Gravitational Dynamics of Trade: Exploring Morocco's Economic Diplomacy and Trade Strategies in Africa

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Abstract: This article examines Morocco's trade dynamics with African countries from 2010 to 2020, using a spatial gravity model to analyze the complex interdependencies of bilateral trade. This methodological approach goes beyond traditional models by taking into account spatial and temporal interactions in commercial exchanges. This model allows for a nuanced analysis of how Morocco's trade is affected not only by direct bilateral relations, but also by broader regional and global trade networks. The results suggest that while some factors such as economic scale and land endowment have a significant impact on trade volume, others such as geographic distance and free trade agreements have less statistical significance. This knowledge is essential for shaping future trade policies and understanding the complexities of international trade in a globalized world.

Keywords: Trade dynamics, economic diplomacy, spatial gravity model, international trade, regional trade agreements.

JEL Classification: C01, C21, F13, F14, F23, F53.

1. INTRODUCTION

Economic diplomacy has emerged as a critical tool in the arsenal of nations seeking to enhance their trade, investment, and economic interests on the global stage (Bayne & Woolcock, 2016; Van Bergeijk, 2014; Côté et al., 2020). Central to economic diplomacy is the interplay between politics and economics, involving the strategic use of a country's economic resources to fulfill its international objectives (Oatley, 2022). Countries employ a diverse array of instruments, ranging from trade agreements and financial incentives to soft power tactics, to establish robust economic relationships and leverage them for broader geopolitical purposes (Brummer, 2014; Carminati, 2022).

In this context, Morocco, with its strategic geographic location and rich cultural heritage, has been pivotal in facilitating commercial and cultural exchanges between Europe and Africa (Berriane et al., 2015). As nations navigate the complexities of changing geopolitical landscapes and globalized economies, the tactics and tools of economic diplomacy have gained increasing importance (Stanzel & und Politik-SWP-Deutsches, 2018). Morocco's endeavors in this realm, however, have faced challenges, particularly in forming advantageous trade agreements and addressing regional geopolitical tensions (Cavatorta, 2001; Lounnas & Messari, 2018).

Moreover, the emergence of multilateral institutions and regional trading blocs, where nations collaborate to establish economic standards and policies, is notable (Fink & Jansen, 2009; Bhalla, 2016). In this milieu, entities such as the African Union and regional economic communities significantly influence Morocco's economic diplomacy in Africa (Holden, 2013). Amidst globalization, Morocco's trade with sub-Saharan Africa has steadily increased, focusing on sectors like manufacturing and agriculture (Morris & Barnes, 2009).

This article aims to delve into the dynamics of Morocco's trade with African nations, shedding light on its economic strategies. This examination is critical for shaping future trade agreements and policy decisions. To achieve this, the study employs the gravitational model of international economics, originally inspired by physics. This model, foundational to the study of international trade, was first introduced by Tinbergen (1962) and Pöyhönen (1963), focusing on trade flows between countries based on their economic size and geographic distance. However, as trade relations have evolved, influenced by regional partnerships, political alliances, and cultural connections, a more nuanced approach has emerged. The spatial gravity model, which accounts for the spatial interdependencies of trading patterns (Head & Mayer, 2014), becomes particularly relevant for a country like Morocco with geographically diverse trading partners. By exploring Morocco's trade relationships within Africa, this article provides valuable insights and a framework for future research in the field of economic diplomacy and international trade.

In addition to the traditional gravity model, this study incorporates the spatial gravity model, recognizing the need for more sophisticated analysis of business dynamics in a globally interconnected environment. The spatial gravity model, which builds on the fundamental work of Erlander (1980), takes into account spatial interdependencies between trading partners. This model has been refined in recent studies, such as those by Chang (2014), to better understand the complex nature of trade flows and the influence of indirect trade routes. By applying this model, we aim to capture the nuanced effects of Morocco's economic diplomacy, not only in bilateral terms, but also in the broader context of regional

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and global economic networks. This approach is particularly relevant for Morocco, given its strategic position as a gateway between Europe and Africa and its involvement in various regional trade agreements. The application of the spatial gravity model in this study draws on Hehnke's work, which demonstrated its effectiveness in analyzing the business models of countries with diverse economic and geographic landscapes.

The article is structured into key sections: it starts with an in-depth literature review, followed by a detailed presentation of the methodological data and variables used, and concludes with a thorough analysis of the results, complemented by a relevant discussion.

