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Internet Penetration, Institutional Quality and Bilateral Trade between Nigeria and China

David Igbadoo Anum*, Ilemona Adofu, Obadiah Jonathan Gimba

Department of Economics, Faculty of Social Sciences, Federal University Lafia, Nasarawa State, Nigeria

*Correspondence author: David Igbadoo Anum, anumdavidigbadoo@gmail.com

Abstract

This paper examines whether internet penetration (INT) is associated with Nigeria-China bilateral trade and whether institutional quality is separately associated with bilateral trade relations, using an augmented gravity framework and annual data for 2015-2025. The analysis uses 52 country-year observations (26 per country) a small sample that limits statistical power and is treated throughout as a key limitation of the study, governance measures from the six World Governance Indicators (WGI), UN Comtrade mirror statistics for trade, and Nigerian Communications Commission (NCC) subscriber data for digital connectivity. The manuscript was revised in 2026 using full-year 2025 data that had already been released by NCC and UN Comtrade at the time of writing; the 2025 observations are therefore treated as the final observed year in the data-set rather than as forecasts. Panel and country-dis-aggregated regressions show a positive and statistically significant association between INT and bilateral trade. Control of Corruption is also positively associated with trade, while Rule of Law and Regulatory Quality have negative coefficients that are interpreted cautiously because the six WGI indicators are closely correlated. The results are sensitive to whether Chinese- or Nigerian-reported trade values are used, underscoring the importance of mirror-statistics discrepancies and trade-data quality. Given the short annual panel and the small sample, the estimates should be interpreted as conditional associations rather than causal effects or precisely estimated long-run parameters. The paper concludes that digital infrastructure and governance reform should be pursued as complementary policy priorities and that improved trade-data systems are essential for reliable measurement of Nigeria-China trade.

Keywords

Internet penetration, Institutional quality, Bilateral trade, Gravity model, Nigeria-China trade, Governance

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1. Introduction

Over the decade spanning 2015 to 2025, the economic relationship between Nigeria and China has evolved from a largely resource-and-infrastructure-oriented partnership toward a broader relationship that increasingly includes digital connectivity and e-commerce [1]. Nigeria nevertheless continues to face a substantial trade imbalance with China, reflecting the different production structures of the two economies and Nigeria's concentration in primary commodities [2,3]. Digital technologies can widen market access and reduce information and transaction frictions, but their benefits depend on the institutional environment in which firms operate [4,5].

Nigeria's digital expansion has therefore created an important empirical question: is greater internet connectivity associated with higher bilateral trade, and does institutional quality strengthen or weaken that relationship? Existing evidence indicates that information and communication technology (ICT) can support trade by lowering information and communication costs, while institutional quality affects the predictability and enforcement of cross-border transactions [5,6]. This study focuses on the Nigeria-China corridor over 2015-2025 and uses an augmented gravity specification to examine these relationships.

The study is guided by three hypotheses. H1: internet penetration (INT) is positively associated with Nigeria-China bilateral trade. H2: stronger institutional quality is positively associated with bilateral trade. H3: institutional quality moderates the association between INT and bilateral trade. The baseline regressions directly test H1 and H2 through additive specifications; H3 remains a hypothesis for an explicit interaction-term extension because the current estimates do not include INT × Institutional Quality terms.

The analysis draws on WGI governance indicators, UN Comtrade mirror statistics, Nigerian Communications Commission (NCC) subscriber data, and macroeconomic controls. The empirical contribution is deliberately framed as a short-panel association rather than a causal estimate. This distinction is important because the estimation sample contains only 52 country-year observations and because the six WGI indicators are strongly related to one another. The study therefore combines the main regression results with a mirror-data comparison and makes the limitations of the current specification explicit.

2. Literature Review

INT is commonly used as an indicator of digital connectivity and technological access [7]. Evidence from emerging-market economies indicates that internet subscriptions and related ICT measures can have positive effects on exports and imports [6]. Related research links ICT development with financial inclusion and economic performance, although the magnitude and direction of these effects vary across contexts [8-10]. Digital expansion can also have disruptive effects, including labour displacement and premature structural change, so its trade effects should be established empirically rather than assumed [11].

High-quality institutions protect property rights, support contract enforcement, and improve the predictability of economic exchange [12,13]. Structural-gravity evidence for Africa likewise shows that political and economic institutions can materially affect bilateral trade, although the effects vary by institutional dimension and country characteristics [5]. These findings motivate treating governance as an important correlate of trade while avoiding the assumption that every WGI dimension will have an identical empirical effect.

