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Security, Infrastructure Expansion and Regional Economic Integration: The Case for Somalia

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Abstract
Somalia joined the East African Community as a full member in March 2024, formalizing a regional market position its geography has long implied. Membership alone does not produce integration. This study examines the short run and long run relationships between security conditions, infrastructure expansion, and regional economic integration in Somalia over the period 2000 to 2023. Security is measured by the World Bank indicator for political stability and absence of violence or terrorism. Infrastructure is separated into physical capacity, measured by access to electricity, and digital connectivity, measured by mobile cellular subscriptions. GDP per capita, inflation, and urban population serve as controls. An Autoregressive Distributed Lag framework is used, which suits a small annual sample containing a mixture of I(0) and I(1) variables. The bounds test indicates a long run levels relationship, and the error correction term is negative and significant. In the long run, mobile subscriptions, inflation, and urban population carry positive coefficients, while political stability, electricity access, and GDP per capita carry negative conditional coefficients. Digital connectivity is the most internally consistent result, positive in the long run and in both the contemporaneous and lagged short run terms, which is plausible in an economy where mobile money is embedded in payments and market coordination. The negative coefficients on stability and electricity access are read as measurement and specification issues rather than substantive findings, since a national security indicator is a weak proxy for risk along particular trade corridors and electricity access records connection coverage rather than reliable supply for logistics, cold chains, or processing. The results support a distinction between nominal integration capacity, meaning the presence of assets conventionally associated with integration, and functional capacity, meaning whether those assets lower the cost and risk of producing, moving, financing, and selling goods across borders.

Keywords: Regional economic integration, Security, Infrastructure expansion, Digital connectivity, Autoregressive distributed lag, Somalia

1. Introduction

Regional economic integration is one of the main strategies developing economies use to expand markets, attract investment, and build resilience to external shocks. In practice,

integration goes beyond tariff reduction. It depends on the movement of goods, services, capital, people, and information across borders, and on institutions that make those flows predictable. Evidence from established trade blocs shows genuine trade creation effects, but a rising intraregional trade share does not by itself mean deeper integration, because the structure and direction of trade also matter (Iapadre, 2004). What separates countries that convert regional membership into economic gains is less about formal participation and more about whether firms can operate in a secure environment with functioning infrastructure. This gap is acute in Africa. Regional integration is intended to overcome fragmented national markets, narrow productive bases, and high trade costs, and frameworks such as the African Continental Free Trade Area and the East African Community exist to enlarge markets and deepen trade. Yet transport gaps, electricity shortages, and inefficient customs procedures continue to raise the cost of intra-African commerce. UNCTAD (2024) reports that infrastructure deficiencies in transport, energy, and information and communication technology make intra-African trade roughly 50 per cent more expensive than the world average, and estimates that full implementation of the African Continental Free Trade Area could support a market of about 3.4 trillion United States dollars. Security compounds the problem. Using data for 52 African countries from 1996 to 2020, Dalyop (2024) finds statistically significant relationships between political stability and the composition of merchandise trade, including a direct relationship with exports of manufactures. These constraints are sharpest in the Horn of Africa, where strategic geography sits alongside conflict, fragile institutions, and high transport costs, and where the economic dimensions of regional conflict and cooperation have long been treated as connected (Healy, 2011).

Somalia sits at the centre of this regional picture. Its coastline, ports, and proximity to Gulf and East African markets give it potential for trade and connectivity. That potential was formalized when Somalia acceded to the Treaty of the East African Community on 15 December 2023 and deposited its instrument of ratification on 4 March 2024, becoming the eighth Partner State of the Community (East African Community, 2024). The International Monetary Fund (2024) identifies trade diversification, accelerated state building and fiscal reform, stronger incentives for consensus across the federal government and member states, and capacity support from the Community as the main channels through which Somalia may gain from membership, while also noting the associated challenges and risks. Somalia has since widened its regional commitments further, ratifying the African Continental Free Trade Area agreement in October 2025 (United States International Trade Administration, 2025). Membership therefore has to be matched by trade facilitation, customs capacity, reliable infrastructure, and security if it is to translate into measured integration. Somalia's regional integration index reflects this unevenness: it remained low through the 2000s, rose modestly after 2012, and then increased more sharply from 2018 onward, reaching its highest recorded value in 2023. That pattern raises a direct question, namely what is driving the increase and whether it can be sustained.

Insecurity is the first constraint. Instability can disrupt trade routes, raise transaction costs, reduce investor confidence, and weaken the movement of goods and services across borders. At the same time, evidence from the Horn of Africa suggests the relationship is neither simple nor immediate, since regional economic cooperation has continued in sectors of the economy even where political insecurity remained unresolved (Healy, 2011). This implies that a single national stability indicator may understate how uneven security conditions are across Somalia's regions and trade routes.

The second constraint is infrastructure. Transport networks shape the cost and reliability of moving goods between markets, and Netirith and Ji (2022) find a positive relationship between the efficiency of transport infrastructure connectivity and trade outcomes within the Regional Comprehensive Economic Partnership. Electricity underpins production,

storage, and logistics, although the evidence on infrastructure and growth is not uniform. Timilsina, Hochman and Song (2020) review a large body of work and conclude that no consensus exists on the effects of infrastructure investment on economic growth, with variation arising from differences in method, measurement, development stage, time period, and geography. Digital connectivity offers a faster route around some of these gaps, since mobile telecommunications and mobile money are widely used in Somalia for payments and market coordination.

