Maritime Corridor Intensity and Trade Diversification: A Gravity-Based Assessment of Albania's Strategic Maritime Partners

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Abstract

The aim of this paper is to determine the factors that affect Albania's trade flows with partner countries by considering the gravity model for bilateral trade as suggested by Anderson & van Wincoop, 2003. The analysis uses panel data for 67 countries for a period of 10 years from 2015 to 2024. The dependent variable is the natural logarithm of Albania's trade flows with trading partners, and the explanatory variables include the logarithm of Albania's GDP, the logarithm of the partner's GDP and the logarithm of the Albania partner distance. The study employs a log-log gravity model estimated using Ordinary Least Squares (OLS), allowing coefficients to be interpreted as elasticities. Two specifications are used a full model and a reduced model addressing multicollinearity and the model validity is assessed through t-tests, F-tests, and collinearity diagnostics. this study provides clear evidence that Albania's trade structure is in line with the fundamental principles of the gravity model: economic size attracts trade, while distance inhibits it. In a context where Albania is transforming its port infrastructure and increasing regional integration, the results of this paper provide a solid analytical basis for designing trade policies and strategic investments in the transport and logistics sector. The paper contributes to the orientation of trade policy priorities towards markets with higher potential and investments that reduce transport costs and trade barriers.

Keywords: gravity model; international trade; panel data; multicollinearity.

1. Introduction

Albania is a coastal country and, as such, maritime transport constitutes one of the most important sectors for the country's economy. For the development of maritime transport, six commercial ports operate in the country, specialized in the processing of various types of cargo. Maritime transport in Albania accounts for approximately 44.7% of all of the volume of exports and 63.3% of imports (INSTAT 2022).

The Port of Durres, as the largest port in the country, specializes in the processing of dry bulk cargo, general cargo, containers (Metalla et al, 2020), as well as passenger transport. At the same time, to the north of the existing port of Durres (about 14 km away), new capacities are being developed for the processing of general and liquid bulk cargo (oil and gas terminal). In addition, the construction of a new terminal for the processing of containers is planned, since the existing terminal in the current port of Durres is close to the limits of its capacity to handle container flows (Metalla et al, 2020), On the other hand, the government has taken the decision to reallocate all port operations to the industrial area of Porto Romano, as the existing port of Durrës will be transformed into a tourist marina.

In addition to the port of Durrës, the ports of Vlorë, Shëngjin and Saranda also operate. Except for the Port of Vlorë, which processes liquid regasification (crude oil terminal), the other ports do not process significant amounts of goods compared to Durrës.

According to INSTAT reports (INSTAT, 2024) in 2024 the port of Durrës processed over 94.9% of the total goods transported by sea in the Republic of Albania. On the other hand, the volume of goods transported by sea has increased significantly since 2018, underlining the need to increase port capacities and improve performance indicators in Albanian ports.

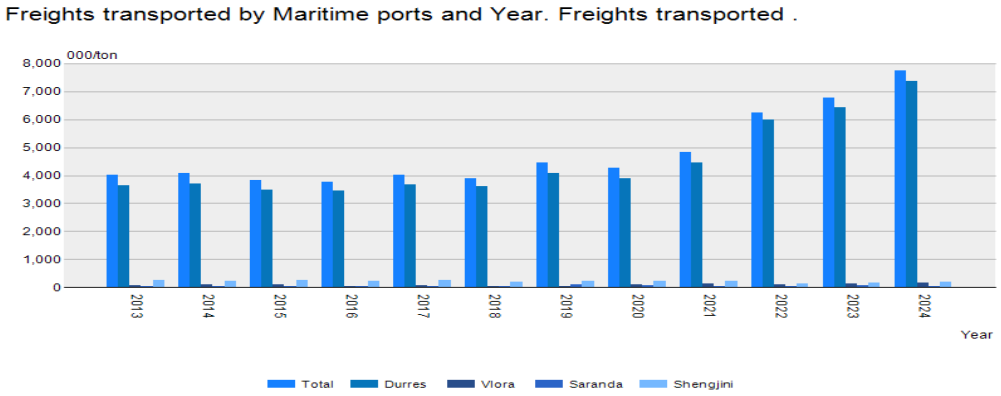


Fig1: Volume of goods transported through Albanian ports 2013 – 2024
Source: INSTAT

In 2024, the port of Durrës (Durrës port complex and Porto Romano) processed a total of 7,353,000 tons of goods, while at the national level the total amount of goods transported by sea reached 7,748,000 tons. The doubling of the volume of goods processed within a period of only six years indicates a significant increase in the demand for goods from the Albanian economy, as well as from the region markets served by the port of Durrës.



