
Infrastructure, trade openness, and territorial development in Morocco: A Time Series Analysis (1970–2023).

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Abstract

Infrastructure is widely regarded as a key driver of trade openness, particularly in developing economies where high transport and transaction costs constrain external integration. Global empirical evidence confirms that modern infrastructure reduces trade barriers, improves competitiveness, and facilitates participation in global value chains. Yet the magnitude and durability of this effect often vary across countries. In Morocco, infrastructure has been at the center of development strategies since the 1990s, with large-scale projects such as the Tangier Med port, highway expansion, and high-speed rail, alongside progressive trade liberalization through WTO membership and multiple free trade agreements. Despite these efforts, it remains unclear to what extent infrastructure development has effectively translated into greater trade openness. This study addresses that question by analyzing the relationship between infrastructure investment and Morocco's trade openness over the period 1970-2023. Using annual data from the World Bank and employing the autoregressive distributed lag (ARDL) approach to capture both short- and long-run dynamics. Trade openness is measured as the trade-to-GDP ratio, with gross fixed capital formation (GFCF) as the proxy for infrastructure, and GDP growth and FDI as control variables. The results show that infrastructure investment has a positive and significant effect on trade openness in the short run, but no evidence of a stable long-run relationship is found. These findings partially validate the research hypothesis and suggest that infrastructure alone is insufficient to sustain openness without complementary policies such as trade facilitation, institutional reforms, and regional integration.

Keywords : Trade openness, territorial development, infrastructure, Morocco, ARDL model.

Introduction

Infrastructure development is widely recognized as a cornerstone of economic growth and international integration. By reducing transaction costs, improving connectivity, and enhancing competitiveness, infrastructure provides the physical and institutional foundations that enable countries to participate more effectively in global trade. For developing economies in particular, modern transport networks, efficient ports, and reliable utilities constitute not only drivers of domestic development but also critical channels for linking local production with global markets.

Morocco offers a particularly relevant case in this regard. Since the 1990s, the country has undertaken ambitious infrastructure programs, including the expansion of its highway network, the construction of the Tangier Med port, and the introduction of high-speed rail. These investments were designed not only to foster internal cohesion and territorial balance but also to position Morocco as a strategic gateway between Europe, Africa, and the Middle East. In parallel, Morocco has pursued extensive trade liberalization, through accession to the World Trade Organization¹, association agreements with the European Union, and numerous bilateral and regional trade agreements. Yet, despite these efforts, questions remain about the extent to which infrastructure investment has effectively translated into greater trade openness.

This article examines the relationship between infrastructure and trade openness. The existing literature provides strong theoretical and empirical evidence of a positive relationship between infrastructure and trade openness. However, few studies have tested this nexus specifically for Morocco, and even fewer have done so over a long horizon that captures the structural transformations of its economy from the 1970s to the present. The objective of this study is to address this gap by answering the following research question: **To what extent does infrastructure development influence Morocco's trade openness during the period 1970–2023?**

To address this question, the study combines a theoretical and empirical approach. The remainder of the paper is organized as follows. Section 1 reviews the relevant literature. Section 2 describes the data and methodology. Section 3 presents and discusses the empirical results. We conclude with the study's findings, limitations and directions for future research.

¹ Morocco joined the WTO in 1995 as a founding member, consolidating its shift from protectionist trade policy to liberalization anchored in multilateral rules (WTO, 1996).

1. Literature review

1.1. Territorial Development: Concepts and Paradigms

Territorial development, rooted in territorial and regional economics, emphasizes the dynamics of value creation and social cohesion within a given space, while taking into account local specificities and the interactions between actors, institutions, and resources (Camagni, 2009; Pecqueur, 2000). Far from being a simple geographical or administrative entity, the territory is also a social and economic construct. Raffestin (1986) defines it as a “socialized space” shaped by processes of appropriation and organization, while Camagni (2009) introduces the notion of «territorial capital», encompassing both tangible assets (infrastructure, natural resources) and intangible assets (knowledge, networks, and social capital).

The literature offers several complementary definitions of territorial development. Pecqueur (1989) conceives it as a coordinated mobilization of local resources for sustainable development. Storper (1997) views it as a process of collective learning and productive specialization that strengthens global integration. Rodríguez-Pose (2013) emphasizes its multidimensionality, combining economic growth, social inclusion, and governance quality. These perspectives converge on the idea that territorial development must be addressed holistically, embracing its economic dimension through wealth creation and diversification (Porter, 1990), its social dimension through the reduction of inequalities (Farole et al., 2011), its environmental dimension through sustainable resource management, and its institutional dimension through the quality of governance (Pierre, 2005).

Within this debate, two paradigms coexist. The endogenous approach emphasizes local resources, human capital, and networks (Pecqueur, 1989; Vázquez-Barquero, 2002), whereas the exogenous approach highlights external drivers such as FDI, technological transfers, and large-scale projects (Storper, 1997). In practice, most territories rely on hybrid strategies, combining internal valorization with external inputs. Among the key determinants of territorial development, infrastructure emerges as a fundamental lever (Rodríguez-Pose, 2013).

1.2. Public Infrastructure as a Pillar of Territorial Development.

Public infrastructure, encompassing transport networks, utilities, and social facilities, represents a foundational element of the public domain and a central determinant of territorial competitiveness. Its contribution to development manifests in several ways. By improving connectivity, infrastructure lowers barriers to mobility and reduces transaction costs, thereby facilitating specialization and efficiency. By providing access to education, healthcare, and essential services, it directly improves social well-being. Infrastructure investment also

stimulates local economies, generating employment, attracting investment, and creating multiplier effects. Finally, in an increasingly globalized economy, the availability of modern and reliable infrastructure is decisive for competitiveness and the attraction of foreign capital (Taghouti & Abdelbaki, 2023).

