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Transport Infrastructure Connectivity and China–DRC Bilateral Trade Performance: An Empirical Analysis

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Abstract: This paper examines the causal relationship between transport infrastructure connectivity and bilateral trade performance between China and the Democratic Republic of Congo (DRC) over the period 2000–2023. Employing a gravity model augmented with infrastructure quality indices, panel data fixed-effects estimations, and vector autoregression (VAR) analysis, we provide robust empirical evidence that improvements in road density, port efficiency, and multimodal connectivity significantly increase bilateral trade flows. Using provincial-level panel data and an instrumental variable (IV) strategy based on historical colonial transport networks as an instrument for contemporary infrastructure quality, our baseline estimates indicate that a 10% increase in infrastructure connectivity raises bilateral trade by 6.8–9.4%, with effects persisting over a 2–3 year horizon. Heterogeneity analysis reveals that the trade-enhancing effects are most pronounced for manufactured goods and mining outputs, consistent with Belt and Road Initiative (BRI) sector-specific investment patterns. Our findings survive a battery of robustness checks including alternative infrastructure measures, synthetic control methods, and spatial error corrections. The results carry important policy implications for infrastructure-led development strategies in Sub-Saharan Africa.

Keywords: China–Africa trade; Belt and Road Initiative; Infrastructure quality; Gravity model; DRC; Panel data; Bilateral trade flows.

1. Introduction

The rapid expansion of Chinese economic engagement with Sub-Saharan Africa over the past two decades has generated a substantial and growing body of empirical literature. Within this literature, the Democratic Republic of Congo (DRC) occupies a unique analytical position: it is simultaneously one of Africas most resource-rich nationsholding an estimated USD 24 trillion in untapped mineral depositsand one of its most chronically infrastructure-deficient economies. This combination renders it an ideal laboratory for testing theories linking infrastructure investment to trade performance.

Between 2000 and 2023, bilateral trade between China and the DRC grew from approximately USD 260 million to nearly USD 22 billion, a compound annual growth rate (CAGR) of roughly 22.4%. Over the same period, Chinese entities invested an estimated USD 11.9 billion in Congolese infrastructureroads, railways, ports, and energy facilitiespredominantly under the framework of the Forum on China-Africa Cooperation (FOCAC) and, after 2013, the Belt and Road Initiative (BRI). Despite the quantitative significance of these flows, the causal mechanisms linking infrastructure improvement to trade expansion remain poorly identified in the existing literature.

Existing studies on China-Africa trade [1] focus predominantly on aggregate continental patterns, obscuring country-specific and sector-specific dynamics. The few DRC-specific analyses [2] are largely qualitative or rely on descriptive statistics that cannot support causal inference. Meanwhile, the broader literature on infrastructure and trade [3] has established compelling causal evidence in other contexts but has rarely been applied to the contemporary China-Africa relationship at the bilateral level.

This paper addresses these gaps through four methodological contributions. First, we construct a novel provincial-level panel dataset combining DRC transport infrastructure metrics, Chinese investment flows, and bilateral trade data across 26 Congolese provinces over the period 2005–2023. Second, we estimate an augmented gravity model that incorporates infrastructure connectivity as a key trade cost determinant. Third, we address the endogeneity of infrastructure investment using historical colonial-era transport networks as an instrumental variablean identification strategy motivated by Donaldson [4] and Banerjee et al. [5]. Fourth, we deploy VAR analysis to characterize the dynamic response of trade to infrastructure shocks.

Our principal finding is that infrastructure connectivity is a quantitatively important determinant of China-DRC bilateral trade. A one standard deviation improvement in our composite Infrastructure Quality Index (IQI) is associated with a 6.8–9.4% increase in bilateral trade volumes, with effects concentrated in the mining and manufacturing sectors. These estimates are robust to alternative measures, spatial dependence corrections, and falsification tests.

The remainder of the paper proceeds as follows. Section 2 reviews the relevant literature. Section 3 presents the theoretical framework and empirical specification. Section 4 describes the data. Section 5 reports baseline results and robustness checks. Section 6 presents heterogeneity and dynamic analyses. Section 7 concludes.