2. LITERATURE REVIEW

In recent years, economic diplomacy, a multifaceted approach combining politics and economics, has become an essential tool for countries and Morocco in particular seeking to strengthen their economic stature. This section presents the literature review on economic diplomacy, highlighting its importance in developing international trade and investment strategies. The review begins by exploring seminal work in the field of gravitational dynamics of trade. In this context, Sharma et al. (2022) analyzed publications on international trade and the gravity model, using data from 1987 to 2021. They studied publication frequency, important journals, key countries and institutions, and author contributions. The study showed a strong focus on the analysis of trade variables, while some topics, such as economic integration, were less covered. 2019 was the most productive year for this research. The United States, Germany, Spain, and China top the list for searches, including the United States, Germany, and the United Kingdom for citations. Jadhav & Ghosh, (2023) carried out a study to measure the impact of trade creation and diversion using the Gravitational Model of Trade. They observed that little research used this model for these measures. Their study also showed that free trade agreements are analyzed more than regional trade agreements. This indicates opportunities for further studies, particularly with evolving regional trade agreements. For their research, they reviewed 648 publications found on Scopus. Their article highlights the main findings and suggests avenues for future research. The Gravitational Model of Trade, widely used in this field, is appreciated for its ability to explain international trade data, and integrates important ideas for evaluating the effects of trade agreements.

Furthermore, Kaliuzhna & Kudyrko (2023) studied different methods to see how economic differences between countries influence their trade integration. They noted that these methods had their advantages and limitations. Their research highlights the importance of cointegration testing. This test helps understand whether economically different countries can integrate effectively in trade. Cointegration shows whether countries, despite their differences, move in sync in trade. This can indicate their compliance with free-market rules and their level of integration into the global economy. Kaliuzhna and Kudyrko suggest continuing to explore this approach, especially for regional trade agreements between countries with very different levels of economic development. Guan & Ip Ping Sheong (2020) analyzed how different factors affect China-Africa trade. They found that GDP influences exports to China and imports from China in opposite ways. An increase in GDP reduces Africa's exports to China, but increases imports of Chinese goods. Furthermore, a high exchange rate encourages African exports and reduces imports. Population increases trade on both sides. Periods of recession have a negative impact on trade, particularly on imports. Trade agreements promote trade in both directions. These findings suggest that Africa could optimize its exports to China and strengthen its trade agreements to balance trade. Raouf et al. (2021) studied how trade liberalization between Morocco and other African countries, under the African Continental Free Trade Agreement, could affect Moroccan industry, its economic contribution and its foreign trade. They looked at the effects on several aspects, such as household welfare, employment at different skill levels and price changes. The study is motivated by the growing role of Moroccan industry in exports and Morocco's objective to play a more important role in global economic trade and benefit from the agreement, while managing issues linked to origins some products. The agreement could reduce import costs for Moroccan industry and expand its access to the African market, in line with increasing trade in manufactured goods between African countries. For this analysis, the team used a computable general equilibrium model, specifically adapted to Morocco and based on a standard model. This model takes into account particular aspects of foreign trade and uses economic data from 2018, distinguishing Africa from the rest of the world.

Our article seeks to fill a gap in research on the spatial dynamics of trade, particularly with regard to the use of the spatial gravity model. Although the literature review discusses various methods for understanding economic diplomacy and trade, the application of the spatial gravity model is not sufficiently explored. We therefore use the spatial gravity model to analyze commercial relationships in detail, taking into account interdependencies and geographic particularities. This is essential to examine Morocco's trade with African countries. Our goal is to provide new perspectives on economic diplomacy and international trade, thereby enriching the understanding of these interactions in a globalized context. Focusing on the spatial aspect of trade gravity will enrich existing research and provide an overview of trade dynamics, considering the distribution and interconnection of countries engaged in trade agreements and economic partnerships. This method is particularly suitable for studying Morocco's strategic position and its trade relations in Africa and beyond.

3. METHODOLOGY AND VARIABLES USED

This section of the article presents in detail the methodology and variables used to analyze trade dynamics between Morocco and African countries. Our methodological approach is based on the spatial gravity model, chosen for its ability to capture the spatial nuances and interdependencies of commercial exchanges. This method allows us to examine not only Morocco's direct trade relations, but also the impact of regional and global trade networks on these trades. At the heart of our analysis, we begin by presenting an essential theoretical framework for understanding international trade flows. This section is structured into several key parts, each exploring a different but complementary aspect of international trade theory.

The gravity model simplifies our understanding of international trade by comparing it to the natural law of gravity, the more significant the economies, the more they trade with each other and the greater the distance between them, the less they trade (Chaney, 2018). While this model is widely used, it's not without its challenges. It doesn't always take into account that events in one country can affect its neighbors, much like how a local business's success can boost its surrounding area. Acknowledging that locations in close proximity often have interconnected economic activities is crucial, yet this is frequently overlooked in traditional trade analysis. Most research assumes that countries operate independently, which isn't always the case. The conventional use of the gravity model has tried to address this by factoring in the physical distances between countries or by incorporating other adjustments. However, some experts argue that these traditional methods fall short in capturing the complex web of trade relationships that exist. By not considering these interdependencies, we risk inaccurate conclusions. This gap is particularly pronounced when evaluating the impact of trade agreements. Countries that enter such agreements are often neighbors, so overlooking the influence they have on each other can lead to flawed interpretations of how these agreements function (Piermartini &Yotov, 2016; Trotignon, 2010).