What emerges from this literature is that infrastructure serves as more than a support to domestic development. It also constitutes the main interface through which territories position themselves in international markets. Efficient infrastructure underpins the ability to connect local production with global demand, to integrate into global value chains, and to reduce the structural disadvantages often associated with geography. This dual role makes infrastructure not only a pillar of territorial development but also a critical determinant of trade openness.

1.3. Trade Openness and the Role of Infrastructure.

Trade openness, typically measured as the sum of exports and imports relative to GDP, reflects the degree of a country's participation in international trade. Over the years, it has been conceptualized from multiple theoretical, empirical, and policy perspectives. The OECD (2011) measures it as the ratio of average exports and imports of goods to GDP, while the World Bank includes both goods and services in the sum of exports and imports relative to GDP. UN ESCWA (2012) frames trade openness in terms of a country's outward or inward economic orientation, shaped by trade policies, infrastructure, technology, economies of scale, and competitiveness. Naz et al. (2013) describe it as integration with other countries, involving the free movement of labor, capital, and trade. Santamaría et al (2025), Rana (2025), and Fatima et al. (2020) emphasize trade openness as the scale of a country's international trade relative to its economic size and exposure to global trade. Shahbaz et al. (2017) highlights efforts to facilitate the exchange of goods, services, labor, information, and capital, while Torres (2001) links it to deeper economic integration driven by trade liberalization, investment, and technology. Wibowo and Setyowati (2023) focus on reducing trade barriers, including softer import-export administration, and Ijirshar (2019) underscores the role of liberalization in facilitating imports and exports. The pursuit of trade openness began shortly after World War II. From the 1980s onward, most developing countries adopted outward-oriented strategies, marked by substantial reductions in tariff barriers. Yet, despite this liberalization, global trade volumes have consistently fallen short of levels predicted by standard trade models, giving rise to the "missing trade" puzzle (Trefler, 1995). This gap, alongside decades of declining tariffs, has fueled scholarly debate and shifted attention to alternative explanations for persistent trade shortfalls. Obstfeld and Rogoff (2001) emphasize that trade costs, including transportation,

communication, search, and information, across borders relative to domestic costs play a key role in understanding this puzzle.

Transport and trade costs are widely recognized as key determinants of trade performance and market access (Anderson and van Wincoop, 2004; Arvis et al., 2013), a relevance amplified by global value chains, where repeated border crossings magnify transaction costs. Africa's persistent infrastructural gaps make transport and trade costs a major constraint on trade potential (Valensisi and Munizzo, 2021). Anderson and van Wincoop (2004) estimate that trade and local distribution costs often exceed marginal production costs, highlighting the limited role of tariffs. Deardorff (2011) and Obstfeld and Rogoff (2000) further emphasize transaction costs as decisive in explaining global trade flows and persistent trade deficits. Empirical studies confirm these effects: Ratnayake (2009), De (2006), Hoekman and Nicita (2008) show that transport costs, non-tariff barriers, and procedural inefficiencies shape trade patterns, while Djankov et al. (2006) and Nordås et al. (2006) link delays to reduced trade volumes. Firm-level evidence (Melitz, 2003) corroborates that high trade costs restrict market entry.

Infrastructure mitigates these costs and enhances trade openness. Francois and Manchin (2013) find that infrastructure development lowers transport costs and increases trade probability and volume. Han and Li (2022) confirm that transport infrastructure boosts international trade. Port efficiency and infrastructure endowments positively affect trade intensity (Feenstra and Ma 2014; Donaubauber et al. 2015, 2016a, 2016b), while Rehman et al. (2020) show infrastructure improves exports and reduces trade deficits. Our study builds on this evidence, examining infrastructure's impact on international and internal trade using a structural gravity approach. These empirical contributions are synthesized in Table 1.

Table N°1 : Empirical literature on infrastructure and trade openness

Authors	Year	Methodology	Results
Bougheas et al.	1999	Augmented gravity model	Infrastructure reduces transport costs and increases trade.
Limão & Venables	2001	Cross-country regression	Poor infrastructure raises trade costs and reduces trade.
Francois & Manchin	2013	Panel regression	Infrastructure improves market access, especially in low-income countries

Djankov et al	2010	Modified gravity equation	Logistics infrastructure reduces delays and boosts exports.
Martincus & Blyde	2013	Fixed effects estimation	Road quality positively influences exports
Anderson & Wincoop	2004	Survey of the literature	Infrastructure lowers trade costs and promotes integration
Nordås & Piermartini	2004	Gravity model	Infrastructure positively affects trade, particularly for landlocked countries
Redding & Turner	2015	Survey of theoretical and empirical literature	Transport infrastructure plays a key role in trade connectivity.
Celbis et al.	2014	Meta-analysis and meta-regression	A 1% increase in public infrastructure generates +0.6% in exports and +0.3% in imports, effects stronger for developing countries, land transport infrastructure, and IV or panel models.
Kareem	2024	Augmented gravity model	High-quality infrastructure (logistics, telecommunications) and LPI increase both the probability and intensity of exports in Africa.
Zheng & Li	2022	Structural model Augmented gravity model OLS and PPML Quantitative analysis	A 10% increase in transport infrastructure generates about +3.9% in real

			income, with gains concentrated in the country improving infrastructure.
Netirith & Ji	2022	DEA (Data Envelopment Analysis)	Highlights the positive link between transport infrastructure connectivity and trade
Ijirshar	2022	System Generalised Method of Moments (GMM)	Port traffic and transport infrastructure quality strongly influence imports, exports, and national income
Gorgulu et al.	2023	Meta-analysis	Estimates of infrastructure elasticities on multiple outcomes, including trade, robustness enhanced through publication bias analysis