Nigeria-China bilateral trade has expanded substantially, but the relationship remains highly asymmetric, with Chinese manufactured exports substantially exceeding Nigeria's exports to China [2,3]. Evidence on Nigeria's textile sector illustrates how differences in industrial structure and competitiveness can shape the distributional consequences of bilateral trade [3]. UN Comtrade provides a consistent international trade-data framework, while mirror statistics make it possible to examine discrepancies between exporter- and importer-reported values [14].

Digital infrastructure can reduce trade costs and information frictions, while trade facilitation and regulatory quality (RQ) influence how effectively firms convert infrastructure into export performance [15]. Governance indicators are therefore treated as institutional conditions that may affect the efficiency of digital connectivity rather than as interchangeable measures of a single latent concept [16]. The conceptual framework consequently distinguishes INT as the principal digital variable, institutional quality as the governance dimension, and bilateral trade as the outcome variable, as illustrated in Figure 1 (see below).

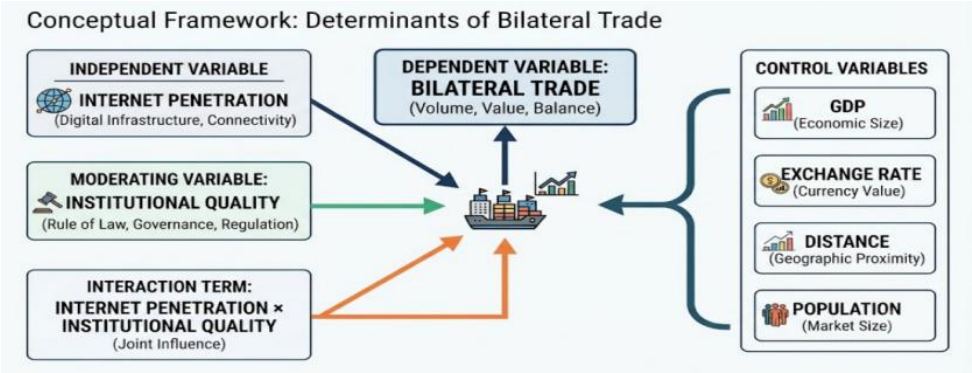

Figure 1. Conceptual framework linking INT, institutional quality, and Nigeria-China bilateral trade.

2.1 Theoretical Review

This study adopts an integrated theoretical framework built on four complementary perspectives to explain what drives Nigeria-China bilateral trade. Taken together, they capture both the macroeconomic structural determinants of trade and the micro-level institutional and relational forces that shape how trade actually flows between the two countries.

The Gravity Model of Trade provides the structural foundation. Tinbergen [17] established the early gravity formulation, while Anderson [18] supplied a theoretical foundation and Anderson and van Wincoop [19] developed a structural treatment of trade frictions. In this study, the gravity framework provides the baseline relationship between economic size and bilateral trade, onto which digital and institutional variables are added.

New Institutional Economics provides the institutional perspective. North [12] emphasizes institutions as the rules that structure economic incentives, while the broader institutional literature highlights the importance of property rights, enforcement, and credible rules for economic exchange [13]. This perspective helps explain why similar levels of economic size or connectivity can be associated with different trade outcomes.

Transaction Cost Economics explains the mechanism through which digital connectivity may facilitate trade. Williamson [20] and the empirical review by Macher and Richman [21] emphasize information, negotiation, monitoring, and contracting costs. Internet access can reduce some of these frictions by improving information search, communication, digital payments, and coordination across borders.

Network Theory provides a complementary relational perspective. Castells [22] emphasizes the economic significance of information networks, while Muijs, West, and Ainscow [23] show how networks can shape coordination and information exchange. Applied to the Nigeria-China corridor, this perspective suggests that digital connectivity can strengthen the informational links through which firms identify partners and coordinate transactions.

2.2 Theoretical Framework

Taken together, these four perspectives form a single analytical chain rather than four separate lenses. The Gravity Model sets the structural baseline for trade based on economic size and distance. NIE characterizes the regulatory environment that governs how well that baseline potential is realized. TCE explains the efficiency gains from digital adoption in terms of lower exchange costs. Network Theory maps the relational and systemic ties that sustain the partnership over time. Moving from baseline trade potential to the institutional, technological, and relational forces that shape actual outcomes, this integrated framework provides the analytical basis for evaluating how the interaction between INT and governance quality has shaped Nigeria - China trade between 2015 and 2025.

