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Trade openness, institutional quality and FDI: what impact on trade balances of North African countries? An analysis of panel data

Ouverture commerciale, qualité institutionnelle et IDE : quel impact sur les balances commerciales des pays d'Afrique du Nord ? Une analyse des données de panel

Nabil EL HAMIDI
PhD; Cadi Ayyad University Marrakesh, Morocco

Mohamed ED-DIB
PhD; Hassan II University Casablanca, Morocco

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Abstract
This study examines the impact of trade openness, foreign direct investment, and institutional quality on the trade balance of North African countries (Morocco, Algeria, Tunisia, Libya, and Egypt) from 2000 to 2018. Using an econometric methodology based on panel data, the analysis explores both the direct effects of these dimensions and their combined interactions, employing robust least squares (RLS) regression. The results show that, in isolation, trade openness does not have a significant effect on the trade balance, indicating that its effectiveness depends on the support of complementary policies and a favorable institutional environment. In contrast, FDI has a positive direct effect, enhancing exports and integration into global value chains. Institutional quality plays a central role in amplifying the positive effects of both trade openness and FDI, through better governance, increased transparency, and political stability. The interactions between these dimensions reveal significant synergies. The tripartite interaction between trade openness, FDI, and institutional quality has a significant and positive combined effect, highlighting the need for integrated public policies to maximize the benefits of these levers. This research highlights the limitations of fragmented approaches and advocates for the strategic coordination of trade, FDI attraction, and institutional reform policies.
Keywords: trade balance, trade openness, FDI, institutional quality, North Africa.
JEL Classification : F14, F21, F50.
Résumé
Cette étude examine l'impact de l'ouverture commerciale, des investissements directs étrangers (IDE) et de la qualité institutionnelle sur la balance commerciale des pays d'Afrique du Nord (Maroc, Algérie, Tunisie, Libye et Égypte) de 2000 à 2018. En utilisant une méthodologie économétrique basée sur des données de panel, l'analyse explore à la fois les effets directs de ces dimensions et leurs interactions combinées, en employant une régression robuste des moindres carrés (RLS).
Les résultats montrent qu'isolément, l'ouverture commerciale n'a pas d'effet significatif sur la balance commerciale, ce qui indique que son efficacité dépend du soutien de politiques complémentaires et d'un environnement institutionnel favorable. En revanche, les IDE ont un effet direct positif, renforçant les exportations et l'intégration dans les chaînes de valeur mondiales. La qualité institutionnelle joue un rôle central en amplifiant les effets positifs de l'ouverture commerciale et des IDE, grâce à une meilleure gouvernance, une transparence accrue et une stabilité politique.
Les interactions entre ces dimensions révèlent des synergies significatives. L'interaction tripartite entre l'ouverture commerciale, les IDE et la qualité institutionnelle a un effet combiné significatif et positif, soulignant la nécessité de politiques publiques intégrées pour maximiser les bénéfices de ces leviers. Cette recherche met en lumière les limites des approches fragmentées et plaide en faveur d'une coordination stratégique des politiques commerciales, d'attraction des IDE et de réforme institutionnelle.
Mots-clés : balance commerciale, ouverture commerciale, IDE, qualité institutionnelle, Afrique du Nord.
Classification JEL : F14, F21, F50.

Introduction

The economies of North Africa, consisting of Morocco, Algeria, Tunisia, Libya, and Egypt, occupy a strategic position in global trade and attract significant foreign direct investment flows. These countries, rich in natural resources and endowed with a diverse economic potential, have gradually adopted trade liberalization policies to better integrate into global value chains. However, the impacts of this openness on their economic performance, particularly on the trade balance, depend on multiple factors such as FDI flows and institutional quality. The trade balance, a key indicator of a country's economic health, is influenced by a variety of structural and cyclical factors. While trade openness aims to improve export performance, it can also increase the vulnerability of local economies to imports.

Moreover, FDI, often considered a catalyst for development, only produces optimal results in a favorable institutional environment. Indeed, strong institutions ensure better governance, reduce corruption, and enhance the attractiveness of economies for foreign investors. This paper proposes an analysis of the interaction between trade openness, FDI, and institutional quality, and their combined impact on the trade balance of North African countries. Through an econometric methodology based on panel data covering the period 2000-2018, this study explores the direct and interactive effects of these three dimensions. The main objective is to assess to what extent trade policies and FDI attraction strategies, combined with institutional reforms, can improve trade performance and strengthen the regional and global integration of these economies.

1. Literature review

Soeng and Cuyvers (2018) emphasize that weak institutions limit trade integration, while demonstrating that institutional quality can enhance exports and attract FDI. These findings highlight the importance of combining trade openness with robust institutional reforms to improve trade balances, particularly by increasing the confidence of foreign investors. Knack and Keefer (1995) complement this perspective by showing that reducing corruption and strengthening governance attract foreign direct investment, which stimulates export diversification and competitiveness, while reducing dependence on imports. In the African context, Ngepah and Udeagha (2018) highlight that regional trade agreements, when accompanied by adequate institutional quality, can improve trade balances through better regional integration. However, they warn that weak institutions may exacerbate imbalances, limiting the positive effects of FDI. On their part, Huchet-Bourdon, Le Mouël, and Vijil (2018) stress the importance of strong institutions to fully benefit from trade openness, which includes better management of trade flows and the reduction of trade barriers, with positive impacts on trade balances.

Bajo-Rubio and Esteve (2016) analyze the effect of FDI on export competitiveness in southern Europe. Their study indicates that foreign investments targeting high-performing companies can support exports and reduce trade deficits, even without a direct link to exchange rate fluctuations. In Asia, Yogatama and Hastiadi (2016) highlight the role of governance and institutional reforms in improving Indonesian exports. Effective governance reduces trade costs and strengthens economic relations with international partners, while increasing the country's attractiveness for FDI. Frankel and Romer (1999) establish that trade openness promotes specialization and allows countries to maximize their comparative advantages, thus contributing to an improvement in trade balances through more efficient exchanges. Dollar and Kraay (2003) show that the interaction between high institutional

quality and increased trade openness not only supports economic growth but also improves trade balances by enhancing FDI attractiveness. Robust institutions play a key role in leveraging the economic benefits of trade and FDI.