Source : Authors

1.4. Linking the Concepts: The Moroccan Case

This relationship between infrastructure and trade openness is particularly relevant for Morocco. Since the 1990s, the country has pursued ambitious infrastructure programs, including the expansion of highway networks, the construction of the Tangier Med port, and the development of high-speed rail. These projects have been explicitly designed not only to support domestic cohesion and territorial balance but also to strengthen Morocco's position in international markets as a gateway between Europe, Africa, and the Middle East. Parallel to these efforts, Morocco has engaged in extensive trade liberalization through association agreements with the European Union, membership in the WTO, and multiple bilateral and regional trade agreements.

Yet, despite these strategies, questions remain regarding the extent to which infrastructural investment has effectively translated into greater trade openness. The relationship may not be linear or permanent, and short-term dynamics can differ from long-term outcomes. Moreover,

while theoretical and empirical literature generally highlights a positive link between infrastructure and openness, empirical investigations focusing specifically on Morocco remain limited, particularly over a long horizon that spans different phases of policy orientation and structural transformation.

This empirical gap justifies the present study, which seeks to analyze the relationship between infrastructure and trade openness in Morocco over the period 1970–2023. By focusing on Morocco as a case study, the analysis highlights the dual role of infrastructure as both a pillar of territorial development and a lever for external economic integration. Building on this context, we put forward the following hypothesis to be tested empirically:

H1: Infrastructure investment exerts a positive effect on Morocco's trade openness over the period 1970-2023, by reducing trade costs, enhancing competitiveness, and facilitating participation in global value chains.

2. Methodology

2.1. Data and key variables

This study examines the relationship between infrastructure and trade openness in Morocco over the period 1970–2023. Infrastructure is proxied by public investment, measured as gross fixed capital formation (GFCF) as a percentage of GDP, following the approach of Boussof and Seghyar (2023). Trade openness is captured through the trade-to-GDP ratio. To control for other factors influencing trade integration, the model includes foreign direct investment (FDI) as a percentage of GDP and the GDP growth rate. Expressing these variables as ratios or growth rates facilitates interpretation and comparability across time. All data are drawn from the World Bank's World Development Indicators (WDI).

GDP growth is controlled for because of its established link with trade openness. Higher GDP reflects greater productive capacity, industrial expansion, and domestic demand, which support export growth and import capacity. Rising income levels also enable investment in technology and trade-related functions, reinforcing integration into global markets (Goswami, 2013; Tahir et al., 2018; Puntoon et al., 2020; Naz et al., 2023; Gnangnon, 2019).

This finding aligns with the gravity model of trade, which predicts that larger and wealthier economies generate greater trade flows (Tinbergen, 1962; Anderson & van Wincoop, 2003; Frankel & Romer, 1999). Evidence from Africa further underscores the importance of income in explaining openness (Coe & Hoffmaister, 1999; Osei et al., 2019; Fauzel, 2022; Sakyi & Afesorgbor, 2019). Although some studies suggest non-linearities, where

very high-income or resource-rich economies may rely less on trade (Guttmann & Richards, 2004; Feenstra, 1998; Ram, 2009; Khan et al., 2023), the predominant evidence supports a positive effect of GDP growth on trade integration.

FDI is also included as a control variable given its catalytic role in promoting openness. FDI brings capital inflows, technology transfer, and integration into global value chains, which expand both export capacity and import demand (Aitken & Harrison, 1999; Naz et al., 2023; Tsaurai, 2021; Rana, 2025).

Multinational enterprises often import intermediate goods and export final products, while also transferring knowledge and technology to local firms, enhancing product quality and international competitiveness (Damijan et al., 2003; Caetano & Galego, 2006; Reganati & Pittiglio, 2005; Faruq, 2010).

Empirical evidence broadly supports this positive link: FDI has been shown to foster openness in Pakistan and China (Khan et al., 2023; Latif et al., 2018), stimulate export growth in Cameroon (Njong, 2008), and reinforce openness in GIPSI economies (Suleman et al., 2023, 2024). Cross-country studies also suggest that investors are more likely to enter open economies where goods and capital can move freely (Gnangnon, 2019; Polat et al., 2015).

While some findings report insignificant or mixed effects (Sharma, 2000; Ngouhouo & Makolle, 2010), the prevailing evidence indicates that FDI enhances trade by stimulating competition, raising product quality, and linking domestic markets to global production networks. In Morocco's case, where FDI has supported industrial modernization and export diversification, it is a critical determinant of trade openness.

2.2. Methodological approach

This article adopts a post-positivist epistemological stance, and follows a hypothetico-deductive reasoning approach. The empirical analysis employs the autoregressive distributed lag (ARDL) model. This approach allows for the identification of co-integration relationships between trade openness, infrastructure, FDI, and economic growth.