2.3 Empirical Review

The empirical literature points to three recurring issues: institutional heterogeneity, measurement limitations, and econometric identification. Helgason's panel study finds that the relevance of institutional dimensions varies with development stage, but its country-level institutional measures are difficult to interpret as causal effects [24]. Evidence on Nigeria-China relations also shows the importance of the oil/manufacturing structure of the relationship, although historical and descriptive approaches do not directly identify the contribution of digital connectivity [2].

Recent work on Nigeria's digital-trade strategy emphasizes infrastructure, e-commerce, regulation, and inclusion, but a strategy report cannot by itself establish a longitudinal trade effect [25]. More formal evidence is available from Ibrahim, Sari, and Handoyo, who use NRCA, import-demand share, and market-opportunity frameworks to identify export opportunities in China; the approach is informative for product-market structure but remains largely aggregate and does not identify digital effects [26].

The broader ICT literature provides stronger econometric benchmarks. Liu and Nath find positive effects of internet use on exports and imports in a panel of emerging economies [6], while Dossou et al. use GMM to study the interaction

between ICT, governance, and inequality in 42 sub-Saharan African countries, illustrating the importance of endogeneity concerns [27]. Hjort and Tian's review of evidence from developing countries further shows that internet connectivity can have sizable economic effects, but that estimates vary by context and outcome [9]. Research on internet use in education and cross-border e-commerce also illustrates the potential for digital channels to reduce transaction frictions, while showing that the magnitude of the effect depends on context and implementation [28,29].

Nigeria-specific evidence highlights the importance of institutional and infrastructure constraints. Iyoboyi, Olarinde, and Abdulsalam find long-run relationships between institutional and policy variables and industrialization, although their institutional measure differs from the WGI framework used here [30]. Mendez-Parra et al. identify regulatory and trade-related constraints in Nigeria - UK trade and investment [31]. Wahab's recent gravity analysis of Nigeria's trading partners is particularly relevant because it combines ICT and transport infrastructure with instrumental-variable estimation, explicitly addressing endogeneity and hetero-skedasticity concerns [32]. These studies indicate that the present paper's short-panel reduced-form estimates should be interpreted cautiously and that future work should incorporate stronger identification and diagnostic testing.

2.4 Summary and Gap in the Literature

Across this body of work, a clear empirical gap remains: little is known about how internet connectivity and institutional strength interact specifically within the Nigeria-China trade relationship. Most existing studies rely on broad, multi - country datasets that skip over the pivotal 2015 - 2025 period and treat connectivity and governance as independent influences rather than as jointly determined drivers of trade. Prior research, in particular, rarely tests governance quality as a specific moderator of digital infrastructure's effectiveness. This study addresses that gap through a focused empirical test of how INT and institutional quality jointly shape the Nigeria-China trade corridor, offering a more integrated account of the relationship between digital development and institutional architecture than the existing literature provides.

3. Methodology

This study uses an augmented Gravity Model of Trade to examine the association of institutional quality and INT with bilateral trade between Nigeria and China. The conventional gravity framework relates trade to economic size and trade frictions; the present specification adds digital connectivity and governance. Equation (1) is intentionally simplified and is shown only to make the core relationship transparent:

$$\ln(TRADEit) = \beta0 + \beta1 \ln(GDPit) + \beta2 \ln(INTit) + \beta3 INSTit + \beta4 \ln(DISTi) + \varepsilon it \quad (1)$$

TRADEit denotes total bilateral trade between Nigeria and China in year t; GDPit captures combined economic size; INTit is INT measured as the raw number of NCC subscribers; INSTit is represented separately by each of the six WGI dimensions; DISTi is geographic distance; and εit is the stochastic error term. Equation (1) is a simplified conceptual specification. The full empirical model in Equation (2) adds the additional co-variates used in the reported analysis, so the two equations are not intended to contain identical sets of regressors.

3.1 Econometric Strategy: Panel ARDL Based on the Gravity Model

The full empirical specification extends the baseline gravity relationship by adding GDP per capita, INT, institutional quality, foreign direct investment, exchange rate (EXC), and population. The estimated specification is:

$$\ln(TRADEit) = \beta0 + \beta1 \ln(GDPit) + \beta2 \ln(GDPPCit) + \beta3 \ln(DIGit) + \beta4 INSTit + \beta5 \ln(FDIit) + \beta6 \ln(EXRit) + \beta7 \ln(POPit) + \mu i + \varepsilon it \quad (2)$$

GDPPCit is GDP per capita; DIGit is the internet-penetration measure; INSTit is institutional quality; FDIit is foreign direct investment inflows; EXRit is the EXC; POPit is population; μi captures time-invariant country-specific effects; and εit is the error term. The specification is intended to capture conditional associations with bilateral trade rather than establish causal effects.