This study addresses three gaps. First, security and infrastructure are usually analysed as separate determinants of trade, growth, or integration, with limited evaluation of their combined role. Second, most available evidence comes from established groupings whose institutional and security conditions differ substantially from Somalia's. Third, Somalia itself remains underrepresented in time series work on the relationship between security, infrastructure, and integration, despite its recent accession and distinctive trade profile.

The study therefore examines the short run and long run relationships between security, infrastructure expansion, and regional economic integration in Somalia between 2000 and 2023, using an Autoregressive Distributed Lag framework suited to a small annual sample. Three questions guide the analysis: how security relates to regional integration, how physical and digital infrastructure relate to it, and whether these variables form a stable long run relationship together.

2. Literature Review

Regional economic integration is increasingly treated as a multidimensional process shaped by trade performance, institutional cooperation, security conditions, and infrastructure connectivity rather than by tariff policy alone. Studies of regional trade agreements indicate that integration can raise intraregional trade, although the size of the effect varies across blocs and sectors. Chigeto, Jayamohan and Ayeru (2025), using a panel of 43 exporting and 127 destination countries over 2000 to 2021, find that most regional trade agreements in sub-Saharan Africa raise intra-bloc trade, with the East African Community an exception on the link between intra-regional trade and exports to non-members. Trade volume alone therefore captures only part of the picture.

Measurement has received corresponding attention. Iapadre (2004) argues that the indicators most commonly used to measure intraregional trade, namely the intraregional trade share and the Balassa intensity index, are inadequate for evaluating the dynamics of integration and for comparing different regions, and proposes alternative indicators applied to four major integration areas over the period 1990 to 2000. This concern is sharpest for countries with low formal integration and substantial informal trade, which describes Somalia closely.

Security is one of the conditions shaping whether integration functions. Insecurity raises transaction risk, disrupts trade routes, discourages investment, and weakens cooperation between neighbours. Dalyop (2024), analysing 52 African countries over the period 1996 to 2020 with the system generalised method of moments, examines the relationship in both directions and finds that political stability has a statistically significant direct relationship with exports of manufactures and an inverse relationship with exports of agricultural raw materials and fuel. Mamba, Wonyra and Evlo (2025), using a panel of 49 African countries over 1996 to 2022 and an instrumental variables approach, find that both regional integration and political stability raise intra-African exports, and that political stability amplifies the effect of regional integration on those exports, which is direct evidence for a joint rather than additive relationship between the two. Omeje and Chukwu (2025), applying a pooled mean group autoregressive distributed lag model to African Continental Free Trade Area countries, similarly find that political stability and the absence of violence and terrorism raise trade

competitiveness in the long run, while short run instability lowers it. The relationship also runs from integration towards security. Healy (2011) documents the juxtaposition in the Horn of Africa between conflict and disintegration in political life and a growing logic of interdependence in several economic sectors, which suggests that economic cooperation and political security are connected but not strictly sequential.

Infrastructure is the second major pathway. Netirith and Ji (2022) apply Data Envelopment Analysis to infrastructure inputs including ports, rail range, road networks, land and maritime borders, and cross-border points, against outputs including GDP, transport, and trade volumes for the Regional Comprehensive Economic Partnership, and identify efficiency differences among member countries alongside a positive association between connectivity efficiency and trade. Using firm-level data for manufacturing firms in sub-Saharan Africa, Calatayud and Rochina Barrachina (2023) find that good infrastructure, including electricity, together with institutional quality and security against crime, is associated with greater participation in global value chains, while weak access to finance and high trade costs discourage it. At the continental level, UNCTAD (2024) attributes a large share of the cost penalty on intra-African trade to deficiencies in transport, energy, and information and communication technology infrastructure, and calls for reduced nontariff trade costs, streamlined import and export processes, and upgraded infrastructure.

The relationship between infrastructure and economic outcomes is not uniform. Timilsina, Hochman and Song (2020) review the literature and report no consensus on the effects of infrastructure investment on growth, with some studies finding positive relationships, others weak or insignificant ones, and the variation traced to differences in measurement, method, development stage, time period, and geography. This implies that the return to infrastructure depends in part on the institutional and security environment in which it is built and used.

That dependence is where the two literatures meet, and where they are usually kept apart. Infrastructure supports trade only when roads, ports, corridors, power systems, and communication networks can be used safely and reliably. Persistent insecurity disrupts corridors, raises operating costs, damages assets, and discourages firms from using otherwise productive networks. Improved security, in turn, yields limited integration gains where physical and digital infrastructure remain inadequate. The economic value of infrastructure is therefore conditional on the security environment, yet most empirical work treats the two as independent determinants.

This interaction matters most in fragile economies. Unlike the countries examined in studies of established groupings, Somalia faces institutional fragility, continuing security challenges, weak transport connectivity, and low recorded formal regional trade. The International Monetary Fund (2024) sets out both the opportunities and the risks attached to Somalia's accession to the East African Community, including trade diversification and fiscal reform on one side and adjustment costs on the other. Major transport and connectivity projects may expand trade opportunities, but insecurity can reduce their returns by raising transport risk, limiting mobility, and discouraging private investment. A road, corridor, or network may hold integration potential that remains unrealised if firms and households cannot use it efficiently.

Three gaps follow. First, security and infrastructure are mostly examined as separate determinants, with little evaluation of their combined effect. Second, most available evidence comes from groupings whose institutional and security conditions differ from Somalia's. Third, Somalia remains underrepresented in work on the relationship between security, infrastructure, and integration. This study addresses these gaps by examining the independent and joint roles of security conditions and infrastructure expansion in Somalia's regional economic integration.