Anderson and Marcouiller (2002) highlight that weak institutions, characterized by high levels of corruption, hinder international trade. By emphasizing the importance of clear rules and institutional transparency, they demonstrate that these elements help reduce transaction costs, increase trade flows, and thus improve trade balances by attracting more foreign direct investment. In this regard, Adeniyi, Omisakin, and Oyinlola (2015) emphasize the role of institutions in optimizing the benefits of trade openness and FDI. They observe that in emerging economies, a strong institutional infrastructure maximizes the positive impacts of these flows on trade balances, particularly by stabilizing trade and limiting fluctuations related to exchange rates. Ozawa (1992) links the improvement of countries' comparative advantages to a synergy between FDI and trade openness. He argues that this combination, supported by strong institutional policies, stimulates exports and reduces dependence on imports. According to him, enhanced institutional quality aligns FDI with national economic priorities, thereby consolidating trade performance. In a similar vein, Hakimi and Hamdi (2016) emphasize the complementarity between trade openness and FDI flows. They observe that institutional quality acts as an essential moderating factor, amplifying the positive outcomes of these interactions on trade balances, while supporting economic growth.

Gani and Prasad (2006) examine this link in the specific context of Pacific island countries, where they find that effective institutions allow for better control of imports and stimulation of exports. This dynamic, strengthened by institutional quality, helps improve trade balances and supports overall economic performance. In a complementary analysis, Gnangnon (2017) explores how FDI, in the presence of a solid institutional framework, promotes trade liberalization and reduces trade barriers. These conditions enable better stability of trade balances, particularly in countries at different levels of economic development. Boutabba (2014) focuses on the interactions between financial development, trade openness, and institutional quality. He highlights that strengthening institutions is essential to maximize the long-term benefits of trade openness on trade balances. This perspective is also supported by Matthew and Adegboye (2014), who examine the impact of these dynamics in Sub-Saharan Africa. They conclude that while trade openness has a positive effect, it remains limited without adequate institutional support. In contrast, strong institutions promote better management of trade flows, indirectly contributing to the stability and performance of trade balances.

Dung (2017) illustrates the effect of trade openness on the trade balance in the long term. By further integrating into the global market, openness stimulates exports, but simultaneously increases imports, particularly in economies where supporting industries remain underdeveloped. This increased dependence on foreign inputs and technologies constitutes a structural challenge. Mwito, Mkenda, and Luvanda (2017) build on this by showing that the impact of openness on trade balances largely depends on the robustness of institutions. When institutions do not support a balanced trade policy framework, the beneficial effects of openness remain limited. Méon and Sekkat (2008) analyze how strong institutions positively influence trade balances. By promoting the export of manufactured goods and facilitating the import of intermediate goods, they allow for an overall improvement in trade. Belloumi (2014) extends this observation by linking trade openness to financial development, emphasizing how efficient resource allocation strengthens financial institutions, particularly in developing countries. Gruber and Kamin (2007) examine current account imbalances and

attribute a limited influence of institutions on major deficits, such as that of the United States. However, they note that deficient institutional quality can exacerbate these deficits through poor resource allocation.

Tran (2018), in the context of emerging economies, highlights that FDI can paradoxically worsen the trade balance due to the increased importation of intermediate goods and equipment, a phenomenon exacerbated by the low transfer of technology to local industries. Rahman (2008) explores the chronic deficits of new EU member states. While trade openness and rapid integration stimulate exports, they also exacerbate trade deficits in the absence of an institutional framework capable of effectively regulating financial flows. Aizenman and Noy (2005) emphasize the importance of institutions in the relationship between FDI and trade. They note that while FDI increases productivity and exports, it also induces a dependence on imports, with this dynamic influenced by institutional governance. Finally, Ullah and Yasmeen (2014) show that trade openness attracts FDI and simultaneously improves exports, provided that the host country's institutional quality is sufficient. This interaction highlights the need for effective governance to maximize the benefits of FDI and openness on trade balances. Based on these elements, the following research hypotheses can be constructed:

- ***H1: A greater trade openness has a significant effect on improving the trade balance.***
- ***H2: Inbound foreign direct investment has a significant impact on the trade balance.***
- ***H3: Better institutional quality enhances the effect of trade openness and foreign direct investment on the trade balance.***
- ***H4: The interaction between trade openness and foreign direct investment has a positive effect on the trade balance.***
- ***H5: The interaction between foreign direct investment and institutional quality has a positive impact on the trade balance.***
- ***H6: The interaction between trade openness and institutional quality positively influences the trade balance.***
- ***H7: The tripartite interaction between trade openness, foreign direct investment, and institutional quality has a combined positive effect on the trade balance.***

2. Methodology

2.1. Research hypotheses and model

To analyze the impact of trade openness, foreign direct investment, and institutional quality on the trade balance of North African countries, this study adopts an econometric methodology based on panel data covering the period 2000-2018. The econometric model is specified as follows:

$$\begin{aligned} BLCMit = {} & \beta 0 + \beta 1.OPENit + \beta 2.FDINit + \beta 3.INSTit + \beta 4.OPENit.FDINit \\ & + \beta 5.FDINit.INSTit + \beta 6.OPENit.INSTit \\ & + \beta 7.OPENit.FDINit.INSTit + \beta 8.EXPOit + \beta 9.REERit \\ & + \beta 10.GDPit + \varepsilon it \end{aligned}$$

The trade balance (BLCM), measured as a percentage of GDP or in millions of USD, is the dependent variable. The main explanatory variables include the degree of trade openness (OPEN), measured by the ratio of trade (the sum of exports and imports) to GDP, inbound foreign direct investment (FDIN), expressed as a percentage of GDP, and the institutional quality index (INST), which assesses dimensions such as governance and political stability. Additionally, control variables are represented by the share of manufactured exports in total

exports (EXPO), the real effective exchange rate (REER), which measures external competitiveness, and real GDP (GDP), an indicator of overall economic capacity.