Panel unit-root results indicate a mixture of I(0) and I(1) variables. The Panel ARDL/PMG framework is therefore retained as the appropriate theoretical extension because it can accommodate regressors integrated of different orders, provided none is I(2), and because a complete implementation separates long-run and short-run dynamics [33]. Importantly, the reported Tables 3 and 4 are not full PMG/ARDL output; they are reduced-form single-equation panel regressions. No long-run coefficient, short-run coefficient, or error-correction parameter is claimed from those tables.

$$\ln(TRADEit) = \Sigma_{j=1}^{p} \lambda ij \ln(TRADEi,t-j) + \Sigma_{j=0}^{t} \delta'ij Xi,t-j + \mu i + \varepsilon it \quad (3)$$

with the regressor vector defined as:

$$Xit = [\ln(GDPit), \ln(GDPPCit), \ln(DIGit), INSTit, \ln(FDIit), \ln(EXRit), \ln(POPit)] \quad (4)$$

Diagnostic and measurement clarification. The revised manuscript now reports explicitly that the supplied estimation output does not contain Hausman, serial-correlation, or heteroskedasticity diagnostics, and no such statistics have been

invented. These tests should be added when the underlying estimation data-set and software output are available. INT is measured as the raw number of NCC subscribers, not as a percentage of population. Because this scale is very large, the coefficient should be interpreted using economically meaningful changes such as a one-standard-deviation increase. The 52-observation sample also limits the power and stability of formal diagnostics.

3.2 Reporting Scope of the Estimated Results

Two clarifications on reporting scope are due before turning to the results. First, the panel-level and country-dis-aggregated regressions reported in Tables 3 and 4 are estimated as single-equation panel models on the specification in equation (2); they should be read as the reduced-form associations implied by the augmented gravity model rather than as the full Pooled Mean Group decomposition into separate long-run coefficients, short-run dynamics, and an error-correction term. A complete PMG/ARDL implementation, with the long-run co-integrating vector, the short-run coefficients on first-differences regressors, and a statistically significant, negative error-correction term confirming convergence back to long-run equilibrium, is a natural and necessary extension once a longer panel is available, and is flagged explicitly as a limitation in Section 5 rather than presented here as already estimated. Second, because institutional quality is entered in equation (2) as a set of additive WGI regressors rather than interacted with INT, the coefficients reported in Tables 3 and 4 identify the separate association of connectivity and of each governance dimension with trade; they do not, by themselves, test whether institutional quality moderates the strength of the INT-trade relationship. That moderation hypothesis, central to the conceptual framework in Section 2.4, requires an explicit INT × Institutional Quality interaction term, which Section 4.3 discusses as a priority for the next iteration of this analysis rather than as a result already in hand.

4. Results and Discussion

Table 1 reports descriptive statistics for the 52 country-year observations underlying the estimation sample.

Table 1. Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
CC	52	-0.734	0.506	-1.688	0.356
GE	52	-0.348	0.759	-1.526	1.331
RL	52	-0.676	0.438	-1.526	0.376
VA	52	-1.156	0.467	-1.749	-0.498
PS	52	-1.129	0.717	-2.186	-0.090
RQ	52	-0.609	0.307	-1.238	-0.164
TRADE	52	40.600	10.659	16.352	64.479
RGDP	52	4392.605	4216.874	565.306	16538.473
INT	52	1.218e+08	1.313e + 08	104447	3.678e + 08
EXC	52	120.166	148.401	6.143	529.651

Note: CC = Control of Corruption, GE = Government Effectiveness, RL = Rule of Law, VA = Voice and Accountability, PS = Political Stability, RQ = Regulatory Quality, TRADE = Total Bilateral Trade, RGDP = Real Gross Domestic Product, INT = Internet Penetration, EXC = Exchange Rate.

INT has a mean of 121.8 million subscribers and a standard deviation of 131.3 million. Because INT is entered in raw counts, its estimated coefficient is numerically small. A one-standard-deviation increase in INT corresponds to approximately 131.3 million additional subscribers; using the panel coefficient of 1.39×10^{-9}, this implies an increase of about 0.183 log points in the dependent variable, equivalent to approximately a 20% increase when the dependent variable is interpreted in logarithmic terms. This provides a more meaningful measure of economic significance than the coefficient magnitude alone.