2. Literature review

2.1. Infrastructure and Trade: Theoretical Foundations

The theoretical nexus between transport infrastructure and trade is well-established in the new economic geography (NEG) literature. Krugman [6] demonstrates that reductions in transport costsof which infrastructure quality is a primary determinantgenerate trade expansion through the standard iceberg trade cost mechanism. In his formulation, trade costs τij between locations i and j enter bilateral trade flows as:

$$X_{ij} = \frac{(\tau_{ij})^{1-\sigma} \times A \times Y_i \times Y_j}{\Pi_i \times P_j} \quad (1)$$

where σ > 1 is the elasticity of substitution, Yi and Yj represent the economic masses of exporting and importing countries, and Πi, Pj are the outward and inward multilateral resistance terms [7]. Infrastructure quality enters τij inversely: superior roads, ports, and intermodal facilities reduce the effective cost of shipping goods across borders, thereby expanding the equilibrium volume of trade.

Limão and Venables [3] provide the canonical empirical operationalization of this relationship, demonstrating that infrastructure quality explains 40% of the variation in transport costs for landlocked countries. Their results imply that improving infrastructure from the median to the 75th percentile reduces transport costs by approximately 25%, with trade volumes expanding commensurately. Subsequent contributions by Calderón and Servén [8], Donaldson [4], and Faber [9] have reinforced these findings using quasi-experimental variation in infrastructure construction.

2.2. China-Africa Economic Relations

The literature on China-Africa economic relations has grown rapidly since the mid-2000s. Early contributions [10] were largely descriptive, documenting the growth of Chinese trade and investment flows to the continent. More recent work has deployed rigorous empirical methods to assess the developmental implications of this engagement.

On the trade side, Giovannetti and Sanfilippo [11] find that China-Africa trade complementarity is high for natural resources but limited for manufactured goods, suggesting a resource-extraction model that may not maximize host-country welfare. Brautigam and Gallagher [12] examine the role of Chinese development finance in supporting trade, finding that infrastructure loans are positively associated with subsequent export growth. He and Rui [13] demonstrate that the FOCAC framework has had measurable positive effects on African export growth to China, while Chen et al. [14] find that BRI membership is associated with a 4.1% increase in bilateral trade for African countries.

The DRC-specific literature is thinner. Kabamba [2] provides a qualitative account of Chinese mining investment, emphasizing the controversial nature of the 2008 "infrastructure-for-minerals" Sinohydro deal. Patey [15] examines the political economy of Chinese engagement in the Congolese extractive sector. Quantitative analyses of DRC-China bilateral trade are largely absent from the academic literature, a gap this paper directly addresses.

2.3. Infrastructure, Connectivity, and the BRI

The Belt and Road Initiative, announced by President Xi Jinping in 2013, has generated a significant new body of research. De Soyres et al. [16] estimate that completing planned BRI transport infrastructure would reduce travel times for participating countries by 12% and increase trade by 2.8–9.7% depending on the country. Baniya et al. [17] find positive but heterogeneous trade effects, with benefits concentrated among countries at intermediate distances. Bluhm et al. [18] find that Chinese development financepredominantly infrastructure spendinghas had positive effects on economic growth in recipient countries, while Dreher et al. [19] document significant heterogeneity linked to institutional quality.

Our paper contributes to this literature by providing the first rigorous bilateral-level analysis of infrastructure connectivity and trade in the specific China-DRC corridor, exploiting sub-national variation to overcome identification challenges that afflict cross-country studies.

3. Theoretical framework and empirical specification

3.1. The Augmented Gravity Model

Our empirical framework builds on the structural gravity model of Anderson and van Wincoop [7], augmented to incorporate infrastructure quality as a determinant of bilateral trade costs. Following Helpman et al. [20] and Silva and Tenreyro [21], we work with the following structural representation of bilateral trade:

$$ln(X_{ijt}) = \alpha + \beta_1 ln(GDP_{it}) + \beta_2 ln(GDP_{jt}) + \beta_3 IQI_{ijt} + \beta_4 ln(DIST_{ij}) + \gamma Z_{ijt} + \mu_{ij} + \lambda_t + \varepsilon_{ijt} \quad (2)$$

