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# Enhancing sustainable mobility in Africa: the role of Chinese investment and construction projects

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**ABSTRACT**

Over the past decades, China has played a significant role in major infrastructural projects as both investors and contractors. Transport systems, including air, rail, and road, are key components of this infrastructure. This paper examines the impact of Chinese investment and construction on sustainable mobility in Africa. We employ robust econometric identification strategies, including the Two-step System Generalised Method of Moments (S-GMM), on a panel sample of 36 African countries over nine years. Sustainable mobility is measured based on the four main transport systems: air, sea, rail, and road. Our results indicate that Chinese foreign direct investment is positively associated with sustainable mobility. Similarly, construction revenue significantly impacts sustainable mobility. These effects are more pronounced in resource-rich countries due to their attractiveness to China. These findings show the contribution of the Chinese-African partnership toward sustainable development in Africa. The results are robust to alternative measurements and are not sensitive to potential endogeneity.

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## 1. Introduction

Transportation is a major contributor to greenhouse gas emissions, primarily through the combustion of fossil fuels in vehicles (Ullah 2023; Xie, Fang, and Liu 2017). The quality of infrastructures such as roads and railways is the key ingredient for efficient, sustainable and quality transportation. Poor transportation infrastructure causes long delays and a high amount of carbon combustion of fossil fuels. On the contrary, good transportation increases the use of public and mass transportation and the free flow of cars on the road (Xie, Fang, and Liu 2017). Consequently, investment in transportation infrastructure promotes public transit and non-motorized transportation, which help reduce carbon emissions and mitigate climate change impacts (Jiang, Zhou, and Liu 2019). Prior studies such as Zhao et al. (2022) suggest that by transitioning to low-carbon and zero-

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emission transportation systems, countries can achieve their climate mitigation targets and contribute to global efforts to limit global warming. Sustainable mobility, defined as transportation systems that support environmental sustainability, economic development, and social equity over the long term (WDI 2024), is essential for achieving sustainable development goals across economic, social, and environmental dimensions (Berg et al. 2017). Sustainable mobility infrastructure, such as roads, railways, ports, and airports, supports economic growth by facilitating the movement of goods, services, and people (Sakib et al. 2018). Efficient transportation networks reduce transaction costs, enhance market access, and stimulate trade and investment, contributing to economic development, job creation, and poverty reduction.

The role of infrastructure investment in driving economic and social progress aligns with modernization theory, which suggests that economic development is contingent on industrialization, urbanization, and technological advancement. According to this theory, developing nations require external capital, expertise, and technology to transition from traditional economic structures to modern, industrialized economies (W. Rostow 1960). Transportation infrastructure, as a fundamental driver of modernization, facilitates industrial expansion, urban connectivity, and international trade, thereby accelerating economic transformation. However, many emerging economies, particularly in Africa, face financial constraints that limit their ability to develop robust transportation infrastructure (S. Li et al. 2020).

To address these challenges, African countries have increasingly partnered with China, which plays a dual role as an investor and contractor in transportation infrastructure projects. Over the years, the China-Africa relationship has drawn both praise and criticism (V. Tawiah, Kebede, and Kyiu 2022; V. K. Tawiah, Zakari, and Khan 2021). However, there is limited research on how Chinese investment and construction projects impact sustainable mobility in Africa. Transportation infrastructure development remains a cornerstone of Chinese investment on the continent, with Africa accounting for 19.4% of China's global construction revenue – a significant portion of which is derived from the transport sector (China Africa Research Initiative 2023). Moreover, China has surpassed the United States as Africa's top foreign direct investor (V. Tawiah, Ayivor, and Oyewo 2023).

Over the years, China has financed and constructed major transportation projects, including the 756-kilometer electrified standard gauge railway linking landlocked Ethiopia with the port of Djibouti on the Red Sea. Another example is the Lusaka-Ndola Dual Carriageway, which connects Zambia's capital to the Copperbelt region, a key economic hub. In West Africa, China has also invested in airport expansion projects, such as the new terminal at Ghana's international airport. These large-scale investments reflect the modernization paradigm, wherein infrastructure development is seen as a prerequisite for economic progress. By enhancing public transit, rail networks, electric vehicle adoption, renewable energy integration, smart cities, and multimodal transport systems, China's investment plays a crucial role in shaping sustainable mobility in Africa (Otele 2020).

Given this context, this study examines the impact of Chinese investment and construction on sustainable mobility in Africa, drawing on Modernization Theory to explain how foreign infrastructure financing fosters economic development. By evaluating

China's role in transport system expansion, this research contributes to the ongoing debate on the sustainability and long-term benefits of the China-Africa partnership.

We test this conjecture by employing robust econometric modeling on panel data from 36 African countries between 2006 and 2015 to examine the relationship between Chinese investment (including construction revenue) and sustainable mobility. We use data from Sustainable Mobility for all Initiatives by the World Development Indicators. This initiative measures the quality and sustainability of a country's transport systems, including roads, airports, railways, and ports. We collect data on Chinese investment and construction from China Africa Research Initiative. Our robust econometric estimation shows that both Chinese investment and construction are associated with quality and sustainable mobility systems in Africa. Unsurprisingly, we find that the relationship is stronger for construction revenue and road infrastructures. In further analysis, we find that the results are more pronounced for resource-rich countries which is logical given China's expressed interest in natural resources. Our results are robust to alternative measurements of the variables and potential endogeneity checks, including the S-GMM.