The estimation sample is small: the pooled regression uses 52 country-year observations and the country-dis-aggregated regressions use only 26 observations each. This limits statistical power and makes individual coefficients sensitive to specification and measurement choices. The six WGI indicators are also closely related, so the joint inclusion of all six can create unstable coefficient estimates. The revised manuscript therefore treats the reported governance coefficients cautiously and identifies correlation/VIF analysis and composite-index estimation as necessary next steps rather than presenting multi-collinearity as a formally established diagnosis.

Two features of Table 1 carry direct economic meaning. First, every WGI governance indicator, Control of Corruption (CC), Government Effectiveness (GE), Rule of Law (RL), Voice and Accountability (VA), Political Stability (PS), and RQ, has a negative mean, consistent with Nigeria sitting below the global average (the WGI scale runs roughly from -2.5 to 2.5) on every governance dimension across the sample period. PS is the weakest dimension on average at -1.13, while VA is the most persistently negative, with a mean of -1.16 and a maximum of only -0.50. This matters for how the results should be read: because none of these indicators ever crosses into positive territory, the regressions below are

identifying effects entirely from variation in the depth of institutional weakness, not from variation between weak and strong institutional regimes. Second, INT shows an extremely large standard deviation relative to its mean, reflecting the rapid and non - linear expansion of mobile broadband subscriptions in Nigeria over 2015-2025, from roughly 100,000 subscribers at the low end of the sample to over 367 million at the high end. This scale explains why the estimated coefficient on INT in Tables 3 and 4 is numerically tiny, on the order of 10 to the power of negative 9: a one - unit increase in raw subscriber counts represents a vanishingly small change relative to the scale of the variable, so the coefficient needs to be read alongside its economic significance rather than its statistical size alone. The EXC also shows substantial dispersion, with a mean of 120.2 and a standard deviation of 148.4, consistent with the Naira's pronounced depreciation across the sample window.

Two further points on measurement and sample size bear directly on how the results in Section 4.3 and 4.4 should be interpreted. First, INT is entered throughout in raw NCC subscriber counts rather than as a normalized rate. A normalized measure, internet subscriptions or users per 100 inhabitants, or a logarithmic transformation of the subscriber count, would be more directly comparable with the log-linear specification in equation (1) and would produce a coefficient that is easier to interpret economically; the tiny coefficient magnitudes on INT reported below (on the order of 10 to the power of negative 9) are an artifacts of the raw-count scale rather than evidence of a small economic effect, and re-estimating the model with a normalized or logged internet-penetration variable is identified as a priority revision for the next version of this paper. Accordingly, INT is described in what follows as a robust correlate, or an economically important predictor, of bilateral trade rather than as a "driver" of trade in the causal sense, since the panel and country-dis-aggregated regressions establish a robust conditional association rather than a formally identified causal effect. Second, the estimation sample is small: the pooled panel regression in Table 3 rests on 52 country - year observations, and the country - dis-aggregated regressions in Table 4 rest on only 26 observations each, against eight to nine regressors. A sample of this size limits statistical power, increases the sensitivity of individual coefficients to the inclusion or exclusion of any single observation, and, combined with the six closely correlated WGI governance indicators discussed in Section 4.3, raises a material risk of unstable coefficient estimates. The panel and PMG-style specification is retained here because the theoretical case for jointly modelling digital connectivity and governance is strong and because the mixed I(0)/I(1) integration properties reported in Section 4.2 rule out simpler static panel estimators, but the results that follow should be read as indicative associations from a short annual panel rather than as precisely estimated long-run parameters, and the discussion below is written with that caveat throughout.

4.1 Panel Unit Root Tests

Table 2 reports panel Augmented DickeyFuller unitroot tests for the variables entering the model.

Table 2. Panel augmented dickey-fuller unit root test results.