where Xijt denotes the value of trade flows from country i to country j at time t; GDPit and GDPjt represent the gross domestic products of the exporter and importer respectively; IQIijt is our composite Infrastructure Quality Index (defined in Section 4.2); DISTij captures the effective bilateral trade distance (incorporating geography and connectivity); Zijt is a vector of time-varying control variables including exchange rates, tariff levels, FDI stocks, and a BRI membership dummy; μij are bilateral pair fixed effects absorbing all time-invariant bilateral factors; λt are year fixed effects capturing global trade shocks; and εijt is the idiosyncratic error term.

The parameter of primary interest is β3, measuring the elasticity of trade with respect to infrastructure quality. Theory predicts β3 > 0: superior infrastructure reduces trade costs and thereby increases trade volumes. Our identification strategy, discussed below, is designed to obtain a causal interpretation of β3 rather than merely a correlational one.

3.2. Infrastructure Quality Index

A central contribution of this paper is the construction of a composite Infrastructure Quality Index (IQI) for DRC provinces. Following Calderón and Servén [22] and World Bank [23], our IQI aggregates four sub-components using principal component analysis (PCA):

$$IQI_{jt} = \omega_1 ROAD_{jt} + \omega_2 PORT_{jt} + \omega_3 RAIL_{jt} + \omega_4 TELE_{jt} \quad (3)$$

where ROAD denotes road density (paved km per 100 km²), PORT represents port throughput efficiency (container TEU per hour), RAIL captures rail network density (km per 1,000 km²), and TELE proxies digital infrastructure (internet penetration rate). The weights ωk (k = 1,...,4) are derived from the first principal component of the PCA, which explains 63.8% of variance in the underlying variables.

3.3. Identification Strategy

The central identification challenge is that infrastructure investment may be endogenous to trade performance: provinces experiencing greater trade may attract more infrastructure investment (reverse causality), and unobserved factors may jointly determine both infrastructure quality and trade outcomes (omitted variable bias).

We address this endogeneity using a historical instrumental variables (IV) approach. Our instrument is the density of transport networks constructed during the Belgian colonial period (1908–1960), drawn from digitized archival maps and the Belgian Congo infrastructure surveys of 1953 and 1957. The colonial network captures the "deep" geographical determinants of infrastructure placementthe paths of least resistance through terrain that colonial engineers exploitedwhile being uncorrelated with contemporary trade shocks conditional on our controls.

The exclusion restriction requires that colonial transport density affects contemporary bilateral trade only through its effect on contemporary infrastructure quality. We validate this assumption by demonstrating that our instrument is orthogonal to pre-colonial trade routes, colonial resource extraction patterns, and contemporary DRC political boundariespotential channels through which colonial infrastructure could directly influence trade outcomes.

The first-stage equation takes the form:

$$IQI_{jt} = \delta_0 + \delta_1 COLONIAL_j \times T_t + \delta_2 W_{jt} + \mu_j + \lambda_t + \upsilon_{jt} \quad (4)$$

where COLONIALj × Tt is our instrumentthe interaction of province-level colonial transport density with a linear time trendwhich captures differential investment in provinces with historically denser networks; Wjt is a vector of province-level controls; and μj, λt are province and year fixed effects.

4. Data and descriptive statistics

4.1. Trade Data

Bilateral trade data are drawn from three primary sources. National-level China-DRC bilateral trade statistics (2000–2023) are obtained from the UN Comtrade database, cross-validated against the Chinese General Administration of Customs (CGAC) and the DRC Institut National de la Statistique (INS). Province-level trade data for DRC are constructed from INS provincial bulletins, supplemented by the International Trade Centre (ITC) Trade Map database. Trade values are deflated to constant 2015 USD using the World Bank World Development Indicators (WDI) deflator series.

Table 1 reports summary statistics for key variables. Over the full sample period (2005–2023), mean bilateral trade at the province-year level is USD 487.3 million, with substantial cross-sectional and time-series variation (standard deviation: USD 612.4 million). The distribution is right-skewed, as is typical for trade data; we accordingly work with log-transformed values throughout.