The ARDL bounds testing approach is employed to empirically investigate the nexus between the variables. The ARDL model has some merits relative to most macro-econometrics' techniques. Pesaran, Shin, and Smith (2001) emphasized the usefulness of the ARDL model in estimating long-run relationships, noting that once the integration order of the variables is identified, OLS can be applied to estimate their relationship. A key advantage of this approach is that it does not require all variables to have the same order of integration, as it can accommodate both I (0) and I (1) variables, with the exception of I (2). Another strength of the

ARDL framework is that its unrestricted error correction model incorporates sufficient lags to reflect the underlying data-generating process, moving from a general to a specific specification. Unlike conventional cointegration techniques, which are often affected by endogeneity issues, the ARDL model clearly separates the dependent variable from the explanatory variables. Furthermore, adjusting the lag structure helps address potential serial correlation in the data (Pesaran, Shin, & Smith, 1999). Given these advantages, the ARDL bounds testing procedure operates in two stages: first, testing for the presence of a long-run relationship among the variables, and second, examining their short-run dynamics. The robustness of the results is then assessed through diagnostic and stability tests.

3. Results and discussion

3.1. Descriptive statistics

The descriptive analysis provides an overview of the behavior of the variables (Table 2). Trade openness (TO) averages 58.91% during the study period, ranging from 36.68 to 101.13%. The relatively high standard deviation (13.55) reflects significant fluctuations in Morocco's trade integration, consistent with phases of protectionism followed by liberalization. The positive skewness indicates episodes of exceptionally high openness, while the Jarque-Bera test confirms non-normality ($p = 0.0163$), illustrating the structural changes Morocco experienced in its external orientation.

Table N°2 : Descriptive Statistics of the Variables (1970-2023)

Statistics	TO	GFCF_GD P	GDP	FDI
Mean	58.91473	25.03907	4.143745	1.358705
Median	54.63556	25.48458	3.737983	1.005970
Maximum	101.1324	31.95474	12.37288	6.444129
Minimum	36.67924	13.53955	-7.178207	-0.265782
Std. Dev.	13.54755	4.263434	3.850787	1.275549
Skewness	0.902321	-1.165845	-0.385276	1.423907
Kurtosis	3.633917	4.436571	3.841683	5.912291
Jarque-Bera	8.231810	16.87615	2.929905	37.33083
Probability	0.016311	0.000216	0.231089	0.000000
Sum	3181.396	1352.110	223.7622	73.37004
Sum Sq. Dev.	9727.417	963.3740	785.9137	86.23230
Observations	54	54	54	54

Source : Authors, Eview 12 version

Gross fixed capital formation (GFCF) averages 25.04% of GDP, with a range between 13.54 and 31.95%. The series is slightly left-skewed and leptokurtic, with the Jarque-Bera test confirming non-normality ($p < 0.01$). This reflects periods of stable investment interrupted by sharp increases, often linked to large infrastructure programs.

GDP growth averages 4.14%, with values ranging from -7.18 to 12.37%. The series shows cyclical volatility typical of Morocco's economy, which is exposed to climate shocks and external fluctuations. The distribution is approximately symmetric (skewness -0.38), and the Jarque-Bera statistic suggests no significant deviation from normality ($p = 0.231$).

FDI inflows average 1.36% of GDP, fluctuating between -0.27 and 6.44%. The distribution is strongly right-skewed and leptokurtic, reflecting a generally low baseline of inflows punctuated by occasional surges during privatization programs or major foreign investment projects. The Jarque-Bera test confirms non-normality at the 1% level.

Overall, the descriptive statistics highlight that while GDP growth is relatively stable, Morocco's trade openness, infrastructure investment, and FDI inflows exhibit significant variability over the study period. This variability justifies the use of time-series econometric methods capable of capturing both short- and long-run dynamics.

3.2. Unit-root tests

Table 3 presents Unit Root test results. Based on ADF test results, TO, GFCF and FDI were found to be integrated of order one I (1), while GDP growth rate is stationary at levels I (0).

Table N°3 : Unit root tests results (Adf and PP tests)

Variables	Levels				1st difference			
	ADF ⁴		PP ⁵		ADF		PP	
	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value	t-statistic	p-value
TO	-1.0156	0.7414	-0.569	0.868	-6.86	0.000	-8.5258	0.0000
GFCF	-2.916	0.0502	-3.053	0.036	-5.811	0.000	-6.5727	0.0000
FDI	-1.9577	0.3041	-4.5452	0.000	-16.98	0.000	-38.6817	0.0001
GDP	-11.6372	0.0000	-10.9388	0.000	-11.3453	0.000	-28.5537	0.0001

Source : Authors, Eview 12 version

Since the variables are of mixed integration order and none are I (2), an ARDL approach is appropriate.

3.3. Bounds test

After determining the integration order of the variables, the ARDL bounds testing approach was applied to examine the existence of a long-run relationship among the variables (Table 4). The bounds test involves estimating an unrestricted error correction model and testing the joint significance of the lagged levels of the variables using an F-statistic. The calculated F-statistic is then compared to the critical bound's values provided by Pesaran et al. (2001). If the F-statistic exceeds the upper bound, the null hypothesis of no long-run relationship is rejected. If it falls below the lower bound, the null cannot be rejected, while a value between the bounds indicates an inconclusive result.