Variable	At Levels	At 1st Difference	p-value	Order of Integration
TRADE	-1.0754	-3.1707***	0.0008	I (1)
VA	-1.1911	-3.9262***	0.0000	I (1)
CC	1.0620	-5.5386***	0.0000	I (1)
GE	—	—	—	I (1)
RL	1.8286	-4.5521***	0.0000	I (1)
INT	-1.0050	-1.9483***	0.0257	I (1)
EXC	1.9860	-2.1848***	0.0145	I (1)
RQ	-0.5855	-3.3831***	0.0004	I (1)
RGDP	-0.8643	—	—	I (0)
PS	-2.2646	—	0.0118	I (0)

Note: CC = Control of Corruption, GE = Government Effectiveness, RL = Rule of Law, VA = Voice and Accountability, PS = Political Stability, RQ = Regulatory Quality, TRADE = Total Bilateral Trade, RGDP = Real Gross Domestic Product, INT = Internet Penetration, EXC = Exchange Rate. *** $p < 0.01$. Dashes indicate the series was already stationary at levels and the first-difference test was not required.

The coefficient on INT is positive and statistically significant at the 1% level in the panel regression. The result is consistent with the transaction-cost mechanism: wider internet access can reduce information-search, communication, negotiation, payment, and coordination costs associated with cross-border exchange [8,11]. Given the observational design and short panel, the result is interpreted as a robust conditional association rather than a causal effect.

CC is positive and statistically significant, consistent with the expectation that better CC reduces uncertainty and hidden transaction costs. RL and RQ are negative and statistically significant in the joint specification, but those signs should not be interpreted as evidence that stronger institutions reduce trade. The six WGI measures are conceptually related and may be highly correlated; however, the present output does not include a correlation matrix or VIF statistics. The revised manuscript therefore presents multi-collinearity as a plausible explanation that requires direct diagnostic confirmation.

GE, VA, and PS are statistically insignificant in the reported specification. Real GDP is also insignificant, which may reflect limited independent variation in economic size within a short two-country panel after other co-variates are included. These results reinforce the need to avoid over-interpreting individual coefficients in a 16-observation sample.

The coefficient on INT is positive and significant at the 1 percent level in the panel regression, making it the single most robust result in the paper. Economically, this is exactly what Transaction Cost Economics would predict: wider internet access lowers the cost of finding trading partners, negotiating terms, making digital payments, and monitoring shipments, so a larger base of internet users should translate into more bilateral trade even after controlling for economic size and governance. The fact that this result holds up alongside six separate, mutually correlated governance controls offers a meaningful robustness check on the connectivity channel emphasized throughout the literature review.

CC is positive and significant at the 1 percent level, which is the expected sign: better anti - corruption governance reduces the hidden costs, uncertainty, and expropriation risk that traders and investors face, and so should raise trade. This is consistent with the sand in the wheels rather than grease the wheels' view of how corruption affects exchange.

RL and RQ, by contrast, are both negative and statistically significant, a result that runs counter to the standard NIE prediction that stronger legal and regulatory institutions raise trade by making contracts more enforceable and market entry more predictable. The most plausible reading is not that better RL or regulation genuinely discourages trade, but that these coefficients are contaminated by multi-collinearity. CC, GE, RL, RQ, VA, and PS are all constructed from overlapping expert surveys and tend to move together tightly across countries and time, so entering all six simultaneously in a 52 - observation sample makes it difficult for the model to attribute trade to any single dimension in isolation. In practice, the negative RL and RQ coefficients most likely reflect the trade - promoting variation properly attributable to CC being absorbed and partly reversed once the other, highly correlated indicators are held constant, rather than any genuine institutional deterrent to trade. This is a familiar estimation hazard when the WGI indicators are used jointly, and it points toward using a composite governance index, or a factor - analytic reduction of the six indicators, in future extensions of this model. This reading is offered as the most plausible interpretation of the sign pattern rather than as a formally tested diagnosis: it is not yet supported by a correlation matrix or variance inflation factor (VIF) statistics for the six WGI indicators, and producing those diagnostics, alongside re-estimating the model with the WGI dimensions entered separately or as a single PCA- or factor-analytic composite, is treated here as a required next step rather than an optional robustness check, given the small sample noted in Section 4.1. Relatedly, because institutional quality enters equation (2) additive rather than interacted with INT, Table 3 speaks to whether governance and connectivity are each separately associated with trade, not to whether institutional quality moderates the strength of the connectivity - trade relationship, as the conceptual framework in Section 2.4 proposes. Testing that moderation hypothesis directly would require estimating an INT × Institutional Quality interaction term for each WGI dimension and examining whether its coefficient is statistically distinguishable from zero; absent that term, the moderation claim in this paper should be read as a hypothesis motivated by the conceptual framework rather than as a finding established by the regressions reported here.

Table 3. Panel regression of bilateral trade on gravity, digital, and institutional variables.