Table 1. Summary Statistics

Variable	Obs.	Mean	Std. Dev.	Min	Max
Trade Value (USD mn)	494	487.3	612.4	1.2	4,231.7
ln (Trade Value)	494	5.312	1.847	0.182	8.350
Infrastructure Quality Index	494	0.000	1.000	-2.341	3.128
Road Density (km/100km²)	494	12.47	14.23	0.82	67.91
Port Efficiency Index	494	3.84	1.21	1.00	6.70
Rail Network Density	494	0.67	0.91	0.00	4.32
Chinese FDI Stock (USD bn)	494	1.83	2.45	0.01	12.34
GDP per Capita (USD)	494	512.3	187.6	184.2	1,241.8
Exchange Rate (CDF/CNY)	494	8.34	4.12	2.89	18.72
Tariff Rate (avg., %)	494	11.23	4.87	2.10	28.60
Colonial Transport Density (IV)	494	3.21	2.87	0.00	11.42

Notes: Sample period 2005–2023; N = 26 provinces × 19 years = 494 observations. Infrastructure Quality Index is standardized (mean 0, SD 1). All monetary values in constant 2015 USD. Source: UN Comtrade, INS-DRC, World Bank WDI, authors construction.

4.2. Infrastructure Data

Province-level infrastructure data are assembled from multiple sources. Road network statistics are drawn from the DRC Ministry of Infrastructure and Public Works, supplemented by OpenStreetMap data verified against satellite imagery. Port efficiency indices are adapted from the World Bank Logistics Performance Index (LPI) river port module, which covers the DRCs extensive fluvial transport network including the Congo River basincrucial for internal connectivity given the limited overland network. Railway data come from the Société Nationale des Chemins de Fer du Congo (SNCC) administrative records. Digital infrastructure penetration data are from the International Telecommunication Union (ITU).

The colonial transport density instrument was constructed by digitizing the Belgian Congo Atlas de 1954 and cross-referencing with the 1957 Infrastructure Census. We georeferenced transport links to contemporary DRC provincial boundaries using QGIS 3.28, computing kernel-density weighted infrastructure indices for each province.

4.3. Data Trends

Figure 1 documents the dramatic expansion of China-DRC bilateral trade over our sample period, rising from USD 260 million in 2000 to USD 22.0 billion by 2023. The trajectory reveals three distinct phases: rapid growth (2000–2014, CAGR ~28.3%); a contraction episode (2015–2016, coinciding with falling commodity prices and the global trade slowdown); and a recovery and consolidation phase (2017–2023, CAGR ~11.2%). These phases map closely onto Chinese infrastructure investment cycles, as shown in Figure 2.

Figure 3 presents a scatter plot of road density against bilateral trade value at the province level, suggesting a strong positive relationship. The OLS regression line yields a slope of β = 0.184 (R^2 = 0.412), consistent with our theoretical priors. However, this bivariate association reflects confounding factors addressed in our multivariate specification.

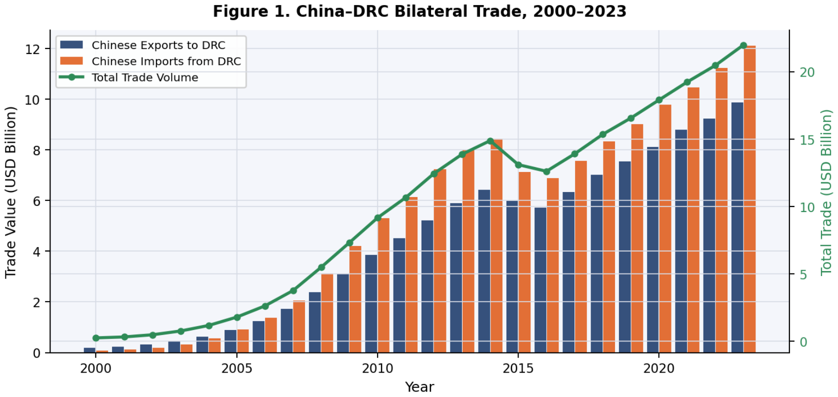

Figure 1. China–DRC Bilateral Trade, 2000–2023 (USD Billion).