2.2. Data (North Africa panel)

The study relies on a panel consisting of five North African countries: Morocco, Algeria, Tunisia, Libya, and Egypt. These countries were selected due to their strategic position and significant role in trade exchanges and foreign direct investment flows in the region. They also offer diversity in terms of governance and institutional quality, enabling an analysis of the interactions between trade openness, FDI, and institutions. The data covers a sufficiently long time period to capture economic and institutional dynamics, while allowing for the analysis of trends and relationships between the studied variables. The primary data sources include the Worldwide Governance Indicators (WGI), which provide detailed indices on governance, and Transparency International, which assesses levels of corruption and transparency. Additionally, economic data comes from the World Bank and the International Monetary Fund (IMF), ensuring comprehensive coverage of the macroeconomic indicators necessary for the study.

2.3. Choice of empirical methodology

The panel data from the five North African countries have been converted to quarterly data. The Levin, Lin & Chu stationarity test (Table 1), based on automatic lag selection according to the Akaike Information Criterion (AIC), is provided in Table 1. The dependent variable, the trade balance (BLCM), is stationary without requiring differentiation, corresponding to an integration order of 0. Among the main explanatory variables, the degree of trade openness (OPEN) becomes stationary after a first-order differentiation, while foreign direct investments (FDIN) and the institutional quality index (INST) require a third-order differentiation. The interactions OPEN.FDIN, FDIN.INST, and OPEN.FDIN.INST are all stationary without differentiation, at an integration order of 0, while the interaction OPEN.INST is stationary after a first-order differentiation. Regarding the control variables, manufacturing exports (EXP) and gross domestic product (GDP) become stationary after a first-order differentiation. The real effective exchange rate (REER), on the other hand, is stationary at an integration order of 2.

Table 1: Levin, Lin & Chu test

Variables	Statistique du Test Levin, Lin & Chu t	Prob.	Order of integrat
BLCM	-19,9974513	0.0000	0
OPEN	-20,7045793	0.0000	1
FDIN	-14,2590155	0.0000	3
INST	-13,2304145	0.0000	3
OPEN.FDIN	-9,62602257	0.0000	0
FDIN.INST	-18,8585629	0.0000	0
OPEN.INST	-13,7898423	0.0000	1
OPEN.FDIN.INST	-24,1720812	0.0000	0
EXP	-21,818418	0.0000	1
REER	-15,7644783	0.0000	2
GDP	-17,9150397	0.0000	1

Source : authors

Table 2 presents the VIFs for the explanatory variables of the econometric model, allowing for the evaluation of the degree of collinearity. The centered VIFs for the main variables (OPEN, FDIN, INST) range between 17.68 and 18.92, indicating notable collinearity. This situation is expected in models where interaction variables, such as OPEN.FDIN or FDIN.INST, are introduced, as these interactions are often correlated with the main variables that make them up. The VIFs for the interaction terms, specifically OPEN.FDIN, FDIN.INST, and OPEN.FDIN.INST, reach higher levels (29.31, 29.40, and 34.91, respectively). These values reflect strong collinearity, but they are normal in this type of modeling.

Table 2: Variance Inflation Factors / MCO

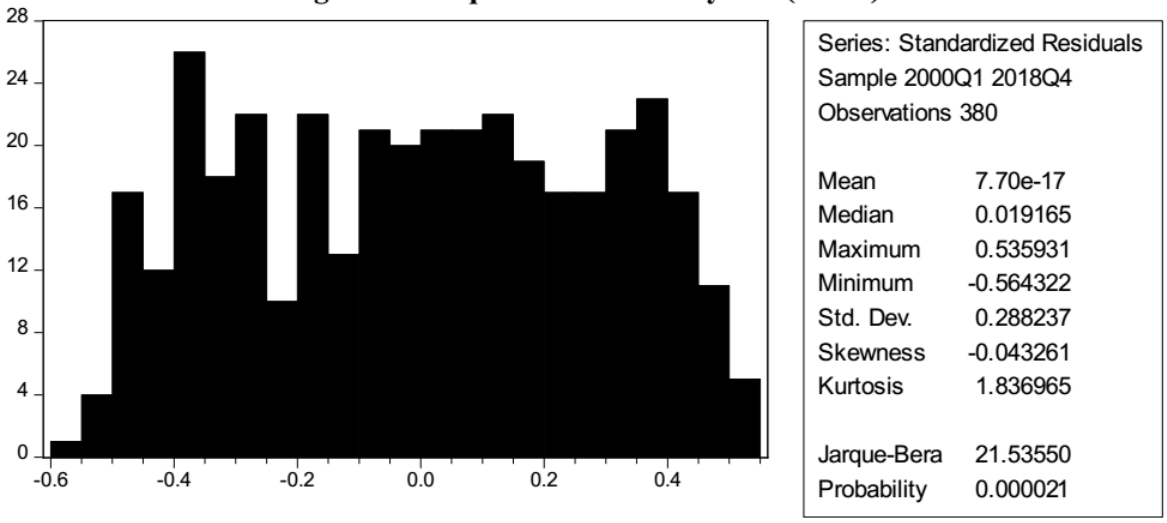
Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.020962	91.93344	NA
OPEN	0.051275	75.93596	18.07426
FDIN	0.053623	86.28785	18.92150
INST	0.052068	75.33440	17.68375
OPEN.FDIN	0.134333	72.45912	29.30831
FDIN.INST	0.146546	73.92418	29.40510
OPEN.INST	0.145407	66.14350	27.03296
OPEN.FDIN.INST	0.399785	64.56813	34.91651
EXPO	0.002780	4.144097	1.015562
REER	0.002725	4.016823	1.013769
GDP	0.002818	3.791089	1.033886

Source : authors

The interaction terms, by construction, are directly dependent on the main variables, which mechanically increases collinearity without necessarily compromising the validity of the model. This collinearity is a structural characteristic rather than an issue to be resolved. In contrast, the control variables (EXPO, REER, GDP) have very low centered VIFs, below 1.05, indicating an absence of problematic collinearity. This ensures that these variables do not introduce excessive dependencies into the model and contribute independently to the estimates.