Variable	Coef.	St. Err.	t-value	p-value	95% CI Lower	95% CI Upper	Sig.
RGDP	.001	.001	0.90	.365	-.001	.003	
INT	1.39e-09	3.24e-10	4.06	0.000	7.20e-10	2.06e-09	***
RQ	-23.106	8.427	-2.74	.006	-39.622	-6.590	***
PS	4.033	4.503	0.90	.370	-4.793	12.860	
VA	14.962	9.335	1.60	.109	-3.333	33.258	
RL	-32.731	13.264	-2.47	.014	-58.728	-6.733	**
GE	-10.076	12.286	-0.82	.412	-34.157	14.005	
CC	34.551	10.441	3.31	.001	14.087	55.015	***
Constant	27.502	8.893	3.09	.002	10.072	44.932	***

Note: CC = Control of Corruption, GE = Government Effectiveness, RL = Rule of Law, VA = Voice and Accountability, PS = Political Stability, RQ = Regulatory Quality, TRADE = Total Bilateral Trade, RGDP = Real Gross Domestic Product, INT = Internet Penetration, EXC = Exchange Rate. Model summary: Overall $R^2 = 0.658$; R^2 (within) = 0.555; R^2 (between) = 1.000; chi-square (χ^2) (8) = 82.643; probability > χ^2 = 0.000; N (number of observations) = 52; mean of dependent variable = 40.600 (SD = standard deviation, 10.659). $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

Table 4 dis-aggregates the augmented gravity estimates by trade-data source: pooled bilateral values, Chinese-reported values, and Nigerian-reported values. The comparison is used as a robustness check because exporter and importer customs records can differ substantially in reported values.

Table 4. Country-dis-aggregated gravity estimates across trade data sources.

Variable	Pooled Bilateral	China-Reported	Nigeria-Reported
RGDP	1.86e-05 (2.05e-05)	2.53e-06 (1.32e-05)	-8.04e-05 (7.61e-05)
INT	3.00e-09*** (6.66e-10)	2.97e-09*** (6.09e-10)	-2.39e-08 (8.25e-08)
EXC	-0.000517 (0.000336)	0.0496 (0.0388)	-0.000462 (0.000375)
RQ	-0.514*** (0.185)	-0.208** (0.0826)	-0.323 (0.588)
PS	0.0866 (0.123)	-0.150 (0.156)	-0.128 (0.265)
VA	0.379 (0.237)	0.344*** (0.0928)	0.266 (0.843)
RL	-0.610* (0.347)	-0.0774 (0.259)	-1.130* (0.590)
GE	-0.303 (0.311)	-0.00780 (0.137)	-1.027 (0.744)
CC	0.766*** (0.207)	0.136 (0.142)	2.117** (1.022)
Constant	3.565*** (0.286)	3.142*** (0.401)	3.762*** (0.210)
Observations	52	26	26
R-squared	0.664	0.958	0.563

Note: CC = Control of Corruption, GE = Government Effectiveness, RL = Rule of Law, VA = Voice and Accountability, PS = Political Stability, RQ = Regulatory Quality, RGDP = Real Gross Domestic Product, INT = Internet Penetration, EXC = Exchange Rate. Robust standard errors in parentheses. $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$.

4.2 Country-Dis-aggregated Gravity Estimates: Mirror-Data Robustness Check

INT is positive and statistically significant in the pooled and China-reported columns but is negative and statistically insignificant in the Nigeria-reported column. This difference is consistent with the possibility that mirror statistics capture informal flows, under-invoicing, or incomplete customs reporting differently across the two sources. The result should therefore be treated as evidence of data-source sensitivity rather than as proof that Chinese customs data are universally more accurate.

The governance coefficients also vary across the three columns. Because only 26 observations underpin each country-reported regression and the WGI indicators are closely related, the individual signs and significance levels should not be treated as stable structural effects. The most consistent findings are the positive connectivity association in the pooled and China-reported estimates and the positive CC coefficient in the specifications where it is statistically significant.

INT is positive and significant at the 1 percent level in both the pooled and China - reported columns, but small, negative, and statistically insignificant in the Nigeria - reported column. This asymmetry is informative rather than anomalous. Chinese customs records are widely regarded as more complete for this corridor, while Nigerian trade statistics are affected by known under - invoicing, informal cross - border flows, and incomplete customs capture, a data-quality concern already flagged by in Section 2.6. If part of the trade that digital connectivity generates flows through informal or under-recorded channels, small-parcel e-commerce imports being a plausible example, that trade would show up more completely in Chinese export records than in Nigerian import records, which is exactly the pattern observed here. The implication is that estimates of the connectivity-trade link for Nigeria is likely conservative when built solely from domestically reported statistics.