Fig. 2. Top 20 countries with the largest volume of maritime trade with Albania
Source: Adopted by authors

The geography of communications and maritime trade of Albania with other countries is wide and includes all continents. However, the main trading partners remain the countries of the region and those of the European Union, such as Italy, Greece, Germany, Spain, Slovenia, etc. Figure 2 below presents the 20 countries with which Albania realizes the highest volumes of trade exchanges, at the same time with a significant amount of cargo transported by sea.

As can be seen from Figure 2, the countries with the largest trade volumes are mainly those located relatively close to Albania. For example, Italy and Greece, two neighboring countries, represent the highest level of maritime trade exchanges. In contrast, countries located at greater distances realize lower volumes of maritime trade, which highlights the impact of transport costs and distance on the intensity of trade relations.

The aim of this paper is to analyze the factors that determine Albania's trade flows with partner countries, using the gravity model. The paper assesses the role of economic size (GDP) and geographical distance in explaining changes in trade between Albania and partner countries.

Korsita et al. (2023) apply the gravity model to foreign direct investment in the Balkan region, finding that distance between countries has a negative and statistically significant effect on FDI flows, while market size is positively related. Merko, Prendi and Memaj (2022) analyze Albania's bilateral trade with 24 major European partners for the period 2008–2020 and find that the gravity model successfully explains trade, where "economic size" has a positive effect while distance has a negative effect.

1.1 Research questions

- How does the partner country's GDP affect Albania's trade flows?
- How does the distance between Albania and its partner affect trade flows?
- Are the estimated coefficients consistent with the theory and empirical evidence in the literature (e.g. Anderson & van Wincoop, (2003)?

The paper is organized into five chapters. The first chapter introduces the relevance, purpose and research questions of the paper. The second chapter explains the trade gravity model. The third chapter presents the data and methodology used. The fourth chapter presents the empirical results and their interpretation, and the fifth chapter presents the main findings, practical recommendations, as well as the limitations of the study and possible directions for future research.

2. Literature Reviewed

The economic gravity model is one of the most widely used methods for analyzing bilateral trade flows between different countries (Head & Mayer 2014). This method is also quite efficient in analyzing foreign direct investment (FDI), as well as other forms of economic interaction between countries. The model originates from Newton's law of gravity, taking into account the size of the countries with which trade is conducted as an indicator of the growth of trade volumes. The main indicators in this approach are the economic size of the country (usually measured by GDP) and the size of the population. On the other hand, distance negatively affects the growth of trade volume. Since its introduction about 60 years ago, the gravity model has been significantly improved and consolidated, becoming one of the most widely used methods in the analysis of international trade.

Anderson and van Wincoop (2003) made a valuable contribution to the theoretical development of this model, especially with their paper "Gravity with Gravitas: A Solution to the Border Puzzle". This paper laid the foundations for the theoretical treatment of the model within the general equilibrium framework. One of the main contributions of the study was the interpretation of the "border puzzle" concept, according to which trade within a country turned out to be disproportionately higher than international trade.

The improved model by Anderson and van Wincoop (2003) was derived from a general equilibrium model with differentiated goods. Their main contribution was the introduction of the concept of multilateral resistance. According to this model, not only bilateral trade costs (such as distance, tariffs, borders or common language), but also the average level of trade barriers that each country faces in relation to all its trading partners, are important influencing factors.

In this context, trade flows between countries depend on:

- The economic size of each country (GDP),
- Bilateral trade costs (distance, borders, trade agreements),
- Multilateral resistance terms reflecting relative trade barriers.

The inclusion of multilateral resistance allowed the authors to resolve the border paradox and placed the gravity model on a solid theoretical footing (Merko et al 2022), (Santos Silva & Tenreyro 2006). Since then, the inclusion of fixed effects of exporters and importers in panel models has become standard practice in empirical analyses.Other authors have used the gravity model to analyze trade and investment in different regions. Korsita et al. (2023) have applied the gravity model. The study demonstrates that the basic variables of the model countries' GDP, market size, and geographical distance are also important determinants of investment flows.Using panel data for Balkan countries and their partners, the authors find that:

- GDP of the host and investing countries has a positive impact on FDI,
- Geographic distance has a negative impact,
- Additional factors such as institutional quality and economic openness play an important role.