Our findings make incremental contributions and offer policy implications. First, unlike prior studies that focused on the generic outcome of the China-Africa relationship (X. Chen et al. 2024; V. K. Tawiah, Zakari, and Khan 2021), our study pays attention to particular sectors that have received massive investment from China (China Africa Research Initiative 2023). Despite the growing presence of Chinese-funded transportation projects in Africa, there is a lack of comprehensive empirical studies assessing their impact on sustainable mobility. Our research systematically evaluates the outcomes of Chinese investment in terms of improved access, reduced emissions, enhanced safety, and social inclusion in transportation systems across different African contexts. Second, the study examines the impact of Chinese investment and construction on all major transport systems, including air, rail, sea, and road. This comprehensive approach allows for a holistic assessment of the influence of Chinese involvement in transport infrastructure across different modes of transportation, providing valuable insights into the overall impact on sustainable mobility in Africa. Third, our findings highlight the significant contribution of the Chinese-African partnership toward sustainable development in Africa. Policymakers can leverage this partnership to foster collaboration and knowledge exchange on sustainable infrastructure development, encouraging joint initiatives that promote environmental sustainability, social inclusion, and economic growth.

The rest of the paper is organized as follows: The next section contains a literature review with some examples of Chinese transport infrastructure development. Section 3 presents the research design. Section 3.1.1 contains the empirical estimations and a discussion of the results. The conclusion and policy implications are presented in Section 5.

## 2. Literature review

Sustainable mobility refers to the movement of people and goods in a manner that minimizes negative environmental, social, and economic impacts while promoting equity, accessibility, and efficiency (Holden et al. 2020; Vergragt and Brown 2007). It encompasses various transportation modes and infrastructure systems designed to meet present mobility needs without compromising the ability of future generations to meet their own needs. Sustainable mobility seeks to balance economic development with environmental protection and social equity, aiming for a transportation system that is environmentally friendly, socially inclusive, and economically viable (Holden et al. 2020).

Transportation infrastructure is a fundamental determinant of sustainable mobility, shaping travel behavior, environmental impacts, social equity outcomes, and urban development patterns (Litman and Burwell 2006). By investing in accessible, efficient, and environmentally friendly transportation infrastructure, cities, regions, and countries can promote sustainable mobility and achieve broader sustainability goals related to economic prosperity, environmental protection, and social well-being (Tumlin 2011). Transportation infrastructure determines the accessibility and connectivity of a region, city, or community. Well-planned and integrated infrastructure networks, including roads, railways, ports, airports, and public transit systems, provide essential links between origins and destinations, enabling people and goods to move efficiently and affordably (Tyrinopoulos and Antoniou 2013). Sustainable mobility relies on accessible and well-connected transportation infrastructure that facilitates seamless travel, reduces travel times, and enhances mobility options for all users. Furthermore, transportation infrastructure influences mode choice and modal shift by providing options for different transportation modes, such as walking, cycling, public transit, carpooling, and private vehicle travel (Tyrinopoulos and Antoniou 2013). Sustainable mobility promotes the use of environmentally friendly and energy-efficient modes, such as walking, cycling, and public transit, over less sustainable modes, such as private car travel. Transportation infrastructure design, including the availability, quality, and affordability of different modes, can incentivize or discourage modal choices, affecting overall sustainability outcomes.

Arguably, almost all transportation infrastructures require significant large capital investment, which is lacking in most African countries. Consequently, prior studies have shown that foreign direct investment impact transportation infrastructure (Ali Ibrahim, Abdel-Gadir, and Devesh 2019). over the years China has financed and constructed many infrastructures which has impacted the sustainable mobility of the host countries (Otele 2020). Among these, transportation infrastructures cut across roads, air rail and ports. For example The Ethiopia-Djibouti Railway is a 756-kilometer electrified standard gauge railway connecting landlocked Ethiopia with the port of Djibouti on the Red Sea. Constructed by Chinese companies, including the China Railway Group and China Civil Engineering Construction Corporation (CCECC), the railway significantly reduces transportation costs and transit times for goods between Ethiopia and Djibouti, enhancing trade and economic integration in the region. Regarding road transport, Chinese companies were involved in the construction of the Lusaka-Ndola Dual Carriageway, a major road corridor in Zambia linking the capital city of Lusaka with the Copperbelt region. Similar in air transport, Chinese companies, such as China State Construction Engineering Corporation (CSCEC), were involved in the construction of Terminal 3 at Kotoka International Airport, the main airport serving the Ghanaian capital, Accra.

These transportation infrastructures by China contribute to high-quality transport systems and sustainable mobility through several mechanisms (Davies 2011). First, Chinese financing often supports the construction and expansion of public transit systems, including buses, trams, metro, and light rail networks (Irandu and Owilla

2020). These systems provide efficient, affordable, and environmentally friendly transportation options, reducing reliance on private vehicles and mitigating traffic congestion and air pollution in urban areas. Chinese investment in railway infrastructure, such as high-speed rail and standard gauge railway projects, facilitates the movement of passengers and freight over long distances. Rail transport is generally more energy-efficient and produces fewer greenhouse gas emissions than road transport, contributing to lower carbon emissions and promoting sustainable mobility (Milewicz, Mokrzan, and Szymański 2023).

Second, Chinese-funded transportation projects often incorporate renewable energy solutions, such as solar-powered streetlights and energy-efficient transportation terminals (X. Chen et al. 2024). By integrating renewable energy technologies into transportation infrastructure, Chinese investment reduces carbon emissions and reliance on nonrenewable energy sources, contributing to sustainable development and climate change mitigation (V. K. Tawiah, Zakari, and Khan 2021).

Third, Chinese companies bring expertise, experience, and technology to transportation infrastructure projects in Africa, contributing to capacity building and technology transfer (Antweiler, Copeland, and Taylor 2001). Training programs, knowledge sharing, and skills development initiatives empower African governments and local communities to develop and manage sustainable mobility systems effectively, fostering long-term sustainability and self-reliance (Xiaoyang and Sun 2016). Fourth, Chinese investment supports the development of multimodal transportation networks that integrate different modes of transportation, such as road, rail, waterway, and air transport. Multimodal transportation systems enhance connectivity, improve logistics efficiency, and reduce transportation costs, promoting sustainable economic development and regional integration (Özispa and Deveci 2019).

These examples demonstrate the diverse range of transportation infrastructure projects that Chinese companies have been involved in across Africa, including railways, airports and roads. Chinese investment and construction in transportation infrastructure have contributed to sustainable mobility by improving connectivity, reducing travel times, promoting modal shifts, and mitigating environmental impacts.