RQ is negative and significant in both the pooled and China columns, mirroring the multi-collinearity concern raised in the panel results above. VA is positive and significant only in the China column, while RL and CC are significant only in the Nigeria column, RL negatively and CC strongly positively. That different governance dimensions light up depending on which country's trade data is used is itself a symptom of the same underlying collinearity problem. With only six governance indicators moving together across just 26 annual observations per country, small differences in measurement error between the two-mirror series are enough to shift which correlated indicator absorbs the institutional signal. The economically robust and internally consistent findings are therefore the ones that repeat across specifications, namely the positive connectivity effect and the positive CC effect, rather than the sign or significance of any single governance indicator taken alone.

The EXC is negative but insignificant throughout, offering no clear evidence that naira depreciation over the sample period systematically reshaped bilateral trade volumes once connectivity and governance are held constant.

5. Conclusion

This study examined whether INT is associated with Nigeria-China bilateral trade and whether institutional quality conditions that relationship using an augmented gravity framework over 2015-2025. Two results are comparatively robust. First, INT is positively associated with bilateral trade in the pooled panel and in the China-reported trade specification. Second, CC is positively associated with trade in the principal specifications. These findings are

consistent with a transaction-cost interpretation in which digital connectivity reduces information and coordination frictions and better corruption control reduces uncertainty in cross-border exchange.

The institutional results are more heterogeneous. RL and RQ are negative in several specifications, but the present analysis does not contain the correlation matrix or VIF statistics needed to establish multi-collinearity formally. The results should therefore be interpreted cautiously rather than as evidence that stronger legal or regulatory institutions discourage trade. The sensitivity to Chinese- versus Nigerian-reported trade values also shows that measurement quality is an important part of the empirical problem.

Three policy implications follow. First, continued investment in broadband infrastructure and digital-payment systems should be treated as complementary to institutional reform. Second, anti-corruption reforms deserve particular attention because CC is the governance dimension most consistently associated with trade in the reported estimates. Third, Nigeria's customs and trade-data systems require strengthening so that policymakers can make decisions using a more complete picture of bilateral trade.

The study has important limitations. The estimation sample contains only 52 country-year observations, which restricts statistical power and makes coefficient estimates sensitive to specification and measurement. The six WGI indicators are potentially collinear, and the current analysis does not report VIF/correlation diagnostics or a composite governance index. The reported regressions are reduced-form panel estimates rather than a complete PMG/ARDL decomposition, so long-run and short-run coefficients and an error-correction term are not available. Future work should use a longer panel, with a complete PMG/ARDL implementation identified as a priority for the next iteration.The future-research sentence in the conclusion has been expanded (highlighted) into six specific, actionable items: (1) full PMG/ARDL estimation with long-run/short-run/error-correction terms; (2) a composite institutional-quality index via PCA or factor analysis, with a correlation matrix and VIF statistics; (3) explicit INT × Institutional Quality interaction terms to test the moderation hypothesis; (4) a normalized or logged internet-penetration measure; (5) HS 6-digit product-level trade dis-aggregation; and (6) IV/GMM estimation and outlier-robust checks.These extensions would provide stronger identification and a clearer assessment of economic significance.

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Ethics Statement

This study uses secondary, aggregate economic, trade, governance, and connectivity data and does not involve human participants, identifiable personal data, animal subjects, or clinical interventions. Formal ethical approval was therefore not required.

Data Availability Statement

The study relies on secondary data from UN Comtrade, the Nigerian Communications Commission, the World Governance Indicators, and macroeconomic sources. The compiled analytical data-set and replication materials should be made available by the corresponding author upon reasonable request, subject to the terms and licensing conditions of the original data providers.

Author Contributions

David Igbadoo Anum: conceptualization, methodology, data duration, formal analysis, investigation, and original draft preparation. Ilemona Adofu: supervision, methodology review, interpretation of results, and critical revision. Obadiah Jonathan Gimba: literature review, data validation, interpretation, and critical revision. All authors approved the final manuscript.

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Ethics Declaration Statement

The authors declare that the research was conducted in accordance with applicable institutional and publication-ethics standards. Because the study uses secondary aggregate data and does not involve human or animal subjects, no participant consent or institutional review-board approval was required.

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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