This study shows the flexibility of the gravity model, which can be adapted to analyze not only trade, but also capital movements. In the Balkan context, the study demonstrates that the gravity model provides an appropriate framework to analyze the effects of market size, geographical proximity, and structural factors.Merko, Prendi, and Memaj (2022) have applied the gravity model with panel data to analyze Albania's bilateral trade flows. The study represents an important application of the modern gravity model in a small and open economy.

The empirical results show that:

- GDP of Albania and partner countries has a positive and statistically significant impact on trade,
- Distance has a negative impact on trade flows,
- Regional integration and proximity to European Union countries have a positive impact on trade intensity.

The findings of Merko et al. (2022) are in line with the theoretical predictions of Anderson and van Wincoop (2003) although in practice multilateral resistance is often captured through fixed effects in panel models. The study confirms that the gravity model is appropriate and applicable to explain the structure of Albania's trade. For an economy like Albania, this model provides a strong analytical basis to assess trade potential, distance effects and the impact of market size.

Beyond the contribution of Anderson and van Wincoop (2003), the empirical literature has also advanced in methodological terms. Fixed-effects panel models, as well as the use of the Poisson Pseudo-Maximum Likelihood (PPML) method, are regularly used to address the problems of heteroskedasticity and the existence of zero trade flows [9].

Studies by Korsita et al. (2023) and Merko et al. (2022) illustrate that the gravity model is a well-established, theoretically justified, and empirically robust framework for the analysis of international economic interactions. It combines structural simplicity with the flexibility to include additional institutional and structural variables.

In summary, the existing literature highlights three main elements:

- The gravity model has a strong theoretical basis in general equilibrium trade theory (Anderson & van Wincoop, 2003).
- It is applicable not only to trade, but also to foreign direct investment and other forms of economic interaction (Korsita et al., 2023).
- It has high explanatory power in the context of small and open economies such as Albania (Merko et al., 2022).

The literature review supports the gravity model as the most widely used model in analyzing trade and investment flows in the Balkan region and beyond.

3. Methodology

The analysis is based on the gravity model where from the literature we saw that there is a positive relationship between trade and the size of the economy and a negative relationship with distance. The dependent variable is the natural logarithm of trade while the explanatory variables are, the logarithm of Albania's GDP, the logarithm of the partner country's GDP and the logarithm of the distance Albania-partner. The transformation to the natural logarithm was done because it reduces the asymmetry of the distributions and allows the interpretation of the coefficients as elasticities.

Variables:

- *ln_trade:* natural logarithm of trade flows (dependent variable).
- *ln_gdp_alb:* natural logarithm of Albania's GDP (size of the domestic economy).
- *ln_gdp_partner:* natural logarithm of the trading partner's GDP (size of the partner's economy).
- *ln_dist:* logarithm of the geographical distance Albania and partner country.

Our data are panel data covering 67 countries over 10 years (2015–2024), generating a total of 670 observations, allowing us to simultaneously analyze cross-country and time-varying changes.

3.1 Econometric Specification

Two log-log models were estimated [16]. Model 1 is the full model, while Model 2 is an alternative model used to check for validity when a variable with multicollinearity signals is excluded from the specification.

Model 1

$$\boldsymbol{ln_trade = \beta 0 + \beta 1 \cdot ln_gdp_alb + \beta 2 \cdot ln_gdp_partner + \beta 3 \cdot ln_dist + \varepsilon}$$

Model 2

$$\boldsymbol{ln_trade = \beta 0 + \beta 1 \cdot ln_gdp_partner + \beta 2 \cdot ln_dist + \varepsilon}$$

3.2 Estimation method and statistical testing

Both models were estimated with linear regression (OLS). For each coefficient, a ***t-test*** was used to verify whether the effect is statistically different from zero. An ***F-test*** was also used to assess the significance of the model as a whole.

Standard hypotheses for the t-test:

H_0: $\beta k = 0$ (variable has no effect).

H_1: $\beta k \neq 0$ (variable has an effect).