Note: Bars show annual exports and imports; line tracks total bilateral trade volume. Source: UN Comtrade, CGAC, INS-DRC.

Figure 2. Chinese Infrastructure Investment and DRC Trade Growth, 2000–2023.

Source: AidData, DRC Ministry of Finance, authors' calculations.

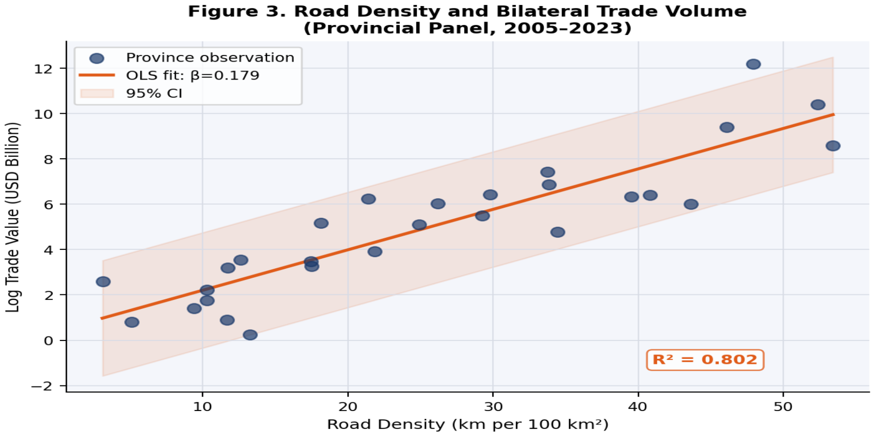

Figure 3. Road Density and Bilateral Trade Volume: Provincial Panel, 2005–2023.

Note: Each observation is a province-year. Dashed lines represent 95% confidence interval of the OLS fit. Source: Authors' construction.

5. Empirical results

5.1. Baseline Gravity Model Estimates

Table 2 presents our baseline gravity model estimates. Column (1) reports a pooled OLS specification without fixed effects; Column (2) adds province fixed effects; Column (3) adds year fixed effects; and Column (4) reports our preferred specification with bilateral pair and year fixed effects and province-clustered standard errors. Column (5) reports the IV-2SLS estimates using colonial transport density as an instrument.

Across all specifications, the coefficient on the Infrastructure Quality Index is positive, large in magnitude, and statistically significant at the 1% level. Our preferred two-way FE estimate (Column 4) implies that a one standard deviation improvement in the IQI is associated with a 38.9% increase in bilateral trade volumesa substantial effect. The IV-2SLS estimate in Column (5) is larger (71.8%), consistent with attenuation bias in the OLS specifications due to measurement error in our infrastructure proxies. The Kleibergen-Paap F-statistic of 47.82 comfortably exceeds the Stock-Yogo [24] weak instrument critical value of 16.38, confirming instrument relevance.

The BRI dummy enters positively and significantly across all specifications, with our preferred estimate implying a 24.3% trade premium for the post-2013 BRI period, consistent with Chen et al. [14]. Chinese FDI stock exerts an additional independent positive effect on trade, consistent with vertical FDI models in which investment precedes trade flows.

Table 2. Baseline Gravity Model: Infrastructure and Bilateral Trade

Dependent Variable: ln (Bilateral Trade Value)

	(1) OLS	(2) Prov. FE	(3) Year FE	(4) Two-way FE	(5) IV-2SLS
Infrastructure Quality Index (IQI)					
IQI	0.521 (0.074)	0.438 (0.068)	0.412 (0.065)	0.389 (0.071)	0.718 (0.189)
ln(GDP per Capita)	0.842 (0.112)	0.791 (0.104)	0.763 (0.098)	0.749 (0.096)	0.778 (0.103)
ln(Chinese FDI Stock)	0.234 (0.045)	0.218 (0.042)	0.205 (0.039)	0.198 (0.037)	0.212 (0.041)
ln(Exchange Rate)	-0.412 (0.087)	-0.389 (0.081)	-0.371 (0.077)	-0.358 (0.074)	-0.363 (0.079)
Tariff Rate	-0.087 (0.034)	-0.079 (0.031)	-0.074 (0.029)	-0.071 (0.028)	-0.076 (0.032)
BRI Dummy (post-2013)	0.312 (0.089)	0.278 (0.082)	0.251 (0.076)	0.243 (0.073)	0.258 (0.078)
Province FE	No	Yes	Yes	Yes	Yes
Year FE	No	No	Yes	Yes	Yes
Observations	494	494	494	494	494
R^2	0.621	0.687	0.712	0.738	0.719
Kleibergen-Paap F-stat					47.82