3.1. Gravity Equation in International Trade Theory

The primary model for explaining bilateral trade flows is commonly referred to as the gravity equation, akin to Newton's law of universal gravitation. The equation is formulated as follows:

$$T_{ij} = G \times \frac{E_i \times E_j}{R_{ij}^2} \quad (1)$$

In this equation, T_{ij} represents the trade force between two entities i and j. Their economic 'masses', indicated by E_i and E_j, are analogous to the masses in Newton's law, while R_{ij} denotes the distance between them. G is a constant similar to the gravitational constant in physics?

Originally proposed by Tinbergen in 1962 and Pöyhönen in 1963 to analyze international bilateral trade flows, it was Anderson in 1979 who provided a formal theoretical underpinning for this empirical model, emphasizing the importance of similar trade preferences and transportation costs within preferential trading blocs.

Building on this, the empirical gravity equation can be simplified as:

$$V_{ij} = C \times \frac{P_i \times P_j}{R_{ij}} \quad (2)$$

Here, V_{ij} denotes the total trade volume from an exporter i to an importer j. The variables P_i and P_j represent the trading capacities of the countries, typically measured by their GDP. Essentially, this model suggests that trade volume is directly proportional to the economic size of the trading countries and inversely proportional to the distance and other barriers between them. Thus, an increase in distance or other forms of trade resistance leads to a decrease in trade volume.

In transforming equation (2) into a log-linear format suitable for any given time t, and substituting Yi and Yj with $GDPi$ and $GDPj$ respectively, we derive equation (3):

$$\ln V_{ijt} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GDP_{jt} + \alpha_3 \ln R_{ijt} + \epsilon_{ijt} \quad (3)$$

Here, ϵ_{ijt} is an independent and identically distributed error term. In both applied econometrics and the field of international political economy, this modified gravity equation often includes additional variables. These variables typically account for characteristics shared between two trading partners, such as a common border or language, which are believed to enhance trade interactions.

Moreover, when considering the impact of Regional Trade Agreements (RTAs), it's important to recognize their role in trade dynamics. RTAs, which can be either bilateral or multilateral, aim to reduce or eliminate tariffs among member states while maintaining them for non-member countries. As theorized by Viner in 1950, the elimination of internal trade barriers leads to 'trade creation' - an increase in trade volume within these blocs. Therefore, by incorporating a factor for trade creation influenced by the similarity S_{ij} of two trading entities i and j, we arrive at equation (4):

$$\ln V_{ijt} = \alpha_0 + \alpha_1 \ln GDP_{it} + \alpha_2 \ln GL_{jt}^{\downarrow} + \alpha_3 \ln R_{ijt} + \alpha_4 S_{ijt} + \epsilon_{ijt} \quad (4)$$

Recent developments in international trade theory, specifically the work of Anderson & van Wincoop (2003) and later Baier & Bergstrand (2007), highlight that trade volumes are influenced not just by bilateral factors, but also by multilateral resistance. This concept suggests that trade flows are contingent on how bilateral trade resistance compares to the overall resistance in the global trade network.

Incorporating this concept of multilateral trade resistance into the empirical gravity equation, as suggested by Anderson & van Wincoop and later Baier & Bergstrand, leads to a further evolved version of the equation (5):

$$\ln \frac{V_{ijt}}{GDP_{it} \times GDP_{jt}} = \alpha_0 + \alpha_3 \ln R_{ijt} + \alpha_4 S_{ijt} - \alpha_5 \ln P_{it} - \alpha_6 \ln P_{jt} + \epsilon_{ijt} \quad (5)$$

Here, P_{it} and P_{jt} are price indices representing multilateral resistance for countries i and j, respectively. These indices are calculated using equation (6):

$$P_{it} = \sum_{i=1}^{N_t} P_i \left(\frac{GDP_{Nt}}{GWP_t} \right) e^{\alpha_3 \ln R_{iNt} + \alpha_4 S_{iNt}} \quad (6)$$

In this equation, GWP_t represents the gross world product at time t, and GDP_{Nt} is the GDP of a specific nation within the global context.

3.2. International Trade Flow Analysis Using Spatial Gravity Equations

The concept of multilateral resistance, as seen in equations (5) and (6), suggests that international trade patterns are influenced by spatial dependencies that connect trading partners with third countries. Therefore, a comprehensive explanation of bilateral trade flows should consider not only the factor endowments and political or cultural similarities (or dissimilarities) between two countries but also these spatial structures.