### 2.1. Theory and theoretical gap

Modernization Theory, as articulated by W. Rostow (1960), posits that economic development follows a linear trajectory from traditional to modern societies, facilitated by industrialization, urbanization, and technological advancement. Central to this theory is the belief that external capital, technology, and infrastructure investment are essential catalysts for transformation in developing countries. Transportation infrastructure – spanning roads, railways, ports, and airports – is particularly critical, as it underpins economic modernization by enhancing connectivity, facilitating trade, and supporting industrial growth.

However, modernization is not solely an economic or technological process; it also involves reshaping social and environmental structures to support long-term development. In this context, sustainable mobility – defined as transportation systems that are economically efficient, environmentally responsible, and socially inclusive (WDI, 2024) –

emerges as a vital component of modernity. The integration of sustainable mobility within the modernization process reflects a broader understanding of development that goes beyond mere industrial expansion to include climate resilience, social equity, and quality of life improvements.

This paper adopts modernization theory as a conceptual lens to explain how Chinese investment in Africa's transport infrastructure contributes to sustainable mobility. By financing and constructing large-scale transport systems, China provides not only the capital and technical expertise necessary for modernization but also facilitates the transition toward sustainability by enabling cleaner, more efficient, and accessible transportation. Projects such as electrified railways, modern airports, and dual carriageways embody this dual transformation – supporting economic growth while aligning with sustainability goals.

Nevertheless, modernization theory traditionally assumes a Western, market-led development model, in which private-sector investment drives infrastructure growth. This overlooks the growing role of state-led development strategies, particularly China's distinctive approach involving state-owned enterprises (SOEs) and government-backed financing (Li et al. 2020). China's involvement in African infrastructure thus represents a deviation from classical modernization trajectories, raising important questions about whether a state-driven model achieves similar – or even superior – outcomes in sustainable mobility.

This theoretical divergence underscores a key gap in the literature: there is insufficient understanding of how state-capitalist models, like China's, influence transportation outcomes, especially in terms of sustainability. While Western-led investments often emphasize profit-maximization, Chinese projects are frequently motivated by long-term diplomatic, strategic, and economic interests. This difference may result in varying impacts on the efficiency, inclusivity, and environmental performance of mobility systems in host countries.

### 2.2. Research gap

Although there is growing research on China-Africa relations and foreign investment in infrastructure V. Tawiah, Kebede, and Kyiu (2022); V. K. Tawiah, Zakari, and Khan (2021); Wen et al. (2024), significant gaps remain concerning the impact of Chinese investment on mobility and sustainable mobility in Africa. For example, Wen et al. (2024) focused on the impact of Chinese investment on energy production in Africa without mention of transportation. While many studies have examined the economic and political dimensions of China's engagement – such as its role in trade expansion, debt sustainability, and geopolitical influence (Bo, Lawal, and Sakariyahu 2024; Ofosu and Sarpong 2022) – there is limited research on how Chinese-funded infrastructure projects directly influence mobility outcomes across the continent.

A major gap in the literature is the lack of focus on mobility outcomes, particularly in terms of how Chinese investment improves transport efficiency, accessibility, and sustainability. Most studies assess transport infrastructure in macroeconomic terms, such as GDP growth, foreign direct investment (FDI) inflows, and bilateral trade volumes, without addressing practical mobility improvements for individuals, businesses, and urban planners (Bo, Lawal, and Sakariyahu 2024; Lema et al. 2021; Sun 2023). There is little empirical research that quantifies the extent to which Chinese-built roads, railways, and airports reduce travel time, lower transportation costs, or enhance regional connectivity. Furthermore, there is limited analysis on whether these investments promote shifts toward greener, more sustainable mobility systems, such as public transit, electrified rail, and non-motorized transport.

## 3. Research design

### 3.1. Data sampling

This study examine sustainable mobility across four major transportation systems: road, railway, air, and sea. Each of these indicators captures respondents' perception of infrastructure quality as it supports logistics operations. While these measures do not directly account for traditional sustainability metrics such as carbon efficiency or public transit usage, they serve as proxy indicators for the infrastructural readiness and efficiency of transport systems, which are integral to the broader framework of sustainable mobility. Below is a breakdown by mode:

#### 3.1.1. Road Quality

Reflects the perceived condition and reliability of road networks. Although it does not explicitly measure emissions or modal share, high-quality roads are typically associated with smoother traffic flow and reduced congestion, which contribute to lower fuel consumption and emissions per trip, indirectly supporting environmental sustainability (Mrad and Mraihi 2023).

#### 3.1.2. Rail Quality

Evaluates the quality of railway infrastructure. While not a direct measure of rail usage or energy efficiency, improved rail infrastructure is closely linked to the promotion of rail freight and passenger services, which are generally more energy-efficient and less carbon-intensive than road transport – supporting the shift toward low-emission mobility systems (Küfeoğlu 2024).

#### 3.1.3. Air transport Quality

Indicates the infrastructure quality of airports and air logistics systems. Although air transport is inherently carbon-intensive, improvements in infrastructure often facilitate better traffic management, fuel-efficient aircraft operations, and reduced delays, thus marginally contributing to sustainability through operational efficiencies (Kharina, Rutherford, and Zeinali 2016; F. Li et al. 2022).

#### 3.1.4. Port (sea) Quality

Measures the perceived quality of port infrastructure. High-quality seaport systems enhance intermodal transport efficiency and can reduce turnaround times and emissions associated with idle times and inefficient logistics chains (Yin et al. 2023). Moreover, ports play a vital role in enabling a modal shift from land-based freight to maritime transport, which is typically more energy-efficient per ton-km.