Table N°4 : Bounds Test for Long-Run Relationship

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
Asymptotic: n=1000				
F-statistic	1.928546	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Finite Sample: n=55				
Actual Sample Size	51			
		10%	2.508	3.356
		5%	2.982	3.942
		1%	4.118	5.2
Finite Sample: n=50				
		10%	2.538	3.398
		5%	3.048	4.002
		1%	4.188	5.328

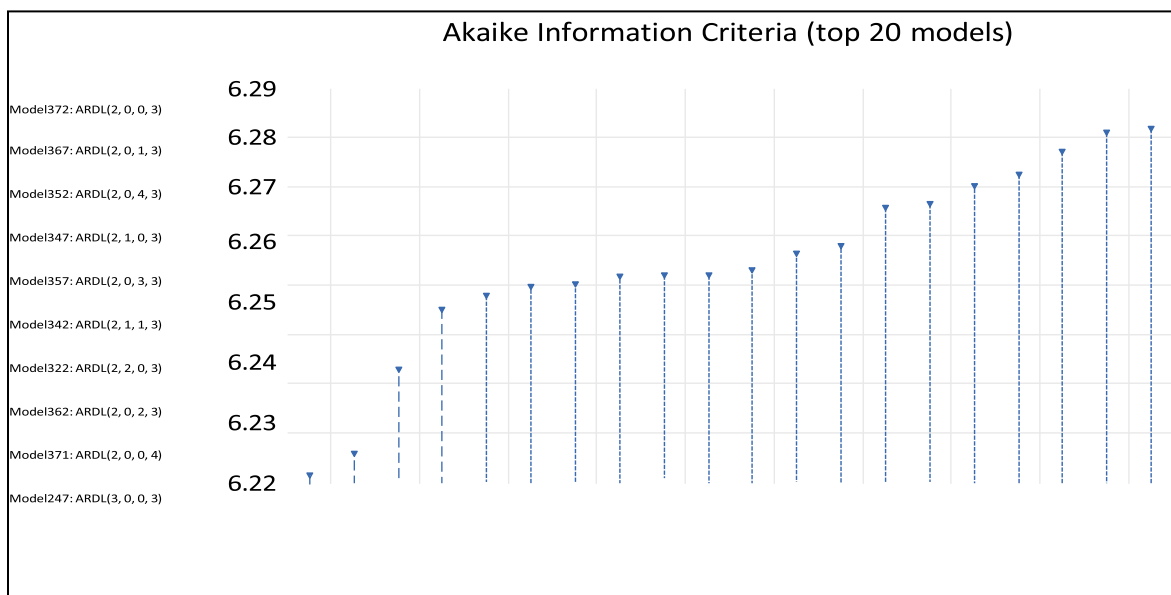
Source : Authors, Eview 12 version

The bounds test indicates that no long-run relationship exists among the variables. In other words, the variables do not move together in equilibrium over time, and therefore, a co-

integration relationship cannot be established. As a result, it is not appropriate to estimate the long-run ARDL model. Instead, the focus shifts to estimating a short-run ARDL model, which relies on the differenced form of the data.

However, before applying the ARDL model, it is proper to determine the appropriate lag length using the Akaike Information Criterion (AIC). Figure 1 reports the recursive search of the ARDL model. Accordingly, the results reveal that ARDL [2,0,0,3] is the appropriate model since it has the lowest AIC.

Figure N°1 : Selection of Optimal Lag Length (ARDL Model)



Source : Authors, Eview 12 version

After determining the optimal lag length, the short-run ARDL model was estimated using differenced data.

Based on the selected lag structure ARDL(2,0,0,3), the model is specified as:

$$\Delta \text{TOt} = \alpha + \beta_1 \Delta \text{GFCFt} + \beta_2 \Delta \text{FDIt} + \gamma_0 \Delta \text{GDPT} + \gamma_1 \Delta \text{GDPT-1} + \gamma_2 \Delta \text{GDPT-2} + \gamma_3 \Delta \text{GDPT-3} + \varphi_1 \text{TOt-1} + \varphi_2 \text{TOt-2} + \varepsilon \text{t}$$

Where:

- Δ denotes the first difference (short-run changes)
- TOt is trade openness at time t
- GFCFt is gross fixed capital formation at time t
- FDIt is foreign direct investment at time t
- GDPT is GDP growth at time t
- α is the constant term

- $\beta_1, \beta_2, \gamma_0, \gamma_1, \gamma_2, \gamma_3$ are short-run coefficients
- ϕ_1, ϕ_2 are the coefficients on the lagged levels of the dependent variable (autoregressive component)
- ε_t is the error term

The estimation results are presented in Table 5.

Table N°5 : Short-Run ARDL Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
DTO(-1)	-0.251822	0.135312	-1.861045	0.0697
DTO(-2)	-0.469362	0.154687	-3.034269	0.0041
DGFCF	0.851641	0.320990	2.653172	0.0112
DFDI	0.308821	0.578374	0.533946	0.5962
GDP	0.076023	0.232449	0.327051	0.7453
GDP(-1)	0.046697	0.255987	0.182418	0.8561
GDP(-2)	-0.711330	0.238193	-2.986356	0.0047
GDP(-3)	-0.576442	0.251830	-2.289011	0.0272
C	6.410878	2.237567	2.865111	0.0065
R-squared	0.420360	Mean dependent var	1.09793	0
Adjusted squared	R-0.309952	S.D. dependent var	6.31351	9
S.E. of regression	5.244584	Akaike info criterion	6.31105	4
Sum squared resid	1155.238	Schwarz criterion	6.65196	5
Log likelihood	-151.9319	Hannan-Quinn criter.	6.44132	6
F-statistic	3.807345	Durbin-Watson stat	2.05918	1
Prob(F-statistic)	0.001936			

Source : Authors, Eview 12 version

The short-run ARDL estimation reveals a nuanced relationship between the explanatory variables and trade openness, with varying levels of significance and direction across lags. Gross fixed capital formation (GFCF) exerts a positive and statistically significant effect ($p < 0.05$), suggesting that increases in contemporaneous investment contribute directly to greater trade openness in the short run. This finding underscores the role of domestic capital accumulation in supporting external integration, possibly through its impact on productive capacity and competitiveness.