Following this line of thought, Behrens *et al.* (2012) proposed that dyadic trade flows are influenced by the trading levels of third-country pairs due to spatial competition effects. This idea, supported by seminal works like Krugman (1991), Porojan (2001), and Anselin (2003), implies that spatial competition creates interdependent trade patterns because of the externalities among geographically close countries.

Starting from the traditional gravity equation, equation (4) can be transformed to:

$$V_{ijt} = \beta \times M + K_t + \zeta_{ijt} \quad (7)$$

In equation (G), K_t represents a vector of all explanatory factors (log-transformed) introduced previously, such as GDP_i, GDP_j, D_{ij}, and S_{ij}, at time t. For simplicity, we will omit the subscript t moving forward. To account for the multilateral spatial dependence arising from spatial competition, we evolve to equation (8) :

$$V_{ij} = \beta \times M + \lambda \times Q \times Z_{ij} + K + \zeta_{ij} \quad (8)$$

Here, Q represents an $N \times N$ spatial weights matrix that defines the spatial connectivity among country pairs. Neumayer & Plümper (2013) note that Q reflects the causal mechanism causing multilateral dependence among trading nations. The scalar λ in this equation is indicative of the proposed spatial competition mechanism.

However, considering the dyadic nature of trade flows, both markets near the origin country (A) and those close to the destination country (B) generate spatial dependencies. This aligns with the theories of LeSage & Pace (2008), who highlight three types of spatial effects in trade flows: (1) rigin-dependence, (2) destinationdependence, and (3) origin-destination dependence. Incorporating these spatial dependencies into equation (8), we get equation (9):

$$V_{ij} = \beta \times M + \lambda_o \times Q_o \times Z_{ij} + \lambda_d \times Q_d \times Z_{ij} + \lambda_{od} \times Q_{od} \times Z_{ij} + K + \zeta_{ij} \quad (9)$$

Put simply, equation (I) suggests that factors influencing trade from country A to B also stimulate similar trade levels from nearby third countries C to B(Q_o), from A to nearby third countries D(Q_d), and also among the third countries C and D themselves (Q_{od}).

Substantively, the vectors $Q_o \times Z_{ij}, Q_d \times Z_{ij}$, and $Q_{od} \times Z_{ij}$ measure the average trade flows from neighboring countries C to B, from A to neighboring countries D, and between neighboring countries C and D, respectively. In essence, these vectors capture the intricate web of dependencies between each origin's neighbors and each destination, and between the neighbors of both the origin and the destination countries.

3.3. Variables Used

In this subsection, we introduce and define the variables that will be utilized in our spatial gravity model, a tool instrumental in dissecting the nuances of Morocco's trade relationships within Africa. The spatial gravity model, an extension of the traditional gravity model of international trade, allows us to consider not only the direct bilateral trade influences but also the broader spatial interactions and dependencies that shape trade patterns.

In the following table, we present a consolidated overview of the key variables employed in our spatial gravity model analysis, focusing on Morocco's trade within Africa. Each variable is carefully chosen for its relevance and impact on trade as per the gravity model of international trade. The table outlines the definition of each variable, along with the authors who have significantly contributed to the development or understanding of these variables within the realm of international trade.

Table 1. Key Variables in the Spatial Gravity Model of Trade.

Variables	Definition	Authors
Ln(TRADE)	The logarithmic transformation of bilateral trade volumes, crucial for normalizing diverse trade data for more effective statistical analysis.	This variable is the cornerstone in gravity model applications, as highlighted in seminal works such as Anderson and van Wincoop's (2003) study.
REMOT	A measure of a country's remoteness from its trading partners, which can significantly impact trade costs and feasibilities.	This aspect is vital in understanding the geographical constraints and opportunities in trade, as explored by Mayer and Zignago (2011).
GDP_distance	A composite variable that integrates the economic scale (GDP) and geographical distance between trading	Bougheas et al. (1999).

	nations, providing insights into the intertwined effects of economic size and physical distance on trade	
SCALE	Reflecting the scale effect in trade, this variable assesses how the economic magnitude of a country influences its trade capacity.	The role of economic size in trade is elaborated by Helpman, Melitz, and Rubinstein (2008)
Kap_endowment and Land_endowment:	These variables represent the capital and land resources available to a country, respectively, indicating the country's potential in capital-intensive and agricultural trade sectors.	Baldwin (1971) and Debaere (2005) provide comprehensive discussions on these aspects.
FTA_dummy	This binary variable indicates the presence or absence of Free Trade Agreements, which are pivotal in shaping trade policies and volumes	as examined by Baier and Bergstrand& Egger (2007).