3. Data and Method

The study uses a quantitative explanatory time series design with annual data for Somalia covering 2000 to 2023, separating short run dynamics from long run relationships. Estimation uses the Autoregressive Distributed Lag approach of Pesaran, Shin and Smith (2001), which suits small samples and variables integrated at level, I(0), or at first difference, I(1), provided that no variable is integrated at second difference, I(2).

3.1. Theoretical Framework

Regional integration is the outcome variable, capturing Somalia's connection to neighbouring and East African Community markets through trade flows and institutional alignment. Political stability represents the security dimension and is drawn from the Worldwide Governance Indicators, whose methodology and margins of error are documented in Kaufmann, Kraay and Mastruzzi (2010). In a fragile setting, insecurity disrupts trade routes, raises transaction costs, and reduces investor confidence, so greater stability is expected to strengthen integration.

Infrastructure enters through access to electricity and mobile cellular subscriptions. Electricity supports production, storage, communication, and service delivery, and can lower operating costs and raise participation in regional trade. Mobile subscriptions capture digital and communication infrastructure, which matters in Somalia because mobile telecommunications and mobile money are widely used in market coordination and business transactions, reducing information costs and linking traders across regions. Mohamed and Nor (2023), using a structural vector autoregressive model on Somali quarterly data from 2010 to 2020, find that mobile money shocks raise consumer spending, help stabilise the exchange rate and the price level, and boost trade openness, which supports treating mobile connectivity as a channel that operates on trade costs directly. GDP per capita, inflation, and urban population are included as controls for the level of economic development, macroeconomic stability, and the scale of urban market concentration.

3.2. Model Specification

The empirical model links regional integration to security, infrastructure, and macroeconomic conditions:

$$RI_t = f(POL_t, ACCS_t, MSC_t, GDPC_t, INFD_t, URPOP_t) \quad (1)$$

$$RI_t = \beta_0 + \beta_1 POL_t + \beta_2 ACCS_t + \beta_3 MSC_t + \beta_4 GDPC_t + \beta_5 INFD_t + \beta_6 URPOP_t + \varepsilon_t \quad (2)$$

where RI denotes regional integration, POL political stability, ACCS access to electricity, MSC mobile cellular subscriptions, GDPC GDP per capita, INFD inflation, and URPOP urban population. The term β_0 is the constant, β_1 to β_6 are the estimated coefficients, and ε_t is the disturbance term. Expected effects are not uniform. Greater stability, wider electricity access, and higher mobile connectivity are each expected to support integration. Higher inflation is expected to weaken price competitiveness and raise uncertainty. Urban population is expected to expand market size, although its net effect depends on the structure of production and trade.

3.3. Data Sources and Variable Measurement

Secondary annual data cover 2000 to 2023, a period spanning post-conflict reconstruction, infrastructure and digital expansion, macroeconomic adjustment, and Somalia's growing engagement with regional institutions. Regional integration data are drawn from UN Comtrade, the Composite Regional Integration Index, and regional integration reports. Political stability data come from the Worldwide Governance Indicators of the World Bank. Access to electricity, mobile cellular subscriptions, GDP per capita, inflation, and urban population come from the World Development Indicators. Table 1 summarizes the variables, their roles, measurement, abbreviations, and sources.

Table 1: Variable Definitions and Data Sources

Variable	Role	Measurement	Abbrev.	Source
Regional integration	Dependent	Composite index of trade flows with East African Community countries and institutional alignment	RI	UN Comtrade; Composite Regional Integration Index
Political stability	Independent	Political stability and absence of violence or terrorism, estimate	POL	World Bank, Worldwide Governance Indicators
Access to electricity	Infrastructure	Access to electricity, per cent of population	ACCS	World Bank, World Development Indicators
Mobile subscriptions	Infrastructure	Mobile cellular subscriptions per 100 people	MSC	World Bank, World Development Indicators
GDP per capita	Control	GDP per capita, current United States dollars	GDPC	World Bank, World Development Indicators
Inflation	Control	Inflation, consumer prices, annual per cent	INFD	World Bank, World Development Indicators
Urban population	Control	Urban population, total	URPOP	World Bank, World Development Indicators

3.4. Econometric Procedure

The analysis proceeds in stages, following the applied guidance of Nkoro and Uko (2016) for specifying, estimating, and interpreting the bounds testing procedure. Unit root tests first establish the orders of integration and confirm that no series is I(2), a precondition for the Autoregressive Distributed Lag framework. The augmented test of Dickey and Fuller (1979) and the test of Phillips and Perron (1988) are both applied, so that conclusions do not rest on a single procedure. The bounds testing procedure then determines whether a long run levels relationship exists among the seven variables. The unrestricted error correction representation is:

$$\Delta RI_t = c_0 + \Sigma\varphi_i \Delta RI_{t-i} + \Sigma\gamma_j \Delta POL_{t-j} + \Sigma\delta_k \Delta ACCS_{t-k} + \Sigma\theta_l \Delta MSC_{t-l} + \Sigma\rho_m \Delta GDPC_{t-m} + \Sigma\psi_n \Delta INFD_{t-n} + \Sigma\eta_r \Delta URPOP_{t-r} + \lambda_1 RI_{t-1} + \lambda_2 POL_{t-1} + \lambda_3 ACCS_{t-1} + \lambda_4 MSC_{t-1} + \lambda_5 GDPC_{t-1} + \lambda_6 INFD_{t-1} + \lambda_7 URPOP_{t-1} + \varepsilon_t \quad (3)$$