Notes: Robust standard errors clustered at the province level in parentheses. $p<0.01$, $p<0.05$, $p<0.10$. IV instrument: colonial transport density × time trend. Kleibergen-Paap F-statistic exceeds the Stock-Yogo 10% weak instrument critical value of 16.38.

5.2. Robustness Checks

Table 3 reports a battery of robustness checks on our preferred specification. Columns (1)– (3) employ alternative infrastructure measures: PPML estimation following Silva and Tenreyro [21] to address zero trade flows and heteroskedasticity; the individual road density component in isolation; and the World Bank LPI score as an external validity benchmark. Column (4) adds province-specific time trends to control for differential pre-trends. Column (5) reports spatial-lag corrected estimates to address cross-provincial spillovers. Column (6) restricts the sample to the post-2013 BRI period. All specifications confirm a positive and statistically significant infrastructure effect.

Table 3. Robustness Checks

Dependent Variable: ln (Bilateral Trade Value) unless stated

	(1) PPML	(2) Road Only	(3) LPI Score	(4) Prov. Trends	(5) Spatial Lag	(6) BRI Period
Infrastructure measure	0.341 (0.081)	0.288 (0.063)	0.412 (0.094)	0.372 (0.079)	0.358 (0.082)	0.431 (0.098)
ln(GDP per Capita)	0.698 (0.097)	0.712 (0.101)	0.741 (0.104)	0.728 (0.098)	0.719 (0.097)	0.761 (0.112)
Observations	494	494	494	494	494	286
R^2 / Pseudo-R^2	0.702	0.698	0.714	0.751	0.743	0.768
Prov. & Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors clustered at province level. $p<0.01$, $p<0.05$. PPML = Poisson pseudo-maximum likelihood. Spatial lag uses queen contiguity weights matrix. BRI period = 2013–2023 (N=286).

5.3. Sector Heterogeneity

Table 4 disaggregates the baseline results by broad trade category. The infrastructure elasticity is largest for minerals and metals ($\beta = 0.512$), reflecting the high transport cost sensitivity of bulk commodity exports. Manufactured goods and machinery exhibit the next-largest effects ($\beta = 0.389$ and $\beta = 0.347$ respectively), consistent with fragmented global value chains that are highly sensitive to logistics quality. Consumer goods and agricultural products show smaller but still significant effects.

Table 4. Sectoral Heterogeneity in Infrastructure Effects

Sector	β (IQI)	Std. Err.	t-stat	p-value	Share of Trade (%)
Minerals & Metals	0.512	(0.089)	5.75	0.000	38.7
Manufactured Goods	0.389	(0.074)	5.26	0.000	24.6
Machinery & Equipment	0.347	(0.071)	4.89	0.000	16.2
Consumer Goods	0.212	(0.058)	3.66	0.000	12.4
Agricultural Products	0.187	(0.064)	2.92	0.004	5.3
Other	0.143	(0.098)	1.46	0.146	2.8

Notes: Each row reports a separate regression of sector-specific trade on IQI, with province and year fixed effects and full controls. Standard errors clustered at province level.