Integrating these variables into the spatial gravity model, we adapt the structure to incorporate spatial dependencies and multilateral resistance. The model could be expressed as:

$$\ln(T_{ij}) = \alpha + \beta_1 \cdot R_i + \beta_2 \cdot G_{ij} + \beta_3 \cdot S_i + \beta_4 \cdot K_i + \beta_5 \cdot L_i + \beta_6 \cdot F_{ij} + \lambda_o \cdot Q_o \times T_{ij} + \lambda_d \cdot Q_d \times T_{ij} + \lambda_{od} \cdot Q_{od} \times T_{ij} + \epsilon_{ij}$$

In this formulation:

- Q_o, Q_d, and Q_{od} represent the spatial weight matrices for origin-dependence, destination-dependence, and origin-destination dependence, respectively.
- λ_o, λ_d, and λ_{od} are the coefficients for these spatial dependencies.
- ϵ_{ij} is the error term.

In this table, we delineate the specific symbols and mathematical representations for each key variable used in our spatial gravity model. This model is instrumental in analyzing Morocco's trade dynamics within Africa. Each variable has been assigned a symbol that concisely captures its essence and role within the model.

Table 2. Variable Symbols in the Spatial Gravity Model.

Variables	Symbol
Ln(TRADE)	In(T_{ij}) Where (T_{ij}) represents the trade volume between countries i and j at time t.
REMOT	R_i This variable indicates the remoteness of country i from its trading partners.
GDP_distance	$G_{ij}=\frac{GDP_i * GDP_j}{D_{ij}}$ Where GDP$_i$ and GDP$_j$ are the GDP$_s$ of countries i and j, and G_{ij} is th geographical distance between them.
SCALE	S_i = In(GDP_i) Capturing the scale of the economy of country i.
Kap_endowment and Land_endowment:	K_i: Referring to the capital endowment of country i L_i: Including the land resources of country i
FTA_dummy	$\begin{cases} 1 & \text{if there is an FTA between } i \text{ and } j \\ 0 & \text{otherwise} \end{cases}$

In our article, we thoroughly explore Morocco's trade dynamics with a targeted sample of 43 African countries over a pivotal ten-year period, spanning 2010 to 2020. This sample was carefully selected to represent a broad spectrum of economic relations within the African continent, thus offering a complete and nuanced vision of Morocco's commercial interactions. The period studied, covering an entire decade, makes it possible to understand long-term trends and significant developments in Morocco's trade policies and economic strategies.

The analysis of Morocco's trade with African countries in 2020 reveals important aspects of its economic and diplomatic strategy in Africa. Morocco trades with a variety of African countries, showing its ability to reach different markets on the continent. Countries like Ivory Coast, Senegal and South Africa stand out with high trade volumes, indicating strong economic relations, perhaps due to historical, cultural ties or beneficial trade agreements. Ivory Coast presents itself as a major trading partner for Morocco, with trade amounting to $232.33 million. Other countries such as Senegal and South Africa are also key partners. On the other hand, limited trade with countries like Rwanda, Ethiopia and Kenya suggests growth potential and the possibility of exploring new markets. These commercial dynamics reflect Morocco's economic strategy in Africa, which seems to favor the diversification of markets and the consolidation of strong economic ties. Morocco's trade policy could be influenced by geopolitical factors and regional agreements like the ZLECAf, in addition to its internal economic development objectives. It is important to note that this 2020 data may have been impacted by the COVID-19 pandemic, which disrupted global trade. The variations observed could therefore reflect the resilience or vulnerability of Morocco's trade relations in the face of these external shocks. Finally, analyzing the types of products exported by Morocco, a country with a diversified economy, could reveal a wide range of exports ranging from phosphates and agricultural products to textiles and automotive components. This diversity of exports is a key asset for Morocco in its commercial strategy in Africa.

4. RESULTS

In this section, we showcase the findings from our spatial gravity model analysis of Morocco's trade with African countries between 2010 and 2020. The section is divided into two main subsections, each delving into a specific but interconnected aspect of our research.

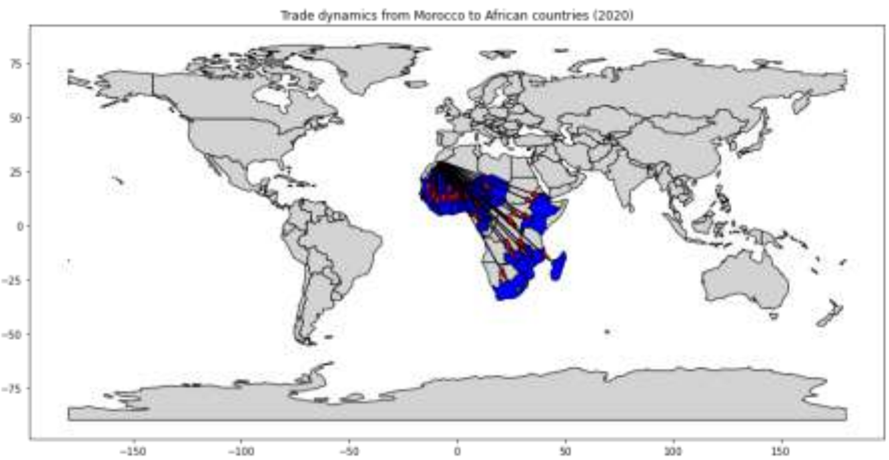

Fig (1). Trade dynamics from Morocco to African countries (2020).