Hypotheses for the F-test:

Ho: all coefficients of the explanatory variables are zero.

H_1: at least one coefficient is different from zero.

3.3 Multicollinearity control

To control multicollinearity, collinearity diagnostics were used through the Condition Index and Variance Proportions indicators. This approach helps us understand if some explanatory variables are highly correlated with each other and are providing similar information, which can make it difficult to separate their effects in the regression. In interpretation, a high Condition Index (usually above 30), accompanied by high concentrations of Variance Proportions for two or more variables in the same dimension, is taken as a signal of problematic multicollinearity.

3.4 Determination of trade parameters/indicators

To better analyze the trade between countries, the values of the trade parameters were analyzed as follows:

a. Trade predicted,
b. Trade gap
c. Trade potential rate,
d. Trade opportunity score, and
e. Distance adjusted trade intensity index.

To calculate the predicted trade, the equation of model 2 was used, which also calculates the distance between countries as a variable. Trade potential rate (TPR) is a parameter that compares the predictions made by the gravity model, and notes whether these values are below or above the values predicted by this model. Values close to 1 indicate moderate or balanced trade, while if we are above this value (TPR > 1) we are dealing with over-trade and below this value (TPR< 1) there is still untapped potential in the corridor (Egger, 2022).

Trade gap shows the value of the difference between the predicted trade and the actual trade. If the values of this difference are positive, then in this trade corridor we have untapped potential again.

Trade Opportunity Score is the ratio between Trade gap and predicted trade (Leitao, 2024). In this case, if the TOS values are close to zero (TOS = 0) we have balanced trade or trade is close to potential. If the TOS value is > 0, then trade is below potential and if TOS < 0, then we are dealing with overtrading.

To assess the trade intensity in a specific maritime corridor while controlling for geographical friction, we construct an indicator adjusted to the distance which derives directly from the gravity model framework. Thus in the case of the gravity model according to Anderson & van Wincoop, 2003, we have:

$$Tij = exp(\beta 0) \cdot GDPi\beta 1 \cdot GDPj\beta 2 \cdot Distance_{ij} - \beta 3$$

Where: Tij = value of bilateral trade

$Distance_{ij}$ = value of bilateral trade costs, and

β^3 = represents the elasticity of trade with respect to distance.

Consequently, distance enters the trade equation as a multiplier and the fraction: $Distance_{ij} - \beta_3$. If we keep the variables constant, bilateral trade decreases inversely proportional to distance to the power of the elasticity of distance. Thus, by dividing the observed trade in a region with distance to the power of the elasticity of distance, we can determine the distance-adjusted trade intensity, which we can also call the maritime gravity index.

MGIj = Tij / Distanceijβdist

Where βdist = absolute value of distance elasticity obtained from the gravity model.

4. Analysis of Results

Following this chapter, we will present the results of the empirical estimation of gravity type to explain changes in trade as a consequence of the size of the partner country and distance. The analysis is based on linear regression with variables transformed into natural logarithm. The econometric model 1 that we will estimate is:

$$ln_trade = \beta 0 + \beta 1 \cdot ln_gdp_alb + \beta 2 \cdot ln_gdp_partner + \beta 3 \cdot ln_dist + \varepsilon$$

Due to the multicollinearity signals identified in Model 1, an alternative robustness control model (Model 2) is also estimated, where ln_gdp_alb is removed. The econometric model 2 that we will estimate:

$$ln_trade = \beta0 + \beta1 \cdot ln_gdp_partner + \beta2 \cdot ln_dist + \varepsilon$$

4.1 Model 1:

The diagnosis of collinearity was performed through the Condition Index and Variance Proportions indicators. We have multicollinearity when the Condition Index is higher than 30 and two or more explanatory variables have high percentages of variance. The results show a very high Condition Index =82.166, accompanied by a concentration of variance mainly in the constant and the independent variable ln_gdp_alb.