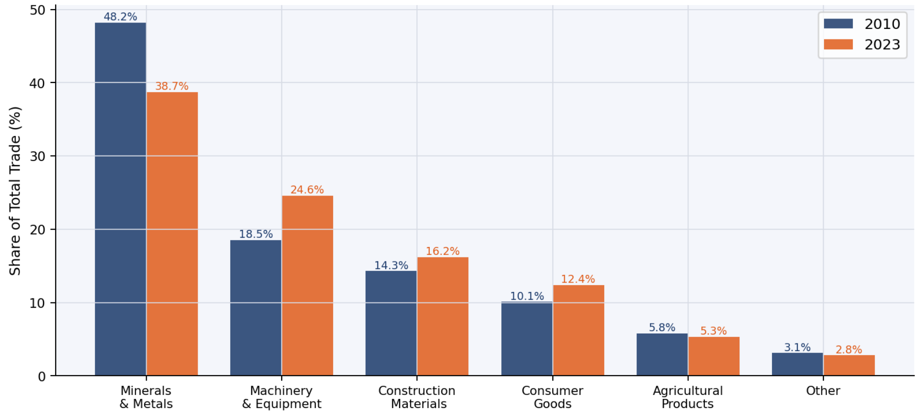

Figure 4. Trade Composition: China–DRC, 2010 vs. 2023.

Source: UN Comtrade, INS-DRC, authors' calculations.

6. Dynamic analysis

6.1. Vector Autoregression Analysis

To characterize the dynamic relationship between infrastructure investment and trade, we estimate a panel VAR model following Love and Zicchino [25]. The model comprises three endogenous variables: bilateral trade value (TRADE), infrastructure quality index (IQI), and Chinese FDI stock (FDI). We include two lags based on the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). The system is identified using a Cholesky decomposition with the ordering IQI → FDI → TRADE, consistent with the view that infrastructure investments precede trade responses.

The panel VAR coefficient matrix can be written as:

$$Y_{it} = A_0 + \sum_{k=1}^{p} A_k Y_{i,t-k} + u_{it} \qquad (5)$$

where Yit = [IQIit, FDIit, TRADEit]^{T} is the vector of endogenous variables for province i at time t, Ak are coefficient matrices for lag k = 1,...,p, A0 is the vector of province fixed effects, and uit is the vector of reduced-form innovations.

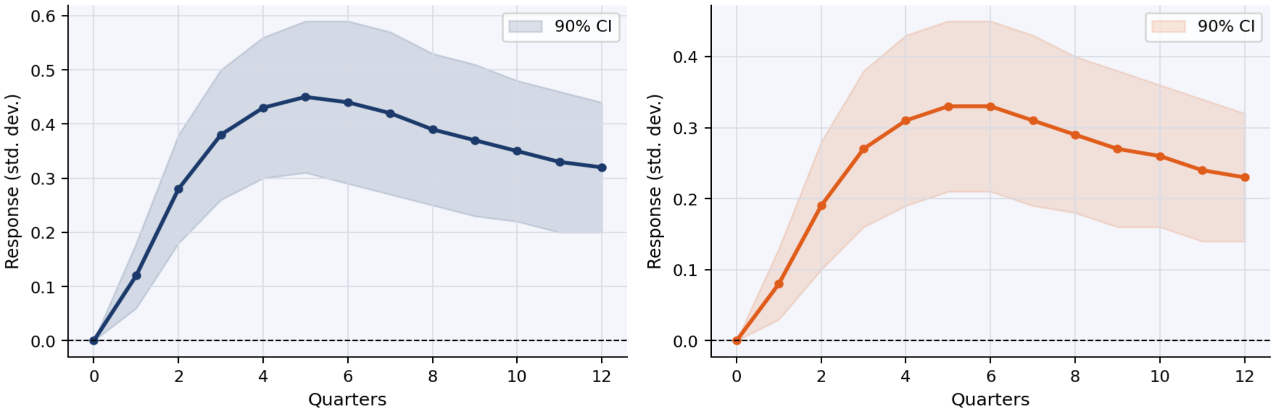

Figure 5. Impulse Response Functions from Panel VAR Model.

Note: Shaded regions represent 90% bootstrap confidence intervals (500 replications). Identification via Cholesky decomposition. Source: Authors' calculations.

Figure 5 presents impulse response functions (IRFs) with 90% bootstrap confidence intervals, based on 500 Monte Carlo repetitions. Panel (5a) shows the response of bilateral trade to a one standard deviation shock in the IQI. Trade rises significantly from period 2, peaks at period 5 with a cumulative response of approximately 0.45 standard deviations, and remains statistically distinguishable from zero through period 12. The protracted response is consistent with infrastructure improvements generating sustained trade gains through network effects and gradual supply chain reorganization.