4.1. Testing for Global Spatial Autocorrelation

The first subsection is dedicated to exploring global spatial autocorrelation. Here, we investigate whether Morocco's trading patterns with its African partners are influenced by spatial factors, essentially checking if a country's trade is correlated with that of its geographical neighbors. This analysis is crucial to determine if trade interactions are regionally concentrated or more evenly distributed across the continent. The outcomes of this examination will help assess the applicability of spatial models in understanding Morocco's trade dynamics with Africa.

In our study, we initially focus on determining whether there is spatial dependence in the log-transformed bilateral trade flows within our subset of data. This involves the application of Moran's I statistic to assess if the spatial arrangement observed in the data is more than just a random occurrence. The fundamental hypothesis here is the absence of spatial autocorrelation in our dataset. However, it's crucial to remember that Moran's I's effectiveness depends heavily on how accurately the spatial weights matrices reflect the actual spatial relationships among countries. If these matrices are not accurately specified, the results from Moran's I could be misleading.

Another critical aspect to consider is that Moran's I is traditionally used for identifying spatial autocorrelation in cross-sectional data for a single variable, although this application has its limitations and is sometimes overlooked (refer to Ward & Gleditsch, 2008). In essence, Moran's I values range from -1 to +1, with positive values indicating spatial clustering (countries with similar trade flow values are near each other) and negative values suggesting a dispersed spatial arrangement (countries with dissimilar trade values are adjacent).

The equation for Moran's I, as used in the context of assessing spatial dependence in log-transformed bilateral trade flows, can be expressed as follows:

$$I = \frac{n}{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}} \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(X_i - \bar{X})(X_j - \bar{X})}{\sum_{i=1}^{n} (X_i - \bar{X})^2}$$

Where:

- I is Moran's I statistic.
- n is the number of spatial units indexed by i and j.
- X_i and X_j are the values of the variable of interest (e.g., log-transformed trade flows) for spatial units i and j, respectively.
- $\bar{X}$ is the mean of X over all spatial units?
- w_{ij} is an element of the spatial weight matrix, representing the spatial relationship between units i and j.

In this equation, the numerator sums the product of the differences from the mean for each pair of spatial units, weighted by their spatial relationship. The denominator is the total variance of the variable across all spatial units. Moran's I ranges from -1 to +1, where positive values indicate spatial clustering and negative values indicate spatial dispersion. The effectiveness of Moran's I in revealing true spatial autocorrelation is contingent upon the accurate specification of the spatial weights matrix (w_{ij}), which must reflect the actual spatial relationships among the units (in this case, countries).

Table 3. Evaluation of Worldwide Spatial Autocorrelation.

Year	Moran's I (Origin)	Moran's I (Destination)
2010	0.1401 (0.060) *	0.030 (0.3006)
2014	0.2200 (0.011) **	0.09720 (0.1164)
2017	0.19180 (0.022) **	0.1018 (0.113)
2020	0.108 (0.109)	0.069 (0.1869)

***p < 0.01, **p < 0.05, *p < 0.1.

This table provides a structured analysis of spatial autocorrelation at the African scale, classified by different Moran I calculations for each year. Categories include autocorrelation based on country of origin, country of the destination, combined assessment of origin and destination.

Additionally, analyzing the table allows us to examine Moran's I values for origin (Morocco) and destination (43 African countries) over different years. These values of Moran's I for the origin show the spatial autocorrelation of trade flows from Morocco to African countries. Positive values indicate geographic concentration in Morocco's trade patterns, suggesting that countries with similar trade with Morocco are likely geographically close. For example, a Moran's I of 0.1401 in 2010 indicates a slight geographic concentration.

On the other hand, Moran's I values for the destination reflect the spatial autocorrelation of trade flows from African countries to Morocco. Positive, but relatively low, values suggest less spatial autocorrelation in African countries' trade patterns with Morocco, indicating little or no significant geographic concentration.

By observing the temporal evolution of these values between 2010 and 2020, we see that the values of Moran's I for origin vary but generally remain positive, indicating constancy in the geographic concentration of Morocco's trading partners. The statistical significance of these values varies, with some years showing more significant autocorrelation. For the destination, although Moran's I values increase slightly over time, they do not present a high level of statistical significance, which could mean that African countries sharing similar trade characteristics with Morocco are not necessarily geographically concentrated.