Foreign direct investment (FDI) also enters the model with a positive sign, though the coefficient is not statistically significant. While this indicates that FDI tends to reinforce trade openness, the lack of significance suggests that its effect is not immediate or strong enough to shape short-term dynamics. A similar pattern emerges for current GDP and its first lag (GDP and GDP-1), which display positive but insignificant associations with trade openness, implying that short-term fluctuations in output do not translate into meaningful changes in external openness.

By contrast, the second and third lags of GDP (GDP-2 and GDP-3) are negative and statistically significant, pointing to a delayed contractionary effect. This may reflect adjustment dynamics, where past expansions in output eventually lead to temporary reversals in openness, potentially due to import substitution tendencies or cyclical corrections.

Turning to the autoregressive component, trade openness lagged one period (TO-1) is negative but insignificant, indicating a weak or negligible short-run persistence effect. However, the second lag of trade openness (TO-2) is negative and statistically significant, highlighting a tendency for short-term openness shocks to dissipate over two periods, possibly due to the corrective forces of trade balance adjustments.

3.4. Residual diagnostics

The Breusch-Godfrey LM test for serial correlation yields a p-value greater than 0.05 (Table 6 in Appendix), which means that the null hypothesis of no serial correlation cannot be rejected. In other words, the residuals of the estimated short-run ARDL model do not exhibit autocorrelation. The absence of autocorrelation, therefore, strengthens the validity of the estimation results, as it indicates that the lag structure of the model is appropriately specified and that the error term behaves like white noise. This enhances confidence in the robustness of the estimated coefficients and the overall reliability of the short-run dynamics captured by the model.

The Breusch-Pagan-Godfrey test for heteroskedasticity produces p-values above 0.05 for both the F-statistic and the Chi-square statistic (See Table 7 in Appendix). This implies that the null hypothesis of homoskedasticity cannot be rejected, meaning the variance of the residuals remains constant across observations. The absence of heteroskedasticity indicates that the model does not suffer from unequal error variances, which could otherwise distort the efficiency of the estimators and lead to unreliable hypothesis testing. Consequently, the homoskedastic nature of the residuals supports the reliability of the estimated coefficients and reinforces the robustness of the model's findings.

The Jarque-Bera test (See Figure 2 in Appendix) assesses whether the residuals of a model follow a normal distribution by examining their skewness and kurtosis. In this case, the test yields a p-value greater than 0.05, which means we fail to reject the null hypothesis of normality. This implies that the residuals of the model do not significantly deviate from a normal distribution, supporting the validity of standard statistical inferences, such as hypothesis tests and confidence intervals, that assume normality of errors. The normality of residuals also suggests that the model is well-specified and that extreme values or outliers are unlikely to distort the results.

The CUSUM test (See Figure 3 in Appendix) evaluates the stability of a model's coefficients by tracking the cumulative sum of residuals over time. In this case, the test shows that the cumulative sum remains within the critical bounds, indicating that the model's parameters do not experience significant structural changes throughout the sample period and that the model is stable. Similarly, the CUSUMSQ test (See Figure 4 in Appendix) examines the cumulative sum of squared residuals to detect sudden shifts in the variance of the residuals or instability in the coefficients. Since the cumulative sum of squared residuals also stays within the critical bounds, it confirms that the coefficients remain stable over time and that the model's parameters are consistently reliable across the sample period.

Based on the residual diagnostics, the model's residuals are homoscedastic, normally distributed, and free from significant autocorrelation. Stability tests further indicate that the model's coefficients remain stable over time. These results confirm that the model is well specified and appropriate for analyzing the relationships between trade openness, gross fixed capital formation, foreign direct investment, and GDP.

3.5. Discussion of the findings

The empirical results offer a nuanced perspective on the central research question: how does infrastructure development influence Morocco's trade openness over the period 1970–2023? The evidence shows that public investment in infrastructure, proxied by gross fixed capital formation, positively and significantly affects trade openness in the short run. This suggests that periods of increased infrastructure investment tend to coincide with greater external integration, likely through expanded productive capacity, reduced transaction costs, and improved competitiveness.

Despite this short-term effect, the ARDL bounds testing does not support a stable long-run relationship between infrastructure investment and trade openness. This may reflect several factors. Gross fixed capital formation measures the quantity of investment but not its efficiency,

quality, or sectoral allocation, which are critical for sustaining long-term openness. Moreover, Morocco's trade performance is influenced by broader factors, including institutional reforms, trade agreements, and global economic conditions, which can overshadow the isolated impact of infrastructure. The long study period also encompasses distinct developmental phases, from protectionist policies in the 1970s and 1980s, through structural adjustment in the 1990s, to large-scale infrastructure projects in the 2000s, suggesting that the effect of infrastructure on openness is likely context-dependent and may vary across sub-periods.