In this specification Δ is the first difference operator. Coefficients on the differenced terms capture short run dynamics, while coefficients on the lagged level terms capture the long run relationship. The null hypothesis of no long run relationship is stated as:

$$H_0: \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = 0 \quad (4)$$

If the computed F statistic exceeds the upper critical bound, the null is rejected and cointegration is supported. If it falls below the lower bound, the null cannot be rejected. A statistic between the two bounds is inconclusive. Critical values follow Pesaran, Shin and Smith (2001), with the refined response surface values of Kripfganz and Schneider (2020) available for small samples. Once cointegration is established, the long run coefficients and the error correction model are estimated as:

$$\Delta RI_t = \alpha_0 + \Sigma\varphi_i \Delta RI_{t-i} + \Sigma\gamma_j \Delta POL_{t-j} + \ldots + \Sigma\eta_r \Delta URPOP_{t-r} + \omega ECT_{t-1} + \varepsilon_t \quad (5)$$

where ECT_{t-1} is the lagged error correction term derived from the long run relationship and ω measures the speed at which short run disequilibrium returns towards long run equilibrium. A negative and statistically significant value of ω indicates convergence after short run shocks (Kripfganz & Schneider, 2023).

4. Results

This section reports the empirical results for Somalia over the period 2000 to 2023. The analysis proceeds from descriptive statistics and pairwise correlations to unit root testing, lag selection, the bounds test, long run coefficients, short run error correction dynamics, and diagnostic and stability tests.

4.1. Descriptive Statistics

Table 2 summarizes the 24 annual observations. Regional integration averaged 0.21 within a range of 0.06 to 0.66. Political stability remained negative throughout, with a mean of minus 2.51 and a standard deviation of 0.34, indicating a persistently weak security score with limited variation. Access to electricity and mobile cellular subscriptions varied more widely, averaging 35.29 per cent and 25.02 subscriptions per 100 people. GDP per capita averaged 416.08 United States dollars, while inflation averaged 4.19 per cent within a range of minus 15.35 to 16.06 per cent. Urban population rose from about 2.92 million to about 9.93 million over the sample. This dispersion provides sufficient variation for dynamic analysis, although the short sample requires a parsimonious specification and cautious inference.

Table 2: Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	SD
RI	0.21	0.15	0.66	0.06	0.15
POL	−2.51	−2.51	−2.02	−3.05	0.34
ACCS	35.29	49.25	52.30	2.10	19.43
MSC	25.02	16.52	53.96	0.91	22.03
GDPC	416.08	442.78	597.46	219.20	118.86
INFD	4.19	5.56	16.06	−15.35	7.22
URPOP	5,661,210	4,940,701	9,926,768	2,922,044	2,214,923

Note. N = 24 annual observations. SD denotes standard deviation. Negative values are shown with the minus sign.

4.2. Correlation Analysis

Table 3 and Figure 1 report the pairwise correlations. Regional integration is positively associated with every explanatory variable at the bivariate level. The strongest associations are with urban population, mobile cellular subscriptions, and GDP per capita, followed by access to electricity and political stability, while inflation shows only a weak positive association. These coefficients describe joint movement rather than effects. They also indicate a common trend concern, because mobile subscriptions and urban population correlate at 0.923, mobile subscriptions and electricity access at 0.810, and electricity access and urban population at 0.754. The correlations are therefore used as preliminary evidence only, and not as conditional estimates.

Table 3: Correlation Matrix

Variable	RI	POL	ACCS	MSC	GDPC	INFD	URPOP
RI	1.000						
POL	0.467	1.000					
ACCS	0.515	0.326	1.000				
MSC	0.761	0.699	0.810	1.000			
GDPC	0.661	0.469	0.385	0.711	1.000		
INFD	0.173	0.417	−0.313	0.067	0.266	1.000	
URPOP	0.891	0.557	0.754	0.923	0.738	0.057	1.000

Note. Values are Pearson correlation coefficients. Correlation indicates association and does not establish causality. The association between mobile subscriptions and urban population warrants explicit checks for multicollinearity and common trends.

Figure 1: Correlation Heatmap of the Study Variables



Note. Author's calculation from the correlation matrix reported in Table 3. N = 24.

4.3. Unit Root Tests and Lag Selection

Table 4 reports the augmented Dickey and Fuller results alongside the Phillips and Perron results. Political stability, access to electricity, mobile subscriptions, GDP per capita, and urban population are nonstationary at level but stationary after first differencing under both tests, and are treated as I(1). Inflation is stationary at level under both tests and is treated as I(0). Regional integration is less clear. The Phillips and Perron test rejects the unit root null after first differencing, while the augmented Dickey and Fuller test does not. The series is therefore treated cautiously as I(1) on the basis of the Phillips and Perron result, recognising that unit root conclusions can be sensitive to lag and bandwidth choices, deterministic terms, and

possible structural breaks. No variable is treated as I(2), so the mixture of I(0) and I(1) regressors remains compatible with the estimation framework.