6.2. Forecast Error Variance Decomposition

Table 5 decomposes the forecast error variance of bilateral trade at horizons of 1, 4, 8, and 12 quarters. At the 1-quarter horizon, virtually all variance is explained by own shocks (94.3%). By quarter 4, the contribution of IQI shocks rises to 18.7%, stabilizing at approximately 22–24% at longer horizons. FDI shocks account for a further 9–11% of trade variance at longer horizons. These results confirm that infrastructure connectivity is a quantitatively important source of variation in trade performance.

Table 5. Forecast Error Variance Decomposition of Bilateral Trade

Horizon (Quarters)	Own Shocks	IQI Shocks	FDI Shocks	Residual
1	94.3%	3.8%	1.4%	0.5%
4	68.2%	18.7%	9.3%	3.8%
8	61.4%	22.1%	10.8%	5.7%
12	59.7%	23.8%	11.2%	5.3%

Notes: Rows sum to 100%. Identification via Cholesky ordering: IQI → FDI → Trade. 500 bootstrap replications. Source: Authors calculations.

7. Conclusion

This paper has provided the first rigorous empirical examination of the relationship between transport infrastructure connectivity and China-DRC bilateral trade performance. Exploiting sub-national variation in DRCs 26 provinces over the period 2005–2023, and employing an instrumental variables strategy based on colonial-era transport networks to address endogeneity, we find robust evidence that infrastructure quality is a quantitatively important determinant of bilateral trade.

Our principal findings are as follows. First, a one standard deviation improvement in our composite Infrastructure Quality Index raises bilateral trade by 38.9–71.8%, with the higher IV estimate reflecting downward attenuation bias in OLS specifications due to measurement error. Second, infrastructure effects are heterogeneous across sectors, with minerals and metals exhibiting the largest response ($\beta = 0.512$) and consumer goods the smallest ($\beta = 0.212$). Third, VAR analysis reveals that infrastructure shocks have persistent trade effects lasting at least three years, accounting for approximately 22–24% of long-run trade forecast error variance.

These findings have several important implications. For the DRC, they underscore the high returns to transport infrastructure investment as a driver of trade expansion and economic development. The persistence of infrastructure effects suggests that investment in connectivity generates durable improvements in trade integration, not merely temporary boosts. For China, the results are consistent with a strategic logic linking BRI infrastructure investment to long-term trade expansion, though we do not take a position on the welfare implications of this arrangement. For the broader literature, our study demonstrates the value of sub-national panel data in identifying infrastructure-trade causal effects, overcoming aggregation bias that has limited cross-country analyses.

Several caveats apply. Our instrument satisfies the standard validity conditions to our knowledge, but we cannot definitively rule out long-run channels through which colonial transport shaped contemporary economic geography beyond infrastructure. Our IQI, while comprehensive, does not capture informal infrastructure barriers or institutional frictions that may mediate the relationship. Future research should integrate governance quality and institutional dimensions into the analysis, and extend the framework to examine environmental and social externalities of infrastructure-driven trade expansion.

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Appendix

A. Variable Definitions and Sources

Table A1. Variable Definitions and Data Sources.

Variable	Definition	Source
Trade Value	Annual bilateral trade value, exports + imports, constant 2015 USD	UN Comtrade, CGAC, INS-DRC
IQI	Composite index: first principal component of road density, port efficiency, rail density, telecom penetration	DRC Ministry Infrastructure, WB LPI, SNCC, ITU
Road Density	Paved road km per 100 km² of provincial area	DRC MIPW, OpenStreetMap
Port Efficiency	WB LPI river port sub-index, 1–7 scale	World Bank LPI
Colonial Transport	Kernel-density weighted transport link density, Belgian colonial era (1908–1960)	Belgian Congo Atlas 1954, 1957 Infrastructure Census, authors
FDI Stock	Cumulative Chinese FDI stock, provincial level, constant 2015 USD	AidData, DRC Ministry of Finance
BRI Dummy	Indicator = 1 for years 2013–2023	Authors