The histogram illustrates the distribution of the standardized residuals (Figure 1) from the ordinary least squares (OLS) estimation. Although the residuals have a mean close to zero and a median of 0.019, indicating no systematic bias, their distribution does not follow strict normality. This deviation is confirmed by the Jarque-Bera test, which gives a statistic of 21.535 with an associated probability of 0.000021. This value strongly rejects the null hypothesis of normality. The skewness (-0.043) indicates a slight leftward asymmetry, and the kurtosis (1.837) shows a distribution that is flatter compared to a normal distribution. These results signal that the residuals do not have the expected concentration around the mean and have shorter tails, characteristics that deviate from the properties of normality. Non-normality can impact the validity of statistical inferences, particularly regarding tests based on the residuals.

Figure 1: Jarque-Bera normality test (MCO)



Source : authors

The presence of collinearity and non-normality of the residuals in the obtained results justifies the use of Robust Least Squares (RLS) regression. Regarding collinearity, the interaction terms in the model, such as OPEN.FDIN and OPEN.FDIN.INST, mechanically introduce significant linear dependence among the main explanatory variables. This collinearity can amplify biases and make the coefficients unstable, especially if certain observations exert disproportionate influence. The RLS method adjusts the weighting of the observations, reducing the impact of data that exacerbate collinearity problems and stabilizing the coefficient estimates. At the same time, the non-normality of the residuals identified by the Jarque-Bera test may be associated with extreme values, heteroscedasticity, or complex data structures. These characteristics can bias statistical inferences and affect the validity of the model.

The RLS method is particularly suited in such contexts, as it detects and effectively handles outliers while minimizing distortions in the estimates. By differently weighting observations based on their influence, RLS produces more robust coefficients, thereby reducing the combined impact of collinearity and non-normality. Overall, while collinearity is not directly targeted by the RLS method, its adaptive properties make it an effective solution in situations where combined issues of collinearity, non-normality of residuals, and outliers are present.

3. Robustness

Table 3 presents the results of the Ramsey RESET Test, which is used to check the functional specification of the estimated econometric model. This test assesses whether important variables, such as nonlinear terms or additional interactions, have been omitted. The results include a t-statistic of 1.153 with an associated probability of 0.2496, an F-statistic of 1.330 with the same probability, and a likelihood ratio statistic of 1.371 with a probability of 0.2417. These values indicate that the null hypothesis of correct model specification cannot be rejected at the 5% threshold, suggesting that the model is generally well-specified.

Table 3: Ramsey RESET Test results for functional specification (RLS)

Ramsey RESET Test				
Specification: BLCM C OPEN FDIN INST OPEN.FDIN FDIN.INST OPEN.INST OPEN.FDIN.INST EXPO REER GDP				
Omitted Variables: Squares of fitted values				
	Value	df	Probability	
t-statistic	1.153098	368	0.2496	
F-statistic	1.329634	(1, 368)	0.2496	
Likelihood ratio	1.370518	1	0.2417	

Source : authors

Table 4 presents the results of the VIFs calculated after applying Robust Least Squares (RLS) regression. Unlike the ordinary least squares (OLS) results analyzed previously, where the centered VIFs for the main variables (OPEN, FDIN, INST) were high, ranging from 17 to 18, and where interaction terms such as OPEN.FDIN or OPEN.FDIN.INST exceeded 29 to 34, the current results show much lower centered VIFs. In the RLS framework, the centered VIFs range between 1.01 and 1.04 for all explanatory variables, including the interaction terms, indicating a near absence of significant collinearity. This improvement can be attributed to the properties of the RLS method, which adjusts the weighting of observations to reduce the influence of linear dependencies between explanatory variables and potential outliers. In comparison, OLS exhibited high collinearity, making the coefficients less stable and prone to bias, especially in models that include multiple interaction terms strongly correlated with the main variables.

Table 4: Variance Inflation Factors / RLS

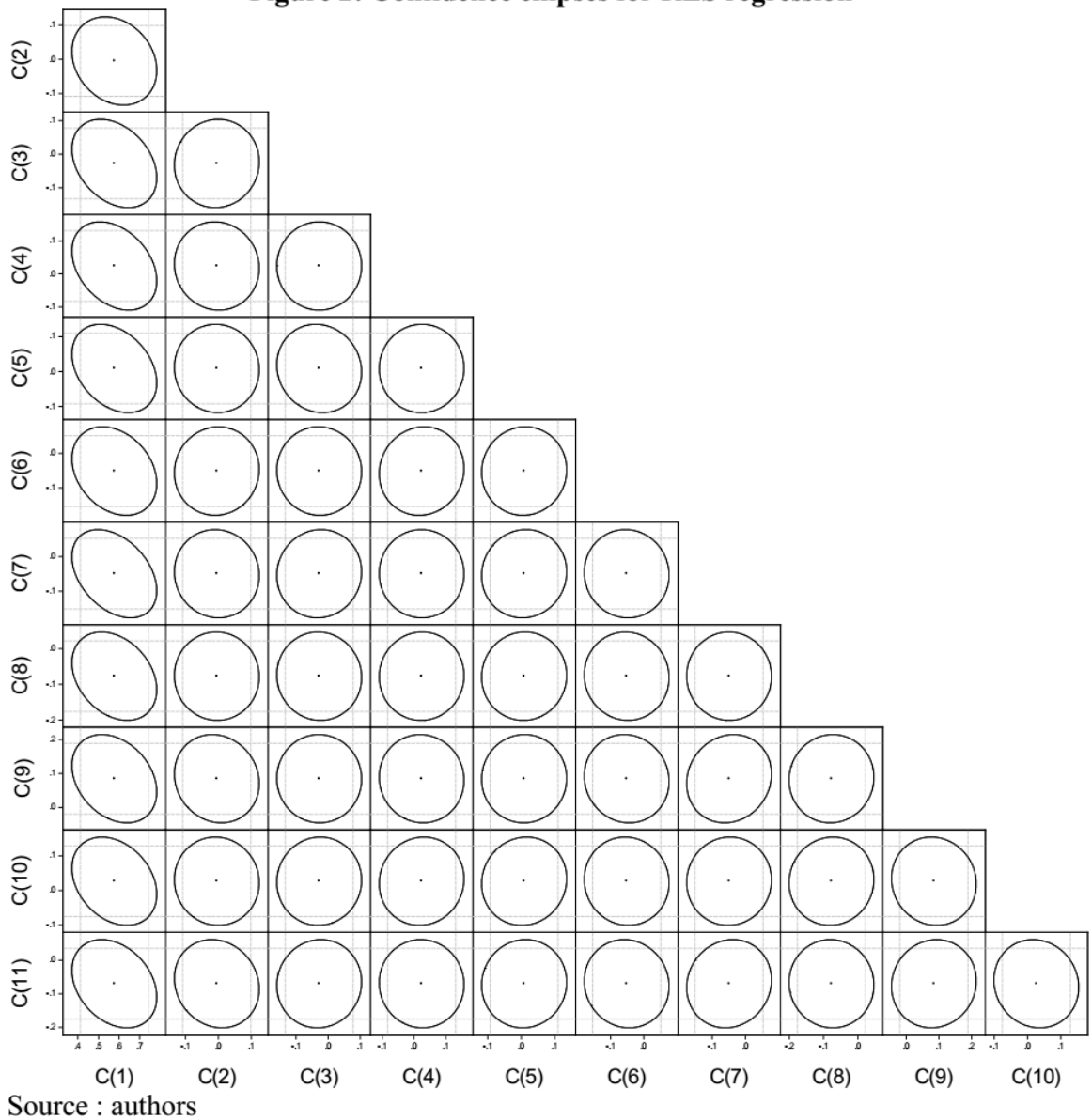
Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	0.006985	31.27102	NA
OPEN	0.002755	4.173993	1.034733
FDIN	0.002873	4.252647	1.014352
INST	0.002963	4.453040	1.011200
OPEN.FDIN	0.002669	3.802859	1.016214
FDIN.INST	0.002707	4.083489	1.016791
OPEN.INST	0.002705	4.104404	1.024109
OPEN.FDIN.INST	0.002543	3.959929	1.005734
EXPO	0.002790	4.238593	1.034875
REER	0.002685	3.891162	1.025033
GDP	0.002882	4.374912	1.039119