These results have important implications for Morocco's economic diplomacy. The moderate to high spatial autocorrelation on the origin side suggests that Morocco maintains regular trade relations with some African countries that are geographically close or share similar economic characteristics, reflecting a focused strategy of Morocco in its trade interactions with Africa. In contrast, the low spatial autocorrelation on the destination side indicates a diversification of Morocco's African partners, meaning that Morocco maintains trade relations with a variety of African countries that are not necessarily close to each other or economically similar.

4.2. Spatial Autoregressive Panel Models

The second subsection centers on the application of spatial autoregressive panel models. This approach enables us to dissect the impact of spatial and temporal interactions on Morocco's trade, factoring in the interdependencies across different countries and over time. By employing this methodology, we aim to unveil complex patterns and underlying relationships that might be less obvious in conventional analyses. This segment is key to gaining a deeper and more nuanced insight into the forces shaping Morocco's trade strategies in Africa.

Table 4. Table of Regression Estimates for Bilateral Trade: Comparison of Fixed and Random Effects.

Regressionestimates Dependentvariable : lnTRADE	Fixed Effects	Random Effects
REMOT	0,0494639 (0,875)	-0,0707639 (0,716)
GDP_distance	0,050812 (0,681)	0,0363872 (0,233)
SCALE	-0,8271327 (0,661)	0,5759118 (0,007) *
Kap_endowment and Land_endowment:	-0,0039885 (0,77)	0,0087399 (0,513)
FTA_dummy	-0,1017153 (0,377)	-0,2055321 (0,026) **
Cons		0,2123189 0,181
REMOT	0,2585627 (0,095)	-17,63951 (0,015) **
Wx REMOT	-0,7355405 (0,241)	-0,553104 (0,171)
WxGDP_distance	-0,0081753 (0,9)	0,0446624 (0,465)
Wx SCALE	-1,689656 (0,132)	-0,000278 (0,991)
WxKap_endowment	-0,0054248 (0,738)	-0,004659 (0,781)

WxLand_endowment	-0,223413 (0,191)	-0,2100648 (0,184)
WxFTA_dummy	-1,236264 (0,029)	-1,306706 (0,014) **
Spatial Rho	-0,0003217 (0,996)	0,0396015 0,569
Variance sigma2_e	1,166217 (0 ,000) ***	-1,511404 (0 ,000) ***

***p < 0.01, **p < 0.05, *p < 0.1.

In the fixed effects regression analysis focusing on bilateral trade volume (lnTRADE), we observe different impacts of the independent variables on trade, although most are not statistically significant. Remoteness, represented by the REMOT variable, shows a slightly positive effect on trade volume, but without statistical significance, suggesting that geographic remoteness does not noticeably affect trade. Similarly, the GDP_distance variable, which combines economic size and geographic distance, presents a positive but insignificant effect on trade.

The scale effect, indicated by the SCALE variable, reveals a negative impact on trade, but this result is also not statistically significant, implying that larger economies do not necessarily equate to more volume. higher trade. Regarding capital and land endowments (Kap_endowment and Land_endowment), we see a small negative impact on trade, but again without statistical significance, indicating that these factors are not key determinants in this context.

The presence of free trade agreements, illustrated by FTA_dummy, appears to have a negative effect on trade, but this relationship is not statistically significant. However, when considering spatially weighted variables, as in the case of "Wx FTA_dummy," we observe a significant negative effect, suggesting that the spatial effects of free trade agreements could have a negative influence on trade.

The Spatial Rho coefficient, measuring spatial autocorrelation, is very close to zero and is not significant, indicating an absence of notable spatial autocorrelation in the model. In sum, these results suggest that although some variables have positive or negative effects on trade, the majority are not major determinants of bilateral trade in this context. The notable exception is the negative spatial effect of free trade agreements, which deserves additional attention in future analyses.

Regression analysis with random effects shows that the REMOT variable, which measures distance, reveals a slightly negative effect on the volume of trade. However, the high p-value suggests that this relationship is not statistically significant, indicating that distance does not noticeably affect trade. Regarding the GDP_distance variable, which combines economic size and geographic distance, we observe a positive effect on trade, but the relationship is not statistically significant, highlighting that the combined impact of distance and GDP is not a determining factor in bilateral trade. The scale effect, indicated by the SCALE variable, shows a positive and statistically significant impact, suggesting that larger economies are associated with higher trade volume. In contrast, capital endowment, represented by Kap_endowment, shows a positive but insignificant effect, indicating that capital endowment is not a crucial factor. Land endowment, Land_endowment, exhibits a significant negative effect, suggesting that larger land endowments could reduce the volume of trade. This observation is interesting because it indicates that land resources may play a different role in bilateral trade. Regarding free trade agreements (FTA_dummy), although the effect is positive, it is not statistically significant, indicating that the presence of free trade agreements does not have an impact determining the volume of trade. Additional variables, which include spatial interactions, show less significant effect, highlighting the complexity and variability of the relationships between these factors and trade. Finally, the Spatial Rho coefficient, close to zero and not significant, indicates weak spatial autocorrelation in the model.