Table 4.1. Collinearity diagnostics (Model 1)

Dimension	Eigenvalue	Condition Index	VarProp (Constant)	VarProp ln_gdp_alb	VarProp ln_gdp_partner / ln_dist (sinjale)
2	0.017	15.422	0	0	ln_gdp_partner=0.46; ln_dist=0.45
3	0.007	23.533	0.03	0.05	ln_gdp_partner=0.53; ln_dist=0.53
4	0.001	82.166	0.97	0.95	ln_gdp_partner=0.01; ln_dist=0.02

Source: Authors calculations

Dimension 4 with Condition Index =82.166 shows a very strong signal of collinearity, which in this case is mainly related to Constanten and ln_gdp_alb, which means that ln_gdp_alb usually varies mainly with years and not with the partner, therefore it may have more limited variation compared to the partner-specific variables. For this reason, in Model 2 we will exclude ln_gdp_alb.

4.2 Model 2:

Model 2 includes only 2 independent variables excluding ln_gdp_alb. This model serves as a robustness check to see if the main conclusions are valid even when the variable with strong collinearity (ln_gdp_alb) is removed.

Table 4.2. Model Summary

R	R^2	Adjusted R^2	Std. Error of Estimate	df (Residual)	N (Total df + 1)
0.444	0.197	0.195	2.10091	674	677

Source: Authors calculations

The model explains about a fifth of the variation we see in ln_trade. So, partner GDP and distance affect trade, but they don't explain everything, because there are many other factors that are not included in the model.

Table 4.3. ANOVA

Source	SS	df	MS	F	Sig.
Regression	730.708	2	365.354	82.775	<0.001
Residual	2974.914	674	4.414		
Total	3705.621	676			

Source: Authors calculations

The F-test shows that the model is statistically significant overall ($p<0.001$). This means that the alternative hypothesis is true where at least one of the coefficients of ln_gdp_partner or ln_dist is different from zero.

H0: $\beta1 = 0$ and $\beta2 = 0$

H1: $\beta1 \neq 0$ or $\beta2 \neq 0$

Table 4.4. Collinearity diagnostics (Modeli 2)

Dimension	Eigenvalue	ConditionIndex	VarProp(Constant)	VarPropln_gdp_partner	VarPropln_dist
1	2.979	1.000	0.00	0.00	0.00
2	0.017	13.349	0.00	0.47	0.44
3	0.005	25.153	1.00	0.53	0.56

Source: Authors calculations

The maximum Condition Index is = 25.153 which means that we have moderate collinearity between ln_gdp_partner and ln_dist. This level usually increases the standard errors but is not considered severe collinearity as in the case of Model 1.

4.3 Construction and interpretation of equations

Estimated equation model 1:

ln_trade = 16.762 + 0.808·ln_gdp_alb + 0.433·ln_gdp_partner − 0.853·ln_dist

Interpretation of elasticities:

1% increase in Albania's GDP brings 0.81% increase in trade, keeping everything else constant.

1% increase in the partner's GDP brings 0.43% increase in trade.

1% increase in distance leads to a 0.85% decrease in trade.

All three coefficients are statistically significant, proving that economic size is positively related to trade, while distance is negatively related.

Table 4.5. Estimated Coefficients

Model	Variable	B	Std. Error	t	p-value
Model 1	(Constant)	16.762	2.449	6.843	<0.001
Modeli1	ln_gdp_alb	0.808	0.264	3.061	0.002
Model 1	ln_gdp_partner	0.433	0.066	6.523	<0.001
Model 1	ln_dist	-0.853	0.082	-10.403	<0.001
Model 2	(Constant)	23.666	0.96	24.646	<0.001
Model 2	ln_gdp_partner	0.45	0.067	6.767	<0.001
Model 2	ln_dist	-0.851	0.083	-10.31	<0.001

Source: Authors calculations

We ran Model 2 because Model 1 had a multicollinearity signal. When this happens, the model can still show the direction of the relationship, but the coefficients can become more unstable and less reliable, because the standard errors increase and interpretation becomes more difficult. To clean up the analysis, in Model 2 we removed ln_gdp_alb and left only the two main variables of the gravity model: partner GDP and distance. The idea was to see if the "main message" remains the same. Partner GDP continues to have a positive effect, distance a negative effect, and the values are almost the same as in Model 1. This gives us more confidence that the conclusion is stable and does not depend on the presence of ln_gdp_alb.

Estimated equation model 2:

ln_trade= 23.666 + 0.450·ln_gdp_partner − 0.851·ln_dist

Interpretation of elasticities:

1% increase in partner GDP is associated with about 0.45% increase in trade.

1% increase in distance is associated with about 0.85% decrease in trade.