**Table 1.** Variables measurement and sources.

| Variables | Measurement | Sources |
|---|---|---|
| Air quality (AQLT) | Measure the quality of air transportation system | WDI (2024) |
| Port quality (PQLT) | Measure the quality of port transportation system | WDI (2024) |
| Railway quality (RAQLT) | Measure the quality of railway transportation system | WDI (2024) |
| Road quality (ROQLT) | Measure the quality of road transportation system | WDI (2024) |
| Chinese investment (FDIGDP) | Chinese FDI Stock in African Countries | China's Ministry of Commerce (2024) |
| Construction revenue (CONSGDP) | Gross Annual Revenues of Chinese Companies' Construction Projects in Africa | China's Ministry of Commerce (2024) |
| Inflation rate (INF) | Consumer price in annual percentage | WDI (2024) |
| Economic development (GDP) | Growth domestic product per capita | WDI (2024) |
| Population growth (POP) | Population growth (annual) | WDI (2024) |
| Institutional quality (INSQ) | Estimated regulatory quality | WDI (2024) |
| Exchange rate (EXC) | Official exchange rate (USD) | WDI (2024) |
| Technology (TECH) | Patent application resident and non-resident | WDI (2024) |

Each unique indicator serves as the dependent variable, while Chinese FDI and construction revenue in Africa are utilized as independent variables. The inflation rate, population growth and technological innovation are employed as a control variable. Data spanning from 2006 to 2015 were collected due to availability constraints. All data on sustainable mobility, inflation rates, population growth, and technological innovation are sourced from the World Development Indicators (WDI), whereas data on Chinese FDI and construction revenue were obtained from the China Africa Research Initiative as showed in Table 1.

### 3.2. Econometric modelling

This study investigates the influence of Chinese investment and construction revenue on the advancement of sustainable mobility in Africa. We employed a dynamic linear regression model to analyze the data as follows:

$$SM_{it} = \beta_0 + \beta_1 FDIGDP_{it} + \beta_2 X_{it} + \varepsilon_{it}(1)$$

$$SM_{it} = \beta_0 + \beta_1 CONSGDP_{it} + \beta_2 X_{it} + \varepsilon_{it}(2)$$

Where SM denotes the sustainable mobility of various transportation modes, including air transport, ports, roads, and railways. FDIGDP and CONSGDP represent the foreign direct investment and construction revenue provided by Chinese entities in the African region. The variables t, i, and ε_it correspond to time, country, and error terms, respectively.

Given the characteristics of our data, we employed a system generalized method of moments (S-GMM) estimator. This flexible tool is ideal for analyzing dynamic panel data and addresses common issues such as endogeneity, measurement errors, and biases caused by small sample sizes. The ability to utilize both differenced and level equations enhances the efficiency and consistency of our estimates, which is crucial for our study. As is typical with S-GMM, we applied lagged levels and differences of endogenous variables to address endogeneity. Specifically, the use of internal instruments ensures that the model accounts for the correlation between explanatory variables and the error term, while avoiding the weaknesses associated with external instruments. Additionally, the validity of these instruments is confirmed using the Hansen test for over-identifying restrictions.

## 4. Results and discussions

### 4.1. Pre-regression estimate

Table 2 provides descriptive data on sustainable mobility in the African region. The results show that the average mean scale for air quality is 81, road quality is 76, port quality is 70, and railway quality is 32. This indicates that railway infrastructure in the region lags behind other modes of transportation, such as air travel, road networks, and ports. China's average annual investment in Africa is $60 million, while their revenue from construction alone reaches a minimum of $20 million.

Table 3 presents the results of the cross-sectional dependence and unit root tests. The findings indicate that we cannot reject the null hypothesis, as most

**Table 2.** Descriptive Statistics.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| AQLT | 370 | 81.314 | 45.680 | 0.000 | 147 |
| PQLT | 370 | 70.421 | 41.319 | 0.000 | 138 |
| RAQLT | 370 | 32.368 | 40.845 | 0.000 | 115 |
| ROQLT | 370 | 75.935 | 42.893 | 0.000 | 147 |
| FDIGDP | 370 | 59540034 | 0.009 | −0.002 | 0.004 |
| CONSGDP | 370 | 0.002 | 0.001 | −0.001 | 0.001 |
| INF | 370 | 35.564 | 270.655 | −8.401 | 4145.106 |
| POP | 370 | 2.567 | 1.021 | −3.326 | 6.0157 |
| TEC | 370 | 47.187 | 161.090 | 0.000 | 900 |
| INSQ | 370 | −.4998281 | .5635702 | −2.248597 | 1.196947 |
| GDP | 370 | 4.767662 | 6.862403 | −50.33852 | 86.82675 |
| EXC | 370 | 1.82e + 07 | 3.50e + 08 | 0.000 | 6.72e + 09 |

**Table 3.** Cross-sectional dependence and unit-root results.

| | CDS | CIPS | |
|---|---|---|---|
| Variables | Statistics | Statistics | Decisions |
| AQLT | −0.570 | −1.3010 | I(0) |
| PQLT | −1.751* | −2.2577 | I(0) |
| RAQLT | 33.307*** | −4.1593 | I(0) |
| ROQLT | 0.203 | −1.2717 | |
| ΔROQLT | | −4.8061 | I(1) |
| FDIGDP | 2.434* | 8.5085 | |
| ΔFDIGDP | | −4.8931 | I(1) |
| CONSGDP | | 0.8316 | |
| ΔCONSGDP | 6.332*** | −9.1207 | I(1) |
| GDP | | 5.8285 | |
| ΔGDP | | −3.7304 | I(1) |
| INF | 21.961*** | −3.0364 | I(0) |
| POP | 0.382 | −0.897 | |
| ΔPOP | | −2.656 | I(1) |
| TEC | 9.853*** | 0.403 | |
| ΔTEC | | −2.120 | I(1) |
| INSQ | 15.269*** | −1.334 | |
| ΔINSQ | | −2.902 | I(1) |
| EXC | 13.150*** | 0.201 | |
| ΔEXC | | −2.396 | I(1) |

variables are significant, except for air quality, road quality, and population growth. Given these facts, we employed the Cross-sectional Im-Pesaran-Shin (CIPS) unit root method to account for cross-sectional dependence. The results, displayed in the third column of Table 3, confirm that the coefficients for air quality, port quality, railway quality, and inflation are stationary at level, indicating an integral of order I (0). Conversely, the other variables are stationary at the first difference, suggesting an integral of order I(1). To address potential multicollinearity in our model or dataset, we conducted a multicollinearity test using the variance inflation factor (VIF). The findings, presented in Table 4, show that the VIF coefficient for all variables is below 10, which may raise concerns about multicollinearity.