Table 5. Analysis of the Effects on the Volume of Bilateral Trade: Direct, Indirect and Total Effects.

Regressionestimates Dependent variable : lnTRADE		Fixed Effects	Random Effects
Directeffects	REMOT	0,063094 (0,845)	-0,0682124 (0,731)
	GDP_distance	0,0464475 (0,697)	0,0354992 0,227
	SCALE	-0,6282396 (0,728)	0,5897879 (0,005) **
	Kap_endowment	-0,00416 (0,756)	0,008379 (0,516)

	Land_endowment	-0,1020176 (0,357)	-0,2028701 (0,021) **
	FTA_dummy	0,2667106 (0,079) *	0,2090894 0,189
Indirecteffects	REMOT	-0,2082487 0,255	-0,1610161 0,141
	GDP_distance	-0,0030227 0,87	0,0147025 0,387
	SCALE	-0,457429 0,137	0,0074789 0,613
	Kap_endowment	-0,0013877 0,761	-0,0014444 0,762
	Land_endowment	-0,0616595 0,186	-0,0612912 0,185
	FTA_dummy	-0,3355878 (0,043) **	-0,3828362 (0,011) **
Total effects	REMOT	-0,1451548 0,687	-0,2292285 0,297
	GDP_distance	0,0434248 0,725	0,0502018 (0,067) *
	SCALE	-1,085669 0,543	0,5972668 (0,006) **
	Kap_endowment	-0,0055477 0,689	0,0069347 0,609
	Land_endowment	-0,1636772 0,171	-0,2641613 0,004
	FTA_dummy	-0,0688772 0,767	-0,1737468 0,456

***p < 0.01, **p < 0.05, *p < 0.1.

Furthermore, the analysis of the regression table reveals the impact of different variables on the volume of bilateral trade (lnTRADE), highlighting the direct, indirect and total effects in the fixed and random effects models. Concerning the direct effects, the REMOT variable shows a slightly positive effect in the fixed effects model and a negative effect in the random effects model, but neither is statistically significant. The variable GDP_distance shows a positive effect in both models, but without statistical significance. The scale effect (SCALE) is negative in the fixed effects model and positive and significant in the random effects model. Capital (Kap_endowment) and land (Land_endowment) endowments have negative effects, but only land endowment is significant in the random effects model. Free trade agree ments (FTA_dummy) have a positive effect in both models, but only approach significance in the fixed effects model.

The indirect effects of all variables are not statistically significant, with the notable exception of free trade agreements in both models. Concerning the total effects, most variables do not show a significant impact on lnTRADE. However, economic scale and land endowment appear to be important factors, particularly in the random effects model. These results indicate that economic scale and land resources are influential elements on the volume of bilateral trade, while free trade agreements have a notable indirect effect.

CONCLUSION

In conclusion, this article presented an analysis of Morocco's commercial strategies in Africa, based on the spatial gravity model. This model, developed in the field of international economics, establishes a parallel between gravitational forces in physics and trade flows, taking into account the economic size of countries and their geographic distance, but also spatial interdependencies.

Morocco, thanks to its strategic position and its rich cultural heritage, plays a key role in commercial and cultural exchanges between Europe and Africa. However, the country faces challenges, particularly in forming beneficial trade deals and managing regional geopolitical tensions. The emergence of multilateral institutions and regional trade blocs also influences Morocco's economic diplomacy.

Our study uses a spatial gravity model to analyze Morocco's trade dynamics with African countries. This approach is crucial for shaping future trade agreements and policy decisions. The spatial gravity model, which takes into account spatial interdependencies between trading partners, is particularly relevant for Morocco with its geographically diverse trading partners.

Furthermore, Morocco, as a strategically positioned nation, should continue to leverage its advantageous geographic location to strengthen and expand its trade ties across Africa. Particular importance should be given to market diversification and the consolidation of strong economic relations, while taking into account geopolitical challenges and opportunities offered by regional trade agreements, such as the ZLECAf. Economic diplomacy, a key element of Morocco's strategy, must be pursued with sustained attention. It is essential to continue developing trade policies that take into account regional and global interconnections, adopting a multilateral approach to maximize Morocco's impact in trade negotiations.

Additionally, the use of the spatial gravity model is recommended for a richer and more detailed analysis of business dynamics. This model, which provides a nuanced perspective on trade interdependencies, should be used not only by Morocco but also by other countries with similar economic and geographic profiles, to effectively inform their trade and diplomatic strategies.

However, this study has certain limitations. As the availability and quality of commercial data is limited, future research with more comprehensive and recent data is needed for a more in-depth understanding of current trends.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no conflict of interest.

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