Complementing this, the analysis reveals that FDI does not significantly affect trade openness in the short run. Although foreign investment is generally expected to facilitate trade through capital, technology, and market access, its impact appears limited here. This may reflect the time needed for FDI to translate into trade-enhancing outcomes or the concentration of FDI in extractive and low-value-added sectors, which offer limited immediate contribution to openness.

GDP also exhibits complex dynamics in its relationship with trade openness. Rather than promoting immediate integration, past output expansions appear to generate short-term pressures that temporarily constrain openness. This could result from a domestic production bias toward local markets, import substitution, or structural bottlenecks in infrastructure, logistics, and industrial capacity. These dynamics imply that growth alone is insufficient to expand trade openness; the timing, sectoral composition, and absorptive capacity of the economy are crucial determinants of whether GDP growth supports or temporarily inhibits external integration.

Taken together, these findings partially validate the research hypothesis. Infrastructure investment does have a positive impact on Morocco's trade openness, but its effect appears short-lived rather than permanent. This highlights the catalytic role of infrastructure in fostering openness in the short run while underscoring the need for complementary policies, such as trade facilitation, institutional reforms, and regional integration, to sustain long-term gains. Future research should explore disaggregated measures of infrastructure, account for sectoral composition, and consider sub-period analyses to better capture the conditions under which infrastructure translates into durable trade openness.

Conclusion

This article set out to examine the extent to which infrastructure development has influenced Morocco's trade openness over the period 1970–2023. By combining a comprehensive theoretical framework with an econometric investigation based on the ARDL approach, the study provides a nuanced answer to the research question. The evidence shows that infrastructure investment, proxied by gross fixed capital formation, exerts a positive and statistically significant effect on trade openness in the short run. However, no robust long-run relationship is detected, suggesting that the contribution of infrastructure to Morocco's external integration is transitory rather than permanent.

These findings partially validate the research hypothesis: infrastructure positively influences trade openness, but its effect is largely short-term, with long-run performance shaped more by institutional reforms, trade facilitation, and global conditions. Moreover, neither FDI nor GDP automatically enhances openness in the short run, FDI may be limited by its sectoral concentration and delayed impact, while GDP growth can temporarily constrain trade due to domestic priorities and structural bottlenecks. Together, this underscores that sustained long-run trade integration requires complementary policies such as institutional reforms, trade facilitation policies, and global economic conditions.

From a policy perspective, the results underline the importance of combining infrastructure programs with broader strategies that enhance efficiency, competitiveness, and integration into global value chains. Investments in transport, logistics, and digital infrastructure should be complemented by institutional reforms and regional integration efforts to ensure sustained openness.

Finally, the study's limitations open avenues for future research. The reliance on aggregate investment data does not capture infrastructure quality, sectoral composition, or efficiency. Further work should therefore explore disaggregated infrastructure indicators and examine whether the effects vary across different phases of Morocco's development trajectory. Such refinements would provide a more complete understanding of the interplay between infrastructure and trade openness in Morocco and beyond.

APPENDICES

Note that the source of all figures in the Appendix is Author’s calculations using Eviews 12.

Table N°6 : Residual Autocorrelation Test (Breusch-Godfrey LM Test)

Breusch-Godfrey Serial Correlation LM Test:				
Null hypothesis: No serial correlation at up to 2 lags				
F-statistic	Obs*R-squared	0.091460	Prob. F(2,40)	0.9128
		0.232162	Prob. Chi-Square(2)	0.8904
Variable	Coefficient	Std. Error	t-Statistic	Prob.
DTO(-1)	0.082277	0.246209	0.334175	0.7400
DTO(-2)	0.001665	0.229099	0.007265	0.9942
DGFCF	-0.008674	0.337238	-0.025720	0.9796
DFDI	-0.040740	0.601282	-0.067754	0.9463
GDP	-0.003417	0.238010	-0.014355	0.9886
GDP(-1)	0.007934	0.262392	0.030237	0.9760
GDP(-2)	0.012908	0.249017	0.051838	0.9589
GDP(-3)	0.050579	0.286439	0.176577	0.8607
C	-0.380750	2.455458	-0.155062	0.8776
RESID(-1)	-0.118998	0.282996	-0.420494	0.6764
RESID(-2)	0.001199	0.266848	0.004495	0.9964
R-squared	0.004552	Mean dependent var		5.79E-16
Adjusted R-squared	-0.244310	S.D. dependent var		4.806741
S.E. of regression	5.361854	Akaike info criterion		6.384923
Sum squared resid	1149.979	Schwarz criterion		6.801591
Log likelihood	-151.8155	Hannan-Quinn criter.		6.544144
F-statistic	0.018292	Durbin-Watson stat		1.985046
Prob(F-statistic)	1.000000			

Table N° 7: Heteroskedasticity Test (Breusch-Pagan-Godfrey Test)

Heteroskedasticity Test: Breusch-Pagan-Godfrey Null hypothesis: Homoskedasticity				
F-statistic Obs*R-squared	0.811361	Prob. F(8,42)		0.5966
Scaled explained SS	6.826753	Prob. Chi-Square(8)	Prob. Chi-Square(8)	0.5554
	5.190689	Square(8)		0.7370
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	34.96301	14.84098	2.355842	0.0232
DTO(-1)	0.513015	0.897476	0.571620	0.5706
DTO(-2)	-1.247589	1.025983	-1.215994	0.2308
DGFCF	-0.188066	2.129010	-0.088335	0.9300
DFDI	-2.091570	3.836149	-0.545226	0.5885
GDP	0.803803	1.541748	0.521358	0.6049
GDP(-1)	1.074538	1.697871	0.632874	0.5302
GDP(-2)	-2.829879	1.579851	-1.791231	0.0805
GDP(-3)	-1.907009	1.670299	-1.141717	0.2600
R-squared	0.133858	Mean dependent var		22.65172
Adjusted R-squared	-0.031122	S.D. dependent var		34.25647
S.E. of regression	34.78544	Akaike info criterion		10.09506
Sum squared resid	50821.13	Schwarz criterion		10.43597
Log likelihood	-248.4240	Hannan-Quinn criter.		10.22533
F-statistic	0.811361	Durbin-Watson stat		1.932566
Prob(F-statistic)	0.596556			