### 4.2. Main results

Table 5 shows the impact of Chinese investment and construction revenue on sustainable mobility in Africa. Notably, the coefficient of Chinese investment shows a positive and statistically significant correlation, suggesting that Chinese investment in Africa is associated with improvements in air transport quality. This is intuitive, as Chinese investments often bring advanced technology and equipment, including state-of-the-art air traffic control systems, navigation aids, and security technologies that enhance the efficiency and safety of air transport. Additionally, Chinese funding supports African airlines in acquiring or leasing modern aircraft, which not only improves service quality but also optimizes fuel efficiency and reduces maintenance costs. This finding is consistent with the results of Kalayci and Yanginlar (2016), who confirmed a positive correlation between FDI and the enhancement of air transport in Turkey.

Similarly, our findings indicate that the coefficient of FDI is positively and significantly correlated with the enhancement of port transportation quality in Africa. This is intuitive, as China has provided substantial financial resources and construction expertise to port development projects in Africa. Chinese companies, often supported by official funding, have been involved in constructing new ports and upgrading existing ones, incorporating advanced technology and efficient construction methods. This finding is consistent with the study of Ali Ibrahim, Abdel-Gadir, and Devesh (2019), which shows that FDI is associated with improvements in port transportation infrastructure in Oman.

Furthermore, the coefficient of FDI is positively and statistically significantly correlated with the quality of road and railway transport. This is anticipated, given that China has allocated substantial financial resources to infrastructure initiatives in Africa. These resources include various forms of financial assistance, such as loans, grants, and direct investments, which are used to secure the necessary funds for the significant expansion and enhancement of road and railway infrastructure. This aligns with our expectations, as Chinese involvement often entails the transfer of technology and expertise, fostering the development of local capabilities in modern construction methods and project management.

On the other hand, columns 5–8 show the correlation between construction revenue and sustained mobility. Interestingly, the coefficient of construction revenue is positive and statistically significant, indicating a connection between construction revenue and

**Table 4.** Variance inflation factor (VIF) results.

| | AQLT | | | | PQLT | | | | RAQLT | | | | ROQLT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Variables | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF | VIF | 1/VIF |
| POP | 1.04 | 0.966 | 1.02 | 0.967 | 1.03 | 0.967 | 1.03 | 0.968 | 1.04 | 0.966 | 1.03 | 0.967 | 1.04 | 0.966 | 1.03 | 0.967 |
| INF | 1.01 | 0.994 | 1.01 | 0.994 | 1.01 | 0.992 | 1.01 | 0.992 | 1.01 | 0.994 | 1.01 | 0.994 | 1.01 | 0.994 | 1.01 | 0.994 |
| TEC | 1.03 | 0.973 | 1.03 | 0.973 | 1.03 | 0.975 | 1.03 | 0.975 | 1.03 | 0.973 | 1.03 | 0.973 | 1.03 | 0.973 | 1.03 | 0.973 |
| INSQ | | | | | | | | | | | | | | | | |
| FDIGDP | 1.01 | 0.999 | | | 1.00 | 0.998 | | | 1.00 | 0.998 | | | 1.01 | 0.998 | | |
| CONSGDP | | | 1.01 | 0.999 | | | 1.00 | 0.998 | | | 1.00 | 0.999 | | | 1.00 | 0.999 |
| Mean VIF | 1.02 | | 1.02 | | 1.02 | | 1.02 | | 1.02 | | 1.02 | | 1.02 | | 1.02 | |

**Table 5.** Main results.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Variables | AQLT | PQLT | ΔROQLT | RAQLT | AQLT | PQLT | ΔROQLT | RAQLT |
| $AQLT_{t-1}$ | 0.276*** | | | | 0.577*** | | | |
| | (0.054) | | | | (0.042) | | | |
| $AQLT_{t-2}$ | | | | | 0.139*** | | | |
| | | | | | (0.031) | | | |
| $PQLT_{t-1}$ | | 0.448*** | | | | 0.591*** | | |
| | | (0.066) | | | | (0.051) | | |
| $PQLT_{t-2}$ | | | | | | 0.050 | | |
| | | | | | | (0.041) | | |
| $PQLT_{t-3}$ | | | | | | 0.129*** | | |
| | | | | | | (0.037) | | |
| $\Delta ROQLT_{t-1}$ | | | 0.270*** | | | | −0.216 | |
| | | | (0.095) | | | | (0.187) | |
| $\Delta ROQLT_{t-2}$ | | | −0.021 | | | | 1.155 | |
| | | | (0.028) | | | | (0.850) | |
| $\Delta ROQLT_{t-3}$ | | | | | | | −2.460** | |
| | | | | | | | (1.189) | |
| $RAQLT_{t-1}$ | | | | 0.190 | | | | −0.424*** |
| | | | | (0.128) | | | | (0.132) |
| $RAQLT_{t-2}$ | | | | 0.172 | | | | −0.588*** |
| | | | | (0.118) | | | | (0.109) |
| $RAQLT_{t-3}$ | | | | 0.249*** | | | | 0.552** |
| | | | | (0.081) | | | | (0.220) |
| $\Delta FDIGDP_{t-1}$ | 0.005* | 0.005* | 0.004** | 0.001** | | | | |
| | (0.003) | (0.003) | (0.002) | (0.005) | | | | |
| $\Delta CONSGDP_{t-1}$ | | | | | 0.007** | 0.005*** | 0.004* | 0.003* |
| | | | | | (0.003) | (0.001) | (0.003) | (0.001) |
| $INF_{t-1}$ | 0.129** | 0.279 | 0.139*** | 0.840 | 0.093 | 0.008 | 0.591** | 0.314** |
| | (0.052) | (0.436) | (0.044) | (0.631) | (0.131) | (0.026) | (0.256) | (0.125) |
| $\Delta POP_{t-1}$ | 3.781 | −0.994 | 3.836 | 7.889 | 1.452 | 7.344 | −6.138 | −1.849 |
| | (3.694) | (2.947) | (4.067) | (9.085) | (1.779) | (9.419) | (17.99) | (9.819) |
| $TEC_{t-1}$ | 0.037 | 0.001 | 0.024 | 0.207** | 0.013 | 0.036 | 0.056 | 0.122 |
| | (0.026) | (0.014) | (0.022) | (0.087) | (0.012) | (0.093) | (0.064) | (0.083) |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR(1) | (0.020) | (0.009) | (0.028) | (0.066) | (0.010) | (0.002) | (0.028) | (0.005) |
| AR(2) | (0.183) | (0.203) | (0.277) | (0.626) | (0.178) | (0.258) | (0.257) | (0.362) |
| Hansen | (0.380) | (0.385) | (0.200) | (0.137) | (0.216) | (0.132) | (0.429) | (0.582) |
| Instruments | 18 | 18 | 19 | 17 | 19 | 19 | 13 | 12 |
| Observations | 185 | 170 | 185 | 148 | 222 | 238 | 148 | 185 |
| Number of ID | 37 | 34 | 37 | 37 | 37 | 34 | 37 | 37 |

Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

the enhancement of air and port transportation quality in Africa. This is expected, given the substantial financial commitment of Chinese corporations to airport and seaport infrastructure. These investments often come with comprehensive bilateral agreements and development loans aimed at improving trade channels and connectivity. This finding partially contradicts Babak (2017), which suggests that the construction of transport infrastructure leads to higher levels of environmental deterioration.

Similarly, the coefficient of construction revenue shows a positive and statistically significant relationship, indicating a connection between construction revenue and the enhancement of road and railway transportation quality in Africa. This is consistent with intuition, as Chinese investments have facilitated the expansion of road networks, connecting previously isolated areas. This connectivity has enabled the exchange of goods, the movement of people, and the provision of essential services. However, this finding contradicts Larpruenrudee, Surawski, and Islam (2022), who found that metro construction activities had a significant and unavoidable impact on the air quality experienced by train passengers.

## 4.3. Heterogeneity analysis

To assess heterogeneity in our study, we categorized countries into lower and higher resource groups as defined by the United Nations. The findings for lower-resource countries are presented in Table 6, while the results for higher-resource countries are shown in Table 7. Table 6 reveals that the coefficients of FDI and construction revenue are both positive and statistically significant, indicating that FDI and construction revenue are associated with improvements in sustained mobility, specifically in air, port, road, and railway transportation quality. Similarly, Table 7 shows that the

**Table 6.** Lower resources countries results.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Variables | AQLT | PQLT | ΔROQLT | RAQLT | AQLT | PQLT | ΔROQLT | RAQLT |
| $AQLT_{t-1}$ | 0.512*** | | | | 0.562*** | | | |
| | (0.0614) | | | | (0.076) | | | |
| $AQLT_{t-2}$ | | | | | −0.156*** | | | |
| | | | | | (0.045) | | | |
| $AQLT_{t-3}$ | | | | | 0.183*** | | | |
| | | | | | (0.049) | | | |
| $PQLT_{t-1}$ | | 0.623*** | | | | 0.699*** | | |
| | | (0.049) | | | | (0.053) | | |
| $\Delta ROQLT_{t-1}$ | | | −0.142 | | | | 0.048 | |
| | | | (0.181) | | | | (0.217) | |
| $\Delta ROQLT_{t-2}$ | | | −0.006 | | | | | |
| | | | (0.137) | | | | | |
| $\Delta ROQLT_{t-3}$ | | | 1.045* | | | | | |
| | | | (0.548) | | | | | |
| $RAQLT_{t-1}$ | | | | −0.182 | | | | 0.019 |
| | | | | (0.323) | | | | (0.070) |
| $RAQLT_{t-2}$ | | | | −0.577*** | | | | −0.094 |
| | | | | (0.211) | | | | (0.059) |
| $RAQLT_{t-3}$ | | | | 0.384 | | | | |
| | | | | (0.272) | | | | |
| $\Delta FDIGDP_{t-1}$ | 0.004* | 0.002* | 0.002** | 0.002* | | | | |
| | (0.002) | (0.009) | (0.010) | (0.009) | | | | |
| $\Delta CONSGDP_{t-1}$ | | | | | 0.004*** | 0.002** | 0.002* | 0.005* |
| | | | | | (0.002) | (0.001) | (0.001) | (0.003) |
| $INF_{t-1}$ | 0.550 | 0.004** | 0.572** | 0.024 | 0.085 | 0.042 | 1.588*** | 0.306*** |
| | (0.360) | (0.002) | (0.274) | (0.111) | (0.079) | (0.044) | (0.572) | (0.090) |
| $\Delta POP_{t-1}$ | −0.917 | −0.243 | 27.06 | 151.6* | −1.021 | 0.364 | 77.50 | −24.87* |
| | (2.827) | (2.339) | (17.86) | (79.70) | (2.079) | (1.208) | (55.34) | (14.55) |
| $TEC_{t-1}$ | 0.097*** | 0.011 | 0.490* | 0.570* | 0.008 | 0.035** | 1.308*** | 0.027 |
| | (0.022) | (0.015) | (0.295) | (0.317) | (0.023) | (0.014) | (0.490) | (0.052) |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR(1) | (0.044) | (0.002) | (0.318) | (0.353) | (0.024) | (0.003) | (0.346) | (0.047) |
| AR(2) | (0.181) | (0.803) | (0.733) | (0.344) | (0.837) | (0.302) | (0.117) | (0.385) |
| Hansen | (0.221) | (0.137) | (0.855) | (0.186) | (0.314) | (0.227) | (0.717) | (0.554) |
| Instruments | 21 | 18 | 16 | 12 | 19 | 19 | 12 | 16 |
| Observations | 174 | 182 | 116 | 203 | 174 | 182 | 145 | 116 |
| Number of ID | 29 | 26 | 29 | 29 | 29 | 26 | 29 | 29 |

Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

Table 7. Higher resource countries results.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Variables | AQLT | PQLT | ΔROQLT | RAQLT | AQLT | PQLT | ΔROQLT | RAQLT |
| $AQLT_{t-1}$ | −0.167 | | | | −0.165 | | | |
| | (0.195) | | | | (0.160) | | | |
| $PQLT_{t-1}$ | | −1.037 | | | | −0.666* | | |
| | | (0.661) | | | | (0.355) | | |
| $\Delta ROQLT_{t-1}$ | | | −0.181 | | | | −0.606 | |
| | | | (0.180) | | | | (0.929) | |
| $RAQLT_{t-1}$ | | | | 0.331** | | | | 0.734** |
| | | | | (0.148) | | | | (0.310) |
| $RAQLT_{t-2}$ | | | | | | | | 1.029*** |
| | | | | | | | | (0.383) |
| $RAQLT_{t-3}$ | | | | | | | | 2.212*** |
| | | | | | | | | (0.547) |
| $\Delta FDIGDP_{t-1}$ | 0.004* | 0.005* | 0.002** | 0.001* | | | | |
| | (0.003) | (0.003) | (0.007) | (0.009) | | | | |
| $\Delta CONSGDP_{t-1}$ | | | | | 0.003* | 0.009** | 0.005* | 0.001** |
| | | | | | (0.001) | (0.004) | (0.003) | (0.005) |
| $INF_{t-1}$ | −0.255 | 0.132 | 0.129* | 0.085*** | 0.768 | 0.016 | 1.082 | 0.110 |
| | (0.546) | (0.099) | (0.066) | (0.028) | (0.873) | (0.057) | (1.504) | (0.150) |
| $\Delta POP_{t-1}$ | −8.325* | −11.33 | −4.261 | −1.424 | −36.15** | −34.20 | −20.62 | −0.184 |
| | (4.775) | (18.36) | (7.142) | (10.38) | (15.15) | (38.11) | (22.29) | (22.37) |
| $TEC_{t-1}$ | −0.326* | −2.588 | 0.833** | −1.928 | 0.377 | −3.143 | 8.495 | −2.595** |
| | (0.190) | (3.336) | (0.329) | (1.881) | (0.537) | (2.822) | (10.89) | (1.293) |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR(1) | (0.528) | (0.214) | (0.056) | (0.060) | (0.234) | (0.151) | (0.991) | (0.272) |
| AR(2) | (0.740) | (0.149) | (0.501) | (0.286) | (0.799) | (0.171) | (0.202) | (0.110) |
| Hansen | (0.321) | (0.857) | (0.895) | (0.134) | (0.401) | (0.937) | (0.856) | (0.560) |
| Instruments | 11 | 10 | 9 | 10 | 10 | 10 | 11 | 11 |
| Observations | 65 | 104 | 78 | 104 | 78 | 91 | 78 | 78 |
| Number of ID | 13 | 13 | 13 | 13 | 13 | 13 | 13 | 13 |

Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.1$.

coefficients of FDI and construction revenue are positive and statistically significant, suggesting a positive relationship between FDI, construction revenue, and the enhancement of sustained mobility across air, port, road, and railway transportation quality.

However, the correlation between the coefficient of FDI and construction revenue is greater in high-resource countries compared to lower-resource ones. This implies that investing in transport infrastructure in resource-rich countries yields more favorable results. This aligns with intuition, as countries that possess abundant resources generate significant revenue from exporting natural resources such as oil, minerals, and gas. This source of income serves as a financial basis for repaying Chinese loans and allocating funds toward infrastructure initiatives. In addition, a consistent flow of revenue generated from natural resources has a significant role in enhancing economic stability, hence increasing the likelihood of attracting additional foreign investments, especially those from China.

## 4.4. Robustness check

For robustness check, we incorporate additional control variables, such as economic development, institutional quality, and exchange rate. The results of this analysis are presented in Table 8. Interestingly, the coefficient of FDI shows a positive and statistically