Comparing Models 1 and 2 shows that the coefficients for ln_gdp_partner and ln_dist remain almost unchanged with the same signs and statistical significance. This suggests that the main conclusions are robust and do not depend on the inclusion of ln_gdp_alb.

4.4 Trade parameters/indicators.

Based on the constructed models, the following parameters were also evaluated:

- *Trade predicted,*
- *Trade gap*
- *Trade potential rate,*
- *trade opportunity score, and*
- *Maritime Trade Intensity Adjusted to Distance Between Countries.*

Through these parameters, it was possible to conduct a more complete analysis of the results produced by Model 1 and Model 2. Since the coefficients of Models 1 and 2 were almost equal (unchanged), the authors did not consider it reasonable to conduct a comparative analysis between the two models.

Predicted trade:

To calculate predicted trade, the equation of model 2 was used as follows:

$$\boldsymbol{ln_trade = 23.666 + 0.450 \cdot ln_gdp_partner - 0.851 \cdot ln_dist}$$

and to convert predicted trade Ln_predicted into predicted trade volumes, the equation was used:

$$\boldsymbol{predicted\ trade = Distance^{\beta 3}}$$

Where β3 = distance elasticity. In the case of Model 2, β3 = -0.851

Based on the values obtained from the application of this equation, predicted trade values were obtained for each country. By making the difference between the predicted and actual trade values, it became possible to determine the "trade gap"

trade gap=predicted trade-actual trade

The analysis of the trade gap (TG) shows a polarized structure of Albania's trade relations. On the one hand, we see countries that have a negative TG (overtrade) and on the other hand, we see countries with positive TG (which suggests the existence of potential for trade growth). The Figure 3 below shows the main countries with positive and negative TG.

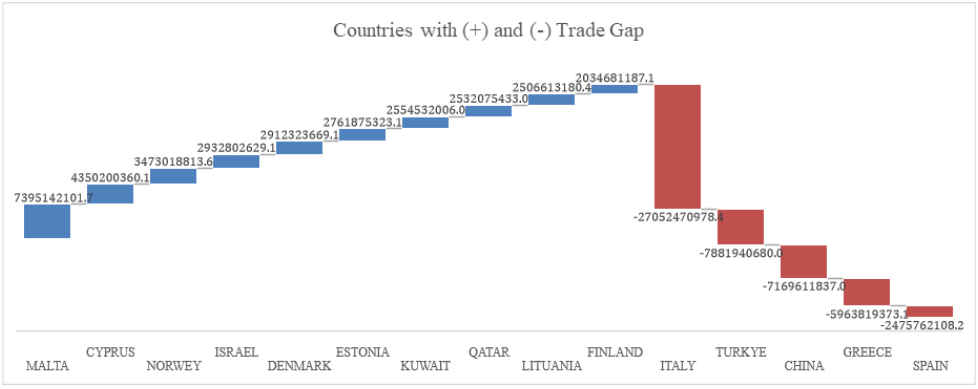


Figure 3. Countries with positive and negative Trade Gap.
Source: Adopted by authors

As can be seen from the figure 3, countries such as Malta, Norway, Israel, Denmark, Estonia, etc. present

negative values of TG, which suggests the existence of potential for trade expansion. While Italy, Turkey, Germany, China, Spain present significant levels of excess trade.

Trade Potential Rate (TPR) this indicator is presented as the ratio between current trade and projected trade. High values of TPR indicate excess trade, values close to unity indicate equilibrium, while values below 1 indicate excess trade potential. The table below presents the main countries according to the relevant categories:

Table 4.6 ranking of countries according to TPR

Category	Country	Trade Potential Rate TPR	Interpretation
Overtrade (TPR very high)	China	>100	Mature trade corridor
	India	>80	Extensive trade
	Italy	>40	Major trading partner
	Turkey	>40	Regional trading partner
	United States	>20	Strong trade corridor
	South Korea	>18	Intensive trade relations
	Russia	>17	Extensive trade
	Germany	>16	Major industrial partner
	Brazil	>14	Intensive trade regardless of distance
	Saudi Arabia	>13	Energy corridor
Equilibrium trade	Spain	= 1	Close to projected level
	France	= 1	Close to projected level
	Egypt	= 1	Close to projected level
	Canada	= 1	Close to projected level
	Israel	= 1	Close to projected level
Under trade (high potential)	United Arab Emirates	< 1	Possibility to expand trade
	Japan	< 1	Possibility to expand trade
	South Africa	< 1	Possibility to expand trade
	Mexico	< 1	Possibility to expand trade
	Australia	< 1	Possibility to expand trade
	Argentina	< 1	Possibility to expand trade
	Morocco	< 1	Possibility to expand trade
	Tunisia	< 1	Possibility to expand trade
	Vietnam	< 1	Mature trade corridor
	Malaysia	< 1	Extensive trade