Table 4: Unit Root Test Results

Variable	ADF level	ADF first diff.	PP level	PP first diff.	Decision
RI	4.6677 (1.0000)	0.9995 (.9943)	2.2231 (.9998)	−3.7486** (.0105)	I(1) on PP
POL	−1.4616 (.5345)	−4.6943*** (.0013)	−1.4975 (.5169)	−4.6977*** (.0013)	I(1)
ACCS	−1.6127 (.4603)	−4.3940*** (.0025)	−1.6127 (.4603)	−4.3940*** (.0025)	I(1)
MSC	−0.2501 (.9184)	−4.1549*** (.0043)	−0.3430 (.9036)	−4.1843*** (.0040)	I(1)
GDPC	−1.1500 (.6775)	−4.4513*** (.0020)	−1.3516 (.5875)	−4.2154*** (.0037)	I(1)
INFD	−6.3150*** (.0000)	not applicable	−4.4503*** (.0021)	not applicable	I(0)
URPOP	−1.6095 (.4619)	−3.7342** (.0108)	−1.8006 (.3708)	−3.7133** (.0113)	I(1)

Note. ADF denotes the augmented test of Dickey and Fuller; PP denotes the test of Phillips and Perron. Test statistics are reported with p values in parentheses. ** $p < .05$; *** $p < .01$.

The lag order criteria select one lag without disagreement. As shown in Table 5, the sequential likelihood ratio statistic, the final prediction error, the Akaike criterion, the Schwarz criterion, and the Hannan and Quinn criterion all favour lag one. Given 24 observations, this parsimonious choice is preferable to a heavily parameterised dynamic specification.

Table 5: Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−695.1073	not applicable	7.72E+17	61.05280	61.39839	61.13972
1	−528.1696	217.7448*	3.36E+13*	50.79735*	53.56204*	51.49266*

Note. LR denotes the sequential modified likelihood ratio statistic; FPE the final prediction error; AIC the Akaike criterion; SC the Schwarz criterion; HQ the Hannan and Quinn criterion. An asterisk marks the selected lag.

4.4. Bounds Test for Cointegration

The bounds test supports a long run levels relationship. The computed F statistic is 11.881, which lies above the upper critical bound at every reported significance level, including the one per cent upper bound of 3.99. The null hypothesis of no long run relationship is therefore rejected, which indicates that regional integration, political stability, electricity access, mobile connectivity, GDP per capita, inflation, and urban population move together within a long run system. This result should be read alongside the mixed unit root evidence for regional integration and the diagnostic issues reported below, rather than as unconditional proof of a stable equilibrium.

Table 6: Bounds Test Results

Test statistic	Value	k	Significance	I(0) bound	I(1) bound
F statistic	11.88108	6	10%	1.99	2.94
			5%	2.27	3.28
			2.5%	2.55	3.61
			1%	2.88	3.99

Note. The null hypothesis is that no long run levels relationship exists. Critical values follow Pesaran, Shin and Smith (2001); refined small-sample values are available in Kripfganz and Schneider (2020).

4.5. Long Run Results

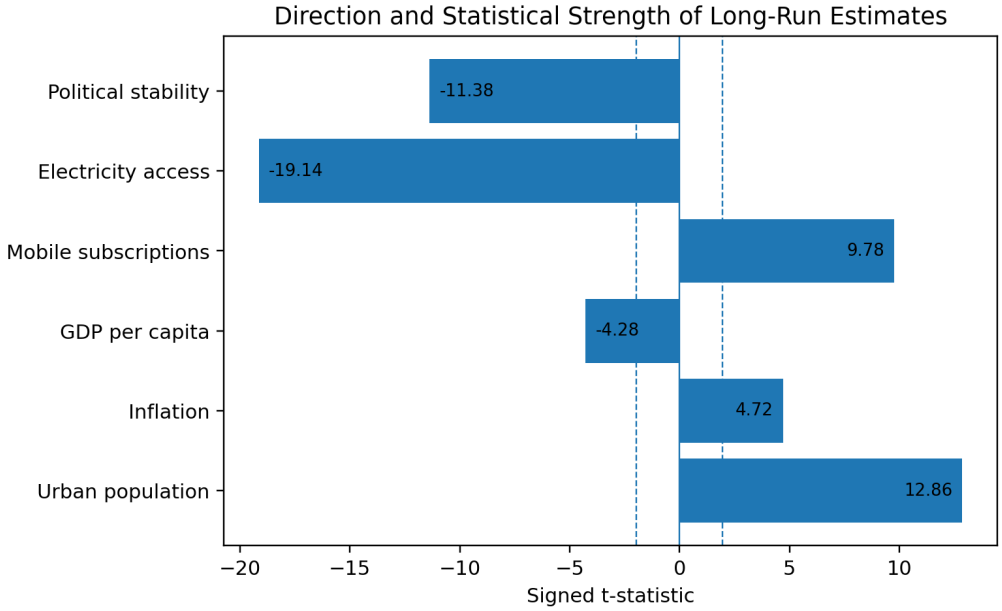
Table 7 reports the estimated long run coefficients, and Figure 2 shows their signed t statistics. Political stability is negative and statistically significant, as are access to electricity and GDP per capita. Mobile cellular subscriptions, inflation, and urban population are positive and statistically significant. Because urban population is measured in persons, its coefficient and standard error round to 0.0000 at four decimal places; only its sign and significance are interpreted. Because the variables are measured in different units, the absolute sizes of the coefficients cannot be ranked as if they were standardized effects.

Table 7: *Long Run Coefficients*

Variable	Coefficient	SE	t	p	Decision
POL	−0.1562	0.0137	−11.3814	.0015	Significant
ACCS	−0.0054	0.0003	−19.1389	.0003	Significant
MSC	0.0060	0.0006	9.7759	.0023	Significant
GDPC	−0.0002	0.00005	−4.2804	.0234	Significant
INFD	0.0044	0.0009	4.7165	.0180	Significant
URPOP	0.0000†	0.0000†	12.8578	.0010	Significant
Constant	−0.4004	0.0439	−9.1236	.0028	Significant

Note. Dependent variable: RI. † Rounds to 0.0000 at four decimal places because urban population is measured in persons. Coefficients are conditional long run associations and not standardised effects.