**Table 8.** Robustness results.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Variables | AQLT | PQLT | ΔROQLT | RAQLT | AQLT | PQLT | ΔROQLT | RAQLT |
| $AQLT_{t-1}$ | 0.395*** | | | | 0.469*** | | | |
| | (0.137) | | | | (0.129) | | | |
| $AQLT_{t-2}$ | −0.060 | | | | | | | |
| | (0.087) | | | | | | | |
| $PQLT_{t-1}$ | | 0.652*** | | | | 0.598*** | | |
| | | (0.073) | | | | (0.041) | | |
| $PQLT_{t-2}$ | | −0.107* | | | | 0.088*** | | |
| | | (0.064) | | | | (0.027) | | |
| $PQLT_{t-3}$ | | 0.271*** | | | | | | |
| | | (0.083) | | | | | | |
| $\Delta ROQLT_{t-1}$ | | | 0.289*** | | | | 0.033 | |
| | | | (0.090) | | | | (0.136) | |
| $RAQLT_{t-1}$ | | | | −0.030 | | | | 0.683 |
| | | | | (0.080) | | | | (0.786) |
| $RAQLT_{t-2}$ | | | | −0.039 | | | | 0.123 |
| | | | | (0.071) | | | | (0.489) |
| $RAQLT_{t-3}$ | | | | 0.081 | | | | 2.379* |
| | | | | (0.100) | | | | (1.331) |
| $\Delta FDIGDP_{t-1}$ | 0.006* | 0.007* | 0.004** | 0.002** | | | | |
| | (0.004) | (0.004) | (0.002) | (0.010) | | | | |
| $\Delta CONSGDP_{t-1}$ | | | | | 0.008*** | 0.002*** | 0.001* | 0.007* |
| | | | | | (0.003) | (0.007) | (0.007) | (0.004) |
| $\Delta INSQ_{t-1}$ | 2.970 | 2.211 | −0.714 | 44.42 | 62.640** | 3.384 | 91.930 | 22.230 |
| | (6.183) | (3.398) | (5.045) | (121.6) | (27.990) | (3.015) | (104.200) | (14.020) |
| $\Delta GDP_{t-1}$ | −0.490*** | −0.938*** | −0.246*** | 0.801 | −1.727*** | −0.202*** | 0.567* | 0.534 |
| | (0.152) | (0.125) | (0.079) | (0.996) | (0.278) | (0.071) | (0.321) | (0.668) |
| $EXC_{t-1}$ | −0.001 | 0.001 | 0.001 | 0.002 | 0.006 | 0.002 | 0.017 | −0.067 |
| | (0.002) | (0.001) | (0.002) | (0.011) | (0.004) | (0.005) | (0.085) | (0.066) |
| Country FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Year FE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| AR(1) | (0.039) | (0.380) | (0.044) | (0.037) | (0.029) | (0.002) | (0.021) | (0.073) |
| AR(2) | (0.108) | (0.766) | (0.154) | (0.155) | (0.100) | (0.142) | (0.905) | (0.343) |
| Hansen | (0.119) | (0.258) | (0.107) | (0.109) | (0.111) | (0.154) | (0.141) | (0.815) |
| Instruments | 18 | 18 | 19 | 17 | 12 | 19 | 17 | 12 |
| Observations | 185 | 170 | 185 | 148 | 259 | 238 | 148 | 185 |
| Number of ID | 37 | 34 | 37 | 37 | 37 | 34 | 37 | 37 |

Standard errors in parentheses.
***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

significant correlation, indicating that FDI is linked to improvements in air, sea, road, and railway transportation quality. Similarly, our analysis reveals that the coefficient of construction revenue is positive and statistically significant, suggesting a strong association between construction revenue and the enhancement of sustained mobility across various modes of transportation, including air, sea, road, and railway. These findings are consistent with the main results in Table 5, leading us to conclude that our results are robust and unaffected by the selection of control variables.

## 5. Conclusion and policy recommendations

This study provides valuable insights into the theoretical and empirical connections between FDI, infrastructure development, and sustainable mobility in Africa. By exploring the impact of Chinese investment and construction on air, rail, and road transport systems across 36 African countries, the research highlights the transformative potential of external capital inflows on sustainable infrastructure outcomes. Our findings support the developmental theory that shows the significance of capital formation and infrastructure expansion as catalysts for economic transformation (W. Rostow 1960). Specifically, we show that Chinese investment not only fosters infrastructure growth but also advances broader sustainability objectives, such as reducing emissions, enhancing connectivity, and improving quality of life.

This study also carries significant theoretical implications for the FDI literature. This is consistent with Dunning and Lundan (2008) eclectic paradigm by demonstrating how location-specific advantages, particularly natural resource endowments, attract investment, which subsequently enhances host country infrastructure. The findings resonate with the perspective that Chinese FDI, often facilitated through state-owned enterprises and concessional lending, differs from Western investment models and can play a crucial role in addressing infrastructure deficits in developing countries (Brautigam 2009). By emphasizing sustainable mobility rather than solely economic output, this study broadens the scope of previous FDI research in Africa (Asiedu 2006), introducing new dimensions of environmental and social impact into the discourse.

Our findings, when compared with existing literature, reveal both similarities and differences. Similar to the work by W. Chen, Dollar, and Tang (2018), we observe that Chinese investment is positively associated with infrastructure improvements. However, our study goes a step further by demonstrating that these benefits are not limited to urban or economically dominant regions but extend to inclusive and sustainable mobility across a broader geographic area. This stands in contrast to critical literature that has questioned the sustainability and long-term value of Chinese-funded projects (Tan-Mullins, Mohan, and Power 2010). Our evidence indicates that, when supported by effective policies and good governance, Chinese investment can yield lasting socio-economic and environmental benefits.

From a policy perspective, this study offers several key recommendations. Firstly, African governments, especially those in resource-poor countries, should establish robust legal frameworks and ensure political stability while providing investment incentives to attract and retain Chinese infrastructure investments. Secondly, policies should promote a balanced investment strategy across all modes of transportation – air, rail, and road – to ensure integrated and sustainable mobility systems. Thirdly, capacity-building policies that support technology transfer, local employment, and workforce training should be prioritized to ensure that the long-term benefits of investment extend beyond infrastructure to human capital development. Fourthly, social and environmental safeguards should be embedded in all transport projects to ensure inclusive access and sustainability. Finally, African policymakers should diversify their sources of infrastructure financing to reduce dependency on any single external partner and enhance economic resilience.

The contributions of this study are threefold. Firstly, we provide empirical evidence using robust econometric approaches, specifically the two-step System GMM, to control for endogeneity and unobserved heterogeneity. This enhances the reliability of our results and strengthens the causal interpretation of the relationship between Chinese investment and sustainable mobility. Secondly, the study offers policy insights by recommending actionable steps for African governments, such as improving the investment climate, strengthening legal frameworks, and integrating sustainability considerations into project design. Thirdly, the study contributes to theoretical discourse by linking FDI flows with sustainable development, human capital formation, and environmental outcomes, particularly in resource-rich economies.

While this study presents robust findings, it also opens up several avenues for future research. Future studies could delve into sectoral variations in Chinese investment to identify which infrastructure domains yield the greatest sustainability dividends. Comparative analyses between Chinese and Western investors may reveal differences in long-term impact and governance standards. Additionally, further investigation into the social equity dimensions of transport infrastructure – such as gender and income distribution effects – would provide a more comprehensive understanding of inclusive development. The role of climate resilience in Chinese-funded infrastructure, especially in the face of increasing environmental stress in Africa, is another important area for future exploration.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

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