Source : authors

This method limits distortions introduced by influential observations or complex data structures. It ensures greater robustness of the coefficients and allows for more reliable statistical inferences. Figure 2 presents the confidence ellipse matrix for the Robust Least Squares regression. The shapes of the ellipses provide crucial information about collinearity: narrow and tilted ellipses indicate a strong correlation, while wide and nearly circular ellipses signal a weak correlation. In this figure, the majority of the ellipses are relatively wide and nearly circular, suggesting a low linear dependence between the explanatory variables. This observation indicates the absence of concerning collinearity in the model. Even for the

interaction terms, such as OPEN.FDIN, FDIN.INST, and OPEN.FDIN.INST, the ellipses are not particularly narrow, confirming that the linear relationships between these terms and their main components remain moderate.

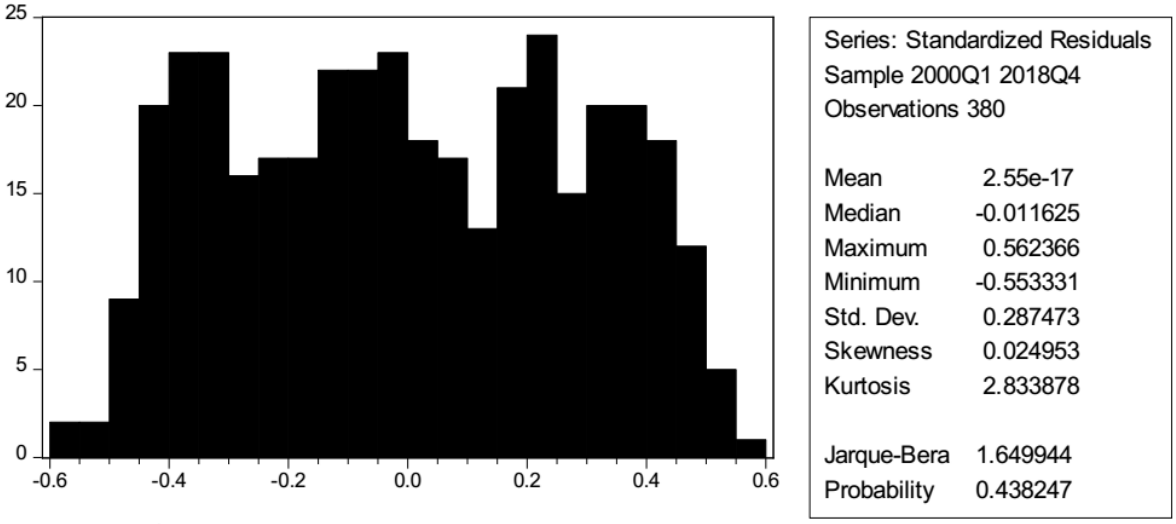
Figure 2: Confidence ellipses for RLS regression



Source : authors

Figure 3 presents the histogram of standardized residuals from the Robust Least Squares (RLS) estimation. The statistical characteristics show that the mean of the residuals is close to zero, and the median is also low (-0.0116), indicating no systematic bias in the predictions. The standard deviation is 0.287, indicating a moderate dispersion of the residuals around their mean. The skewness (0.0249) is close to zero, signaling a symmetric distribution, while the kurtosis (2.833) is slightly below 3, suggesting a distribution that is slightly less flat than a perfect normal distribution. The Jarque-Bera test gives a statistic of 1.6499 with a probability of 0.4382. This high probability fails to reject the null hypothesis that the residuals follow a normal distribution. Although normality is not required for RLS, it enhances confidence in the obtained results.

Figure 3: Jarque-Bera normality test (RLS)



Source : authors

Table 5 presents the results of the autocorrelation and partial correlation tests for the residuals in the RLS regression. The autocorrelation (AC) and partial autocorrelation (PAC) coefficients show low values for the different lags, suggesting the absence of significant linear dependence in the residuals. For example, for the first lags, the AC and PAC coefficients are close to zero (0.050 for lag 1, 0.000 for lag 2), and the associated Q-Stat statistics are low (0.9588 and 0.9589, respectively), with high probabilities (greater than 0.3), indicating that the null hypothesis of no autocorrelation cannot be rejected. At higher lags, some coefficients (e.g., -0.135 at lag 7) show slight variations, but the probabilities associated with the Q-Stat statistics remain high overall (e.g., 0.088 at lag 7 and 0.110 at lag 8), suggesting that these variations are not statistically significant.