Figure 2: Direction and Statistical Strength of the Long Run Estimates



Note. Bars show signed t statistics rather than coefficient magnitudes, because the regressors are measured in different units. Reference lines mark an absolute t value of approximately 1.96.

4.6. Short Run Dynamics and Error Correction

Table 8 and Figure 3 report the short run estimates. The contemporaneous change in political stability is negative and significant. Electricity access carries a negative coefficient in the current period and a positive coefficient at the first lag, while mobile subscriptions are positive both contemporaneously and at the first lag. GDP per capita is negative in both the current and lagged differences. Inflation is positive contemporaneously. Urban population is negative contemporaneously and positive at the first lag. The lagged change in regional integration is positive and significant, which indicates short run persistence.

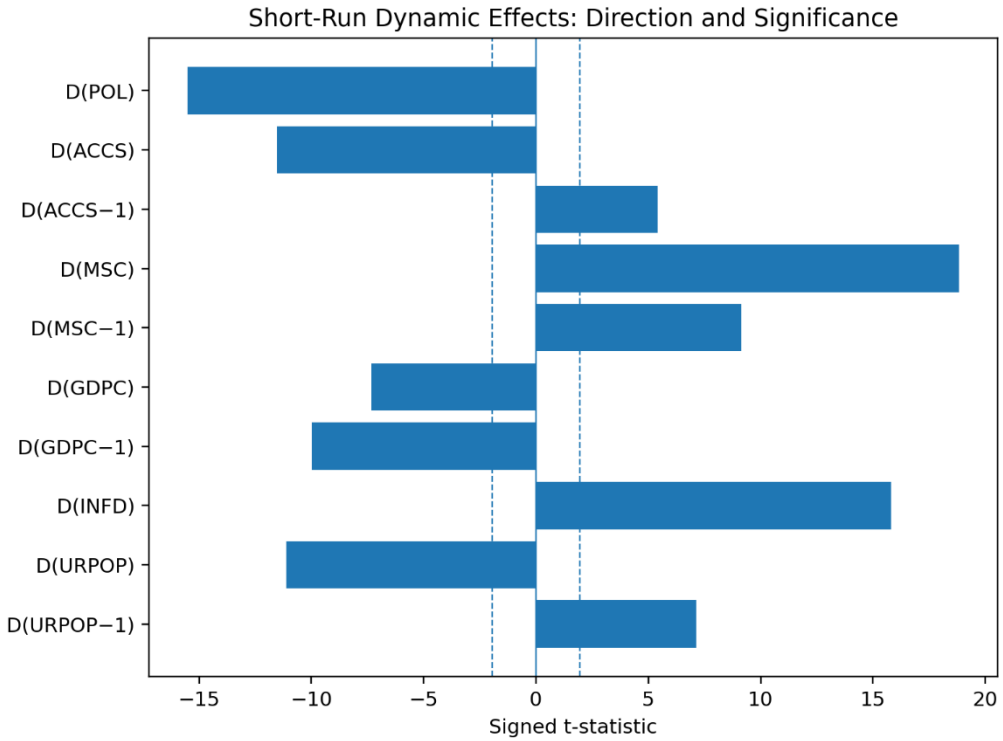
Table 8: Error Correction and Short Run Results

Variable	Coefficient	SE	t	p
ΔRI, lag 1	0.8341	0.1528	5.4579	.0121
ΔPOL	−0.3674	0.0237	−15.5260	.0006
ΔACCS	−0.0140	0.0012	−11.5136	.0014
ΔACCS, lag 1	0.0063	0.0012	5.4174	.0123
ΔMSC	0.0417	0.0022	18.8393	.0003
ΔMSC, lag 1	0.0126	0.0014	9.1360	.0028
ΔGDPC	−0.0004	0.00006	−7.3268	.0053
ΔGDPC, lag 1	−0.0009	0.00009	−9.9996	.0021
ΔINFD	0.0110	0.0007	15.8079	.0006
ΔURPOP	−1.29E−06	1.16E−07	−11.1094	.0016
ΔURPOP, lag 1	7.37E−07	1.03E−07	7.1300	.0057
Error correction term, lag 1	−5.5081	0.3094	−17.7997	.0004

Note. Dependent variable: ΔRI. The symbol Δ denotes the first difference operator.

The error correction coefficient is negative and statistically significant at minus 5.5081, but its magnitude lies well outside the range between minus one and zero normally associated with smooth adjustment towards equilibrium. A value of this size is more consistent with overshooting or oscillatory dynamics, so it is not interpreted here as a conventional speed of adjustment (Pesaran et al., 2001; Kripfganz & Schneider, 2023).

Figure 3: Short Run Dynamic Effects: Direction and Statistical Significance



Note. Bars show signed t statistics for the differenced regressors. The error correction coefficient is omitted because it is not interpreted as a conventional speed of adjustment.