Figure N° 2: Residual Normality Test (Jarque-Bera Test)

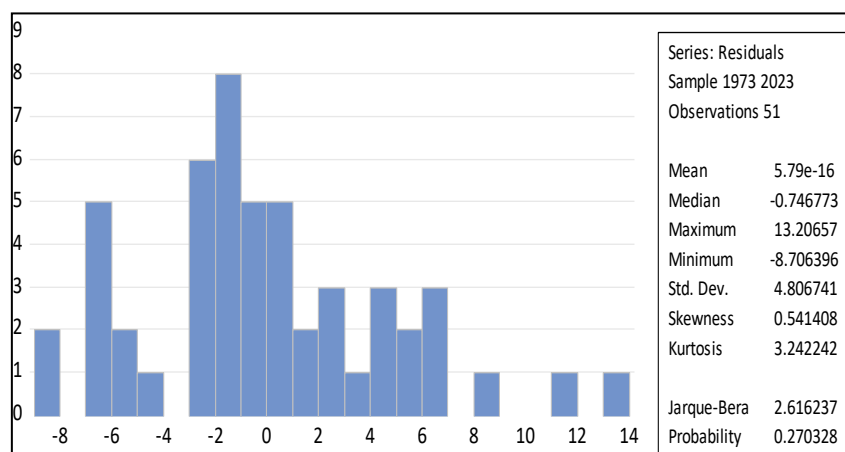


Figure N° 3: CUSUM Test for Model Stability

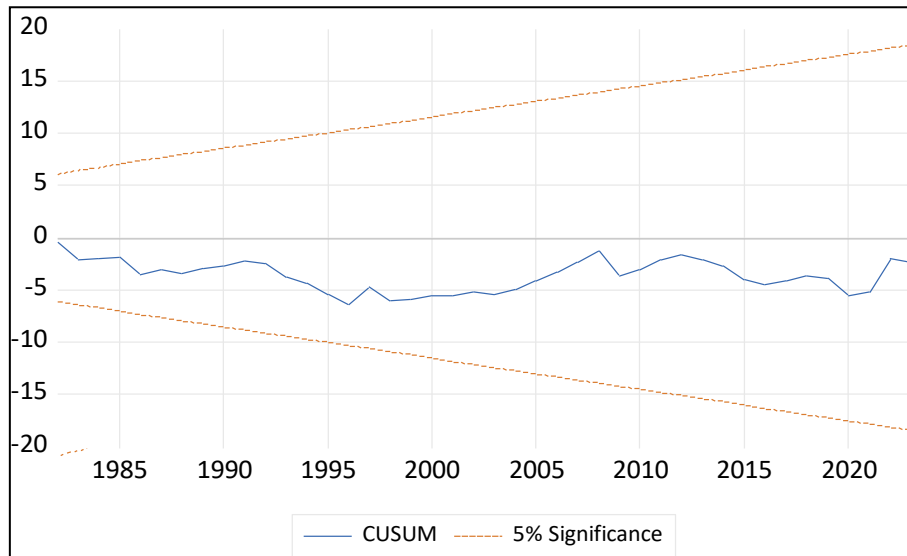
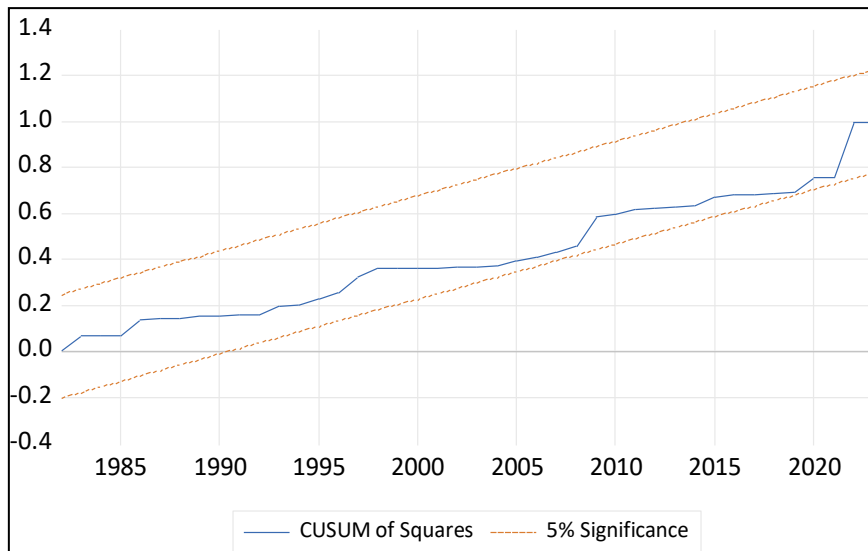


Figure N° 4: CUSUMSQ Test for Model Stability



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