Table 5: Test of autocorrelation and partial correlation of residuals for RLS

Lag	AC	PAC	Q-Stat	Prob
1	0.050	0.050	0.9588	0.327
2	0.000	-0.002	0.9589	0.619
3	0.065	0.065	2.5969	0.458
4	-0.079	-0.086	4.9762	0.290
5	-0.022	-0.013	5.1630	0.396
6	-0.020	-0.023	5.3169	0.504
7	-0.135	-0.123	12.397	0.088
8	0.041	0.052	13.064	0.110
9	0.032	0.026	13.455	0.143
10	-0.037	-0.027	13.995	0.173
11	-0.013	-0.036	14.056	0.230
12	0.017	0.019	14.172	0.290
13	0.031	0.035	14.543	0.337
14	-0.056	-0.078	15.772	0.327
15	0.012	0.027	15.829	0.393
16	0.038	0.040	16.420	0.424

Source : authors

The results for the lags up to 16 confirm this trend, with Q-Stat values progressing moderately (up to 16.420) and probabilities remaining above 0.05. In summary, the results show an absence of significant autocorrelation in the residuals for all the tested lags. These observations reinforce the validity of the RLS model by confirming that the residuals are independent, which is an important condition for ensuring reliable and robust statistical inferences.

Table 6 presents the results of the Harvey heteroscedasticity test. This test evaluates whether the variance of the residuals is constant or varies with the explanatory variables. The results show an F-statistic of 0.878434 with an associated probability of 0.5536, indicating that the null hypothesis of homoscedasticity (constant variance) cannot be rejected. Similarly, the Chi-squared statistic based on Obs.R-squared is 8.835855 with a probability of 0.5477, and the statistic based on the Scaled Explained SS is 8.366856 with a probability of 0.5931. These high probabilities also confirm the absence of significant heteroscedasticity in the residuals. Thus, these results suggest that the RLS model satisfies the homoscedasticity assumption.

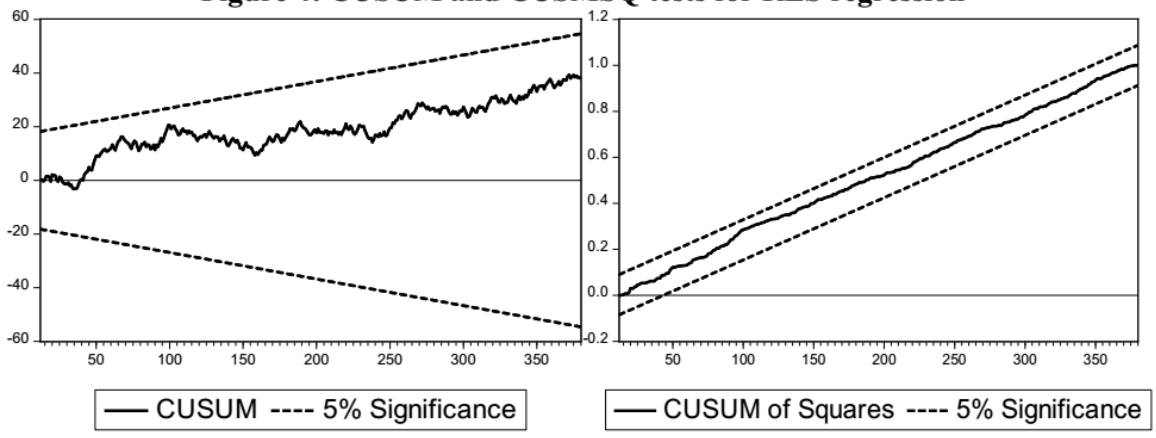
Table 6: Diagnosis of heteroscedasticity (Test: Harvey) for RLS regression

Heteroskedasticity Test: Harvey			
F-statistic	0.878434	Prob. F(10,369)	0.5536
Obs.R-squared	8.835855	Prob. Chi-Square(10)	0.5477
Scaled explained SS	8.366856	Prob. Chi-Square(10)	0.5931

Source : authors

The figure 4 shows the results of the stability tests for the estimated coefficients, based on the CUSUM and CUSUM of Squares statistics for the Robust Least Squares Regression. These tests assess the structural stability of the model over the entire sample. In the first graph (CUSUM), the curve representing the CUSUM statistic stays within the 5% confidence limits (denoted by dashed lines). This indicates that the model's coefficients remain stable over the observed sample, with no major structural break in the modeled relationships.