4.7. Diagnostic and Stability Tests

Table 9 reports the diagnostic results, which are mostly but not uniformly favourable. The Jarque and Bera statistic provides no evidence against residual normality. The test of Breusch, Pagan and Godfrey provides no evidence of heteroskedasticity, and the Ramsey RESET probability provides no evidence of functional form misspecification. The CUSUM and CUSUM of squares plots remain within the five per cent critical boundaries, which supports parameter stability. The two versions of the Breusch and Godfrey serial correlation test disagree, however. The F statistic probability is .3427, while the probability associated with the observations multiplied by R squared is .0001. The F version has better small sample properties and is given more weight here, but residual autocorrelation cannot be fully excluded and would affect the standard errors and significance tests reported above.

Table 9: Diagnostic Test Results

Test	Statistic	p	Decision
Jarque and Bera normality	0.151056	.927254	Pass
Breusch and Godfrey LM, F statistic	3.758029	.3427	No serial correlation by F test
Breusch and Godfrey LM, Obs × R-squared	19.41665	.0001	Possible serial correlation
Breusch, Pagan and Godfrey	0.762729	.6985	No heteroskedasticity
Ramsey RESET	1.400161	.3583	No evidence of misspecification
CUSUM	Within 5% bounds	not applicable	Stable
CUSUM of squares	Within 5% bounds	not applicable	Stable

Note. The two serial correlation diagnostics give conflicting decisions; the F version is preferred in small samples.

5. Discussion

5.1. Nominal and Functional Integration Capacity

Taken together, the estimates point to a distinction between nominal and functional integration capacity. Nominal capacity is the presence of assets conventionally associated with integration, such as electricity connections, mobile subscriptions, rising income, urban growth, and formal membership of a regional bloc. Functional capacity is whether those assets lower the cost and risk of producing, moving, financing, and selling goods across markets. The two can move apart. Electricity access can rise without reliable supply for cold storage, processing, customs systems, or logistics. Income can rise without export diversification or participation in value chains. Formal membership can be recorded without the customs capacity, standards infrastructure, or payment systems needed to use it. On this reading, the economic function of an input matters more than its headline coverage rate, which is consistent with the conclusion of Timilsina, Hochman and Song (2020) that the measured returns to infrastructure vary with measurement, context, and development stage rather than following a single pattern.

5.2. Digital Connectivity as the Most Consistent Result

Mobile cellular subscriptions are the only variable carrying the expected sign across all three parts of the model, being positive in the long run, positive contemporaneously, and positive at the first lag. This internal consistency makes it the most defensible finding in the analysis. A plausible mechanism is that mobile connectivity affects transaction costs directly rather than through a long chain of intermediate steps. Where mobile telecommunications and mobile money are used for payments, price discovery, remittance transfers, and supplier coordination, an additional subscription translates quickly into lower search and settlement costs for traders. This contrasts with physical infrastructure, whose benefits depend on complementary investments in roads, storage, and reliable power before they reach the trader. The result is also consistent with the broader finding of Netirith and Ji (2022) that connectivity efficiency, rather than the mere presence of infrastructure, is what associates with trade performance.

A caution applies. Subscriptions per 100 people measure account uptake rather than usage intensity, transaction value, or network quality. Multiple subscriptions per user are common, and the indicator cannot distinguish an active commercial user from a dormant

account. The positive association should therefore be read as evidence that digital connectivity deserves closer measurement in this context, not as a precise estimate of the effect of mobile money on trade.

5.3. Interpreting the Security Coefficient

The political stability result requires particular care. The World Bank indicator is coded so that higher values denote greater stability. The negative long run coefficient therefore means that higher stability scores are associated with lower recorded regional integration once the other variables are held constant. It cannot be restated as evidence that insecurity raises integration, and it does not sit comfortably with the wider African evidence, including the finding of Dalyop (2024) that political stability has a statistically significant direct relationship with exports of manufactures.

Four explanations deserve testing before any substantive interpretation is offered. The first is measurement. A single national governance score is a weak proxy for risk along the specific corridors, ports, and border posts that carry Somalia's trade, and it varies little over the sample, with a standard deviation of 0.34 around a mean of minus 2.51. A variable with limited variation carries limited identifying information. The second is the composition of trade. Where a large share of commerce is informal, cross-border, and unrecorded, periods of greater state consolidation may shift activity from unrecorded to recorded channels, or in some cases the reverse, which affects the measured index without a corresponding change in real trade. The third is common trends. Political stability, electricity access, mobile subscriptions, and urban population all trend over the sample, and with 24 observations the model may not separate their contributions reliably. The fourth is the sample itself. Twenty-four annual observations with six regressors leaves few degrees of freedom, and the estimates should be treated accordingly. The observation by Healy (2011) that economic interdependence in the Horn of Africa continued to develop even while political relations remained conflictual offers a substantive rather than statistical reading of the same pattern. Trade networks in the region have historically adapted to insecurity rather than simply contracting under it, relying on clan-based trust, informal finance, and alternative routing. If that adaptation is present in the data, a national stability score would be a poor predictor of trade outcomes in either direction. Robustness checks using conflict intensity, recorded fatalities, measures of border and corridor security, or alternative governance indicators would help distinguish these explanations.

5.4. Electricity Access and the Reliability Gap

The negative long run coefficient on electricity access invites a similar reading. Access, defined as the share of the population with a connection, records coverage and not reliability, capacity, cost, or industrial suitability. In Somalia, much supply is provided by private and fragmented networks at tariffs that are high by regional standards, and the productive uses most relevant to trade, including cold chains, processing, port handling, and customs systems, require continuity of supply rather than household connection. An index of household coverage can therefore rise substantially while the constraint that binds exporters remains unchanged.

