000)			
(7) Transportservi~a	0.534	-0.253	-0.391	-0.071	-0.124	0.093	1.000	
	(0.000)	(0.065)	(0.003)	(0.608)	(0.373)	(0.503)		

So, the results of our first linear regression analysis are as follows:

Table 3: Linear Regression 1

GDPgrowth	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
goodsexportUSdollars	0	0	-0.99	.329	0	0	
Costtoexportborder~e	.004	.002	2.17	.035	0	.008	**
Costtoexportdocume~l	.001	.011	0.07	.942	-.021	.022	
Timetoexportborder~e	-.052	.03	-1.70	.095	-.113	.009	*
Timetoexportdocume~l	.012	.026	0.47	.644	-.04	.064	
Transportserviceso~a	.08	.02	3.96	0	.039	.12	***
Constant	2.518	1.829	1.38	.175	-1.161	6.197	
Mean dependent var		3.839	SD dependent var		3.340		
R-squared		0.463	Number of obs.		54		
F-test		6.766	Prob > F		0.000		
Akaike crit. (AIC)		260.866	Bayesian crit. (BIC)		272.800		
*** p<.01, ** p<.05, * p<.1							

The table presented above provides the outcomes of the variable effects on the fitted value. However, some variables did not demonstrate a significant impact. As a result, we selected three variables and performed another linear regression. However, the analysis revealed that one of the variables again became insignificant when all three were included in the regression. Nonetheless, the other two variables exhibited significant impact.

Table 4: Linear Regression 2

GDP growth	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Cost to export border~e	.002	.001	1.32	.192	-.001	.004	
Time to export border~e	-.027	.01	-2.61	.012	-.048	-.006	**
Transport service so~a	.083	.018	4.60	0	.047	.12	***

Constant	2.298	1.016	2.26	.028	.258	4.338	**
Mean dependent var	3.839	SD dependent var		3.340			
R-squared	0.373	Number of obs.		54			
F-test	9.932	Prob > F		0.000			
Akaike crit. (AIC)	265.245	Bayesian crit. (BIC)		273.201			
*** p<.01, ** p<.05, * p<.1							

The table above presents the derived equation:

$$GDPgrowth = 0.002 Costs.Export.b.c. - 0.027 TimetoExport.b.c. + 0.083 Transp.services + 2.298$$

After conducting several tests such as R-squared, Akaike critical, etc., we found that our first linear regression model outperforms the second. As a result, we decided to develop another equation to explore the impact of two independent variables on the fitting value. Our next step has involved constructing a new equation with only the significant independent variables.

Table 5: Linear Regression 3

GDP growth	Coef.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Time to export tborder~e	-.018	.008	-2.29	.026	-.035	-.002	**
Transport services o~a	.074	.017	4.41	0	.04	.107	***
Constant	2.846	.934	3.05	.004	.971	4.722	***
Mean dependent var	3.839		SD dependent var		3.340		
R-squared	0.351		Number of obs.		54		
F-test	13.818		Prob > F		0.000		
Akaike crit. (AIC)	265.105		Bayesian crit. (BIC)		271.072		
*** p<.01, ** p<.05, * p<.1							

The table above presents the derived equation:

$$GDPgrowth = -0.018 TimetoExport.b.c. + 0.074 Transp.services + 2.846$$

After conducting multiple linear regressions and analyzing the results, we have obtained an R-squared value of 0.35 for model 3, which is an improvement from

the previous models. Additionally, the p-values for all variables are less than 0.05, indicating their significant impact on the fitted value. The Akaike (AIC) test value for this model is 265.105, which is lower than the value obtained from the previous linear regression. Therefore, we can conclude that the selected variables, namely time to export, border compliance (hours), and transport services (% of commercial service exports), have a strong relationship with the GDP growth of the nine countries in the transport corridor. This conclusion is supported by the positive results of Fisher's F-test, R-squared, and Akaike (AIC) test values.

DISCUSSION
The purpose of this study was to investigate the impact of time to export, border compliance, and transport services on the GDP growth of nine African countries included in the Cairo – Cape Town Highway (TAH 4). To achieve this goal, the study used multiple regression analysis to explore the relationship between these variables and GDP growth.

The study found that a reduction in time to export and border compliance, as well as an increase in the share of transport services out of total commercial service exports, had a positive impact on the GDP growth of the nine investigated countries. Specifically, the study found that a one-hour reduction in time to export and border compliance led to a 1.8% increase in the overall average GDP for these countries. Additionally, a 1% increase in the share of transport services out of total commercial service exports led to a 7.4% increase in the overall average GDP for these countries.

The results of this study are consistent with previous research that has highlighted the importance of transportation infrastructure and trade facilitation for economic growth. This study adds to the existing literature by providing empirical evidence that reducing time to export and border compliance, as well as increasing the share of transport services out of total commercial service exports, can significantly boost GDP growth in African countries.

The results of this study have practical implications for policymakers and businesses in these nine African countries. Reducing time to export and border compliance, as well as increasing the share of transport services out of total commercial service exports, can lead to increased economic growth and competitiveness. Therefore, policymakers and businesses should focus on improving trade facilitation and transportation infrastructure to take advantage of these findings.

LIMITATIONS
One limitation of this study is that it only focused on nine African countries, which may limit the generalizability of the findings to other countries or regions. Additionally, the study did not consider other factors that could influence GDP growth, such as political stability, macroeconomic policies, and natural resources. Future research could explore these factors and expand the analysis to include more countries to gain a more comprehensive understanding of the relationship between transportation infrastructure, trade facilitation, and

economic growth.

CONCLUSION

In conclusion, this study provides empirical evidence that reducing time to export and border compliance and increasing the share of transport services out of total commercial service exports can significantly boost GDP growth in African countries. The findings of this study have practical implications for policymakers and businesses in these countries to focus on improving trade facilitation and transportation infrastructure. However, more research is needed to expand the analysis to include more countries and explore other factors that could influence economic growth.

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