Figure 4: CUSUM and CUSMSQ tests for RLS regression



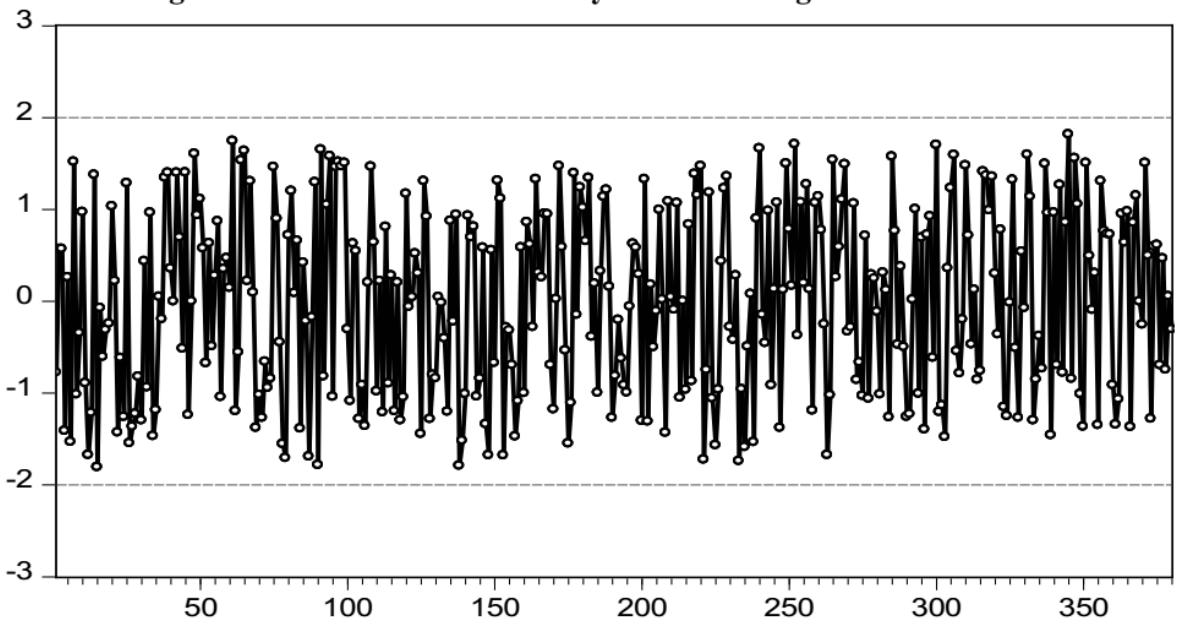
Source : authors

In the second graph (CUSUM of Squares), the curve also follows a path within the confidence limits, confirming the absence of unstable variance or structural changes in the model's coefficients. This reinforces the hypothesis that the model is well-specified and consistent throughout the analyzed period. Overall, both tests confirm the structural stability of the RLS model, suggesting that the relationships between the explanatory variables and the dependent

variable remain constant throughout the sample. These results strengthen the validity of the estimates and the robustness of the conclusions drawn from this econometric model.

Figure 5 presents the series of standardized residuals (RStudent). It provides a visual assessment of the independence and homoscedasticity of the residuals. The values of the residuals mostly oscillate between -2 and 2, which is in line with expectations for standardized residuals.

Figure 5: Influence statistics analysis for RLS regression: RStudent



Source : authors

The distribution of the residuals appears random and does not show any obvious trend or repetitive structure, indicating that the residuals are independent. Moreover, their amplitude remains relatively constant throughout the sample, suggesting the absence of heteroscedasticity. The few points near the upper and lower limits (-2 and 2) do not seem to represent a significant proportion of the total, indicating a relatively normal distribution without an excessive presence of outliers. Therefore, the visual analysis of the standardized residuals confirms that the RLS model satisfies the assumptions of independence and homoscedasticity of the residuals, strengthening the robustness and validity of the results obtained.

4. Results

The study examines the impact of trade openness, foreign direct investment, and institutional quality on the trade balance of North African countries: Morocco, Algeria, Tunisia, Libya, and Egypt. The methodology relies on panel data analysis covering an extended period from 2000 to 2018, with data sourced from reliable indicators such as the Worldwide Governance Indicators, Transparency International, the World Bank, and the IMF. Stationarity tests confirm the integration of the data at various orders, and robust least squares regression (RLS) is used to address issues of multicollinearity and non-normality of the residuals. Structural stability tests, particularly the CUSUM and CUSUM of Squares, confirm that the modeled relationships remain consistent across the entire sample, demonstrating the absence of significant structural breaks.

Harvey's heteroscedasticity test validates the homoscedasticity hypothesis, showing constant variance of the residuals in the RLS model. Additionally, autocorrelation and partial correlation tests of the residuals indicate significant independence, excluding any problematic linear dependence in the residuals across different time lags. The residuals' normality test using Jarque-Bera, applied to the RLS model, shows a symmetric distribution close to normality, enhancing the credibility of the results. Finally, the Ramsey RESET functional specification test confirms that the model is well-specified, with no omission of key variables or significant nonlinear effects.

Table 7: RLS regression results for the North Africa panel

Dependent Variable: BLCM				
Method: Robust Least Squares				
Sample: 2000Q1 2018Q4				
Included observations: 380				
Method: M-estimation				
M settings: weight=Bisquare, tuning=4.685, scale=MAD (median centered)				
Huber Type I Standard Errors & Covariance				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	33.507293	5.948306	5.633081	***0.0000
OPEN	-5.273078	4.010010	-1.314979	0.1893
FDIN	8.916479	4.661384	1.912839	*0.0565
INST	3.002998	1.254955	2.392912	**0.0172
OPEN.FDIN	33.279814	12.616249	2.637853	***0.0087
FDIN.INST	38.481811	10.246452	3.755623	***0.0002
OPEN.INST	29.299270	9.919771	2.953624	***0.0033
OPEN.FDIN.INST	26.977062	10.890620	2.477092	**0.0137
EXPO	13.159621	8.093748	1.625900	0.1048
REER	-3.308853	1.777483	-1.861539	*0.0634
GDP	8.012322	3.427127	2.337912	**0.0199

Source: authors; ***Significant at 1%; **Significant at 5%; *Significant at 10%.

The results (Table 7) reveal that trade openness (OPEN) has no significant impact on the trade balance ($p = 0.1893$). The negative coefficient suggests that openness alone may not be sufficient to improve trade performance. Therefore, H1, which posits a significant effect of trade openness on the trade balance, is rejected. Foreign direct investment (FDIN) shows a positive and significant direct effect at the 10% level ($p = 0.0565$). This validates H2, which states that FDI has a positive effect on the trade balance. Institutional quality (INST) has a positive and significant direct effect at the 5% level ($p = 0.0172$), confirming its key role in improving trade performance. This result validates H3, which posits that institutional quality enhances the effect of trade openness and FDI. Institutional quality forms an essential foundation for leveraging economic dynamics, particularly by promoting transparency, political stability, and the effectiveness of public policies.