The short run pattern is also worth noting. Electricity access carries a negative coefficient in the current period and a positive coefficient at the first lag. One interpretation consistent with the data is that expansion involves an adjustment period in which resources are absorbed before the network is used productively, with the effect turning positive once capacity is in place. This remains a hypothesis rather than a finding, and testing it would require data on generation capacity, outage frequency, and industrial tariffs rather than the coverage measure used here.

5.5. Income, Inflation and Urban Population

The negative coefficient on GDP per capita is small in absolute terms and should not be over-interpreted. One reading is that rising income in a consumption-led and import-dependent economy raises demand for goods from outside the region as readily as it raises regional trade, which would attenuate or reverse the expected association with a regionally defined integration measure. The positive coefficient on inflation is more difficult to rationalise on economic grounds and may reflect the co-movement of prices with import volumes over the sample rather than any competitiveness channel. Urban population carries a positive coefficient consistent with expectations, since urban concentration expands market size and consolidates commercial and transport nodes, although its per-person coefficient is very small because the variable is measured in persons.

5.6. Simple Correlations Against Conditional Estimates

The divergence between the bivariate correlations and the multivariate estimates deserves explicit comment, because it is the single most likely source of misreading. Regional integration correlates positively with every regressor in Table 3, yet political stability, electricity access, and GDP per capita carry negative coefficients in the long run equation. Reversals of this kind are common when several strongly trending variables capture overlapping dimensions of the same underlying transformation, which is the situation here given the association of 0.923 between mobile subscriptions and urban population. The multivariate coefficients answer a different question from the correlations. They describe what is associated with regional integration when one variable changes and the others are held constant, which is not the same as describing what happened historically as all of them rose together. Reported in these terms, the counterintuitive signs generate hypotheses about sequencing and productive use rather than claims that stability, electricity, or income are harmful to integration.

5.7. The Joint Role of Security and Infrastructure

The bounds test indicates that the variables are jointly related in the long run, and the short run model shows that security, electricity access, and mobile connectivity all carry statistically significant coefficients. This supports the framing of the study at the level of a joint system, and is consistent with continental evidence that political stability amplifies rather than simply adds to the effect of regional integration on exports (Mamba et al., 2025). It does not, however, establish that security moderates the effect of infrastructure specifically, because the estimated specification contains no interaction term between political stability and either infrastructure variable. The claim that infrastructure yields returns conditional on the security environment therefore remains a proposition supported by the literature and by the descriptive pattern, rather than a result of this estimation. Given the sample size, interaction terms should be introduced one at a time in parsimonious alternative specifications, with attention to the resulting loss of degrees of freedom.

6. Conclusion

This study examined the relationship between security conditions, infrastructure expansion, and regional economic integration in Somalia between 2000 and 2023 using an Autoregressive Distributed Lag framework. The bounds test supports a long run relationship among the variables, and the error correction term is negative and significant. Mobile cellular subscriptions carry the expected positive sign in the long run and in both the contemporaneous and lagged short run terms, making digital connectivity the most internally consistent result in the analysis. Political stability, electricity access, and GDP per capita carry negative long run

coefficients that conflict with expectations and with parts of the wider literature, and these are attributed here to measurement and specification rather than to substantive relationships.

The wider argument the results support is that the assets conventionally associated with integration do not deliver integration on their own. What matters is whether those assets reduce the cost and risk of trading, which depends on reliability, usability, and the security conditions along the specific routes that carry trade. For Somalia, which has recently joined the East African Community and holds a geographic position that has long suggested a larger trading role than it currently occupies, this distinction has practical consequences for how integration is measured and where investment is directed. Confirming it will require corridor-level security data, infrastructure measures that capture reliability rather than coverage, and specifications that test the interaction between security and infrastructure directly.

6.1. Policy Implications

Three implications follow, stated with the caution the estimates warrant. First, integration progress is better monitored through measures of function than through coverage rates. Border clearance times, transport costs per tonne-kilometre, payment settlement times, and outage frequency describe the constraints firms actually face, whereas connection rates and membership status do not. Second, digital payment and communication systems deserve treatment as trade infrastructure rather than as a separate telecommunications matter, since they are the component of the infrastructure stock for which this analysis finds the most consistent association with integration, and since interoperability across providers and across borders is a policy variable. Third, security policy relevant to trade is corridor-specific. Aggregate national stability is not the operative variable for a trader deciding whether to move goods along a particular route, and monitoring designed around corridors, ports, and border posts would support both better policy and better measurement in future work.

7. Limitations

Several limitations qualify the findings. The sample of 24 annual observations is small relative to the seven variables in the system, which constrains the lag structure and limits the precision of the estimates. The dependent variable is a composite index whose construction should be documented in full, since the classification of regional integration for a country with substantial informal and unrecorded trade is itself contested, a point raised in general terms by Iapadre (2004). The unit root evidence for the dependent variable is mixed across the two tests applied, and the classification adopted here rests on one of them. The error correction coefficient is outside the range associated with smooth convergence, so the adjustment dynamics cannot be described in conventional terms. The two serial correlation diagnostics disagree. Finally, the absence of interaction terms means the central proposition about the joint role of security and infrastructure is not directly tested. Each of these points identifies work to be completed rather than a reason to discard the results, but together they indicate that the estimates should be treated as preliminary.

Declarations

Ethics Statement: Not applicable.

Data Availability Statement:

The data used in this study are publicly available from the World Bank (Worldwide Governance Indicators and World Development Indicators).

Author Contribution Statement:

All authors contributed to the conception and design of the study, data analysis, and interpretation of results, and approved the final manuscript.

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