The interaction between trade openness and FDI (OPEN.FDIN) has a positive and significant effect at the 1% level ($p = 0.0087$). This result allows for the acceptance of H4, which posits that this interaction improves the trade balance. It highlights that trade openness amplifies the impact of FDI, likely by facilitating its integration into more competitive value chains. Thus, a strategy combining controlled openness and a proactive FDI attraction policy can have significant effects on the trade balance. The interaction between FDI and institutional quality

(FDIN.INST) shows a strongly positive and significant effect at the 1% level (p = 0.0002). This validates H5, which suggests that institutional quality amplifies the effect of FDI on the trade balance. This result illustrates the importance of institutions in maximizing the benefits of FDI, ensuring good governance, and fostering sustainable economic returns. The interaction between trade openness and institutional quality (OPEN.INST) has a significant effect at the 1% level (p = 0.0033). This confirms H6, which states that this interaction positively influences the trade balance. It demonstrates that strong institutions enhance the benefits of trade openness by creating a more stable and attractive environment for international trade.

Regarding the tripartite interaction between trade openness, FDI, and institutional quality (OPEN.FDIN.INST), it has a combined positive and significant effect at the 5% level (p = 0.0137). This validates H7, showing that the simultaneous combination of these three dimensions amplifies their impact on the trade balance. This result highlights the synergistic effect of integrated policies, where trade openness and FDI are optimized through strong institutions. Regarding control variables, the share of manufactured exports (EXPO), while positive, is not significant, suggesting that trade performance is not solely linked to the structure of exports. The real effective exchange rate (REER) has a significant negative effect at the 10% level (p = 0.0634), indicating that external competitiveness remains a key factor. Finally, real GDP (GDP) has a positive and significant effect at the 5% level (p = 0.0199), highlighting the importance of economic robustness in improving trade performance.

5. Discussion

The absence of a significant effect of trade openness on the trade balance raises important questions about the ability of North African countries to transform this openness into an economic performance lever. This result suggests that trade openness, when implemented without adequate support, can expose local economies to the risk of imbalances. Increased competition in international markets can harm less competitive domestic industries, while exports may not always compensate for the rising imports. This highlights the need for a well-managed trade strategy, integrating policies to strengthen local productive capacities and improve competitiveness. The results confirm the positive effect of FDI on the trade balance, reflecting their potential to boost exports and stimulate economic growth. These investments often promote the transfer of technologies, the creation of skilled jobs, and the integration of local businesses into global value chains. However, for these benefits to be sustainable, countries must establish effective regulatory frameworks that guide FDI into strategic sectors. The results also show that FDI alone, although beneficial, is not sufficient to guarantee significant impacts without strong institutional support.

The significant impact of institutional quality highlights its central role in maximizing the positive effects of trade openness and FDI. Strong institutions ensure effective governance, reduce corruption, and enhance transparency. These elements foster a stable and attractive business environment for foreign investors, while ensuring better use of economic resources. This result underscores the importance of strengthening institutions in North African countries to maximize the economic returns of trade policies and foreign investment flows. The interaction between trade openness and FDI reveals a synergy between these two dimensions. Well-calibrated trade openness facilitates the integration of FDI into the local economy by expanding market access opportunities and strengthening export value chains. Furthermore, the interaction between FDI and institutional quality shows that robust institutions play a key intermediary role by ensuring good governance of investments. This

dual effect suggests that economic policies should be integrated and coordinated, combining strategies for trade liberalization, FDI attraction, and institutional strengthening.

The tripartite interaction between trade openness, FDI, and institutional quality reveals a powerful synergistic effect. This means that fragmented or isolated policies are insufficient: maximum benefits are achieved when these three dimensions are aligned. These results reinforce the idea that countries must adopt a holistic approach, integrating institutional reforms with strategies for trade liberalization and proactive management of FDI. This also highlights the importance of public policies capable of coordinating these levers to ensure balanced and sustainable commercial development. These results indicate that North African countries must adopt an integrated approach to improve their trade balance. Policymakers should focus on three main areas: implementing institutional reforms to strengthen governance and the attractiveness of FDI, developing controlled trade openness to protect strategic sectors, and coordinating economic policies to maximize the combined effects of these dimensions. By fostering complementarity between openness, FDI, and institutions, these countries can hope to enhance their integration into the global economy while protecting their national economic interests.

Conclusion

This study analyzes the combined impact of trade openness, foreign direct investment, and institutional quality on the trade balance of North African countries. Trade openness, when not accompanied by complementary policies, can expose local economies to trade imbalances. Indeed, increased competition in international markets can harm less competitive domestic sectors, while rising imports are not always compensated by equivalent export performance. These results call for a strategic and controlled approach to trade openness, supported by policies aimed at strengthening local productive capacities and sectoral competitiveness. In contrast, FDI has a direct positive and significant effect on the trade balance, confirming its key role in economic development. These investment flows promote the transfer of technologies, modernization of infrastructure, and integration of local businesses into global value chains. However, these benefits can only be fully exploited in the presence of a strong institutional framework. Institutional quality acts as a key lever to optimize the benefits of FDI. By reducing corruption, ensuring effective governance, and promoting transparency, robust institutions create an attractive business climate for foreign investors while ensuring optimal allocation of economic resources.

The interactions between trade openness, FDI, and institutional quality reveal particularly powerful synergies. The results show that the interaction between trade openness and FDI significantly amplifies their effects on the trade balance. This dynamic can be explained by the fact that well-calibrated openness facilitates the integration of FDI into the local economy, expanding market access opportunities and strengthening export value chains. Similarly, the interaction between FDI and institutional quality demonstrates that strong institutions play a key intermediary role by ensuring good governance of investments and maximizing their positive impacts. Finally, the tripartite interaction between trade openness, FDI, and institutional quality reveals an even more pronounced synergistic effect, highlighting the importance of integrated policies to maximize the benefits of these dimensions.

Thus, this study demonstrates that improving the trade balance of North African countries requires an integrated and coherent approach, combining institutional reforms, controlled trade policies, and targeted strategies to attract FDI. Institutions must be strengthened to ensure effective governance, reduce inefficiencies, and promote an attractive business

environment. Trade openness must be calibrated to protect strategic sectors while fostering better integration into global value chains. Finally, FDI should be directed toward high-value-added sectors to maximize their economic returns. These results highlight that fragmented policies are insufficient to produce significant impacts. On the contrary, coordinating economic and institutional policies can help maximize the combined effects of reforms and promote sustainable and inclusive economic growth.

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