Source: Adopted by authors

4.5 Maritime Trade Intensity Adjusted to Distance Between Countries.

To make the specific assessment regarding maritime corridors, we have constructed an indicator that derives directly from the gravity model and adjusts for distance and controls for geographic friction. Starting from the model of Anderson & van Wincoop, 2003 which is presented in the equation:

$$Tij=exp(\beta 0)\cdot GDPi\beta 1\cdot GDPj\beta 2\cdot Distanceij-\beta 3$$

Where: Tij - is the bilateral trade,

$Distance_{ij}$ – is the distance including the costs of the trade between countries, and

β_3 = is the elasticity of the trade with respect to distance

we note that distance enters the equation multiplicatively as a friction term:

$$Distanceij-\beta 3$$

Holding other variables constant (GGDPi and GDPj) bilateral trade decreases proportionally with increasing distance raised to the power of the calculated elasticity of distance (β3). In this way we re-

estimate the gravity of the corridor by dividing the actual trade by the distance in power with the estimated elasticity.

This allows us to remove the mechanical effect of geography (geographic distance) which affects the structure of the gravity model. As a result, the Maritime Corridor Intensity Index would be:

$$\boldsymbol{Maritime\ Trade\ Intensity\ Index\ (MTI) = (Trade\ j)/(Distance)^{\beta}}$$

Where β represents the 0.851 elasticity coefficient of *ln distance*, while Trade, is the average value of trade. in Model 2.

MTI measures bilateral intensity in a geographical area. The higher the MTI – it is an indicator that the maritime corridor represents a significant trade, and conversely, a low MTI indicates a weak corridor. The MTI does not replace the gravity model but serves as an instrument to rank transport corridors in the maritime context.

According to this index, Italy is the country with the greatest gravity of trade exchanges on maritime routes, but on the other hand, it is also the most overtraded country. Based on the maritime trade intensity index, the trade gap between countries we can distinguish the following maritime trade corridors:

- *Saturated maritime corridors (mature).* This corridor includes countries such as Italy, Greece, Germany, Turkey, and China. A characteristic of trade with these countries is the fact that these countries have large negative differences in terms of trade gaps, have very high values of the Trade potential rate (>1.2) and at the same time have very high results of the MGI index
- *Intermediate corridors.* These corridors include countries such as Spain, France, India, Japan, South Korea, Brazil, Canada and Egypt which offer large trade volumes but have negative trade gaps. These are indicators of a mature corridor with modest trade expansion potential.
- *Maritime corridors with expansion potential.* Based on gravity model data, countries such as the United Arab Emirates and Israel show real potential for trade expansion due to the fact that they have positive trade gaps, have TPR <1, and have moderate MGI.

The table below lists the countries with the highest intensity of maritime trade corridors.

Table 4.7 Countries with highest maritime gravity trade for Albania

COUNTRIES	maritime gravity index (MGI)	opportunity rank (out of 67 countries)	opportunity mean
ITALY	1413911015	67	-37.105
GREECE	367511580	59	-7.922
TURKYE	163441340	66	-25.751
GERMANY	151407309	62	-12.269
BULGARIA	93511776	33	-0.403
SPAIN	47935797	60	-9.175
RUMANIA	47282215	41	-1.268
POLAND	33125314	51	-2.719
CHINA	32486174	68	-130.730
FRANCE	32437360	54	-2.844
AUSTRIA	32109924	32	-0.192
SLOVENIA	30512225	30	-0.062
CROATIA	25126015	38	-1.133
SWITZERLAND	21734740	45	-2.153
NETHERLANDS	17272131	35	-0.969
UNITED KINGDOM	12046806	36	-0.975
EGYPT	10384067	49	-2.477
UCRAINA	9933509	43	-1.535

Source: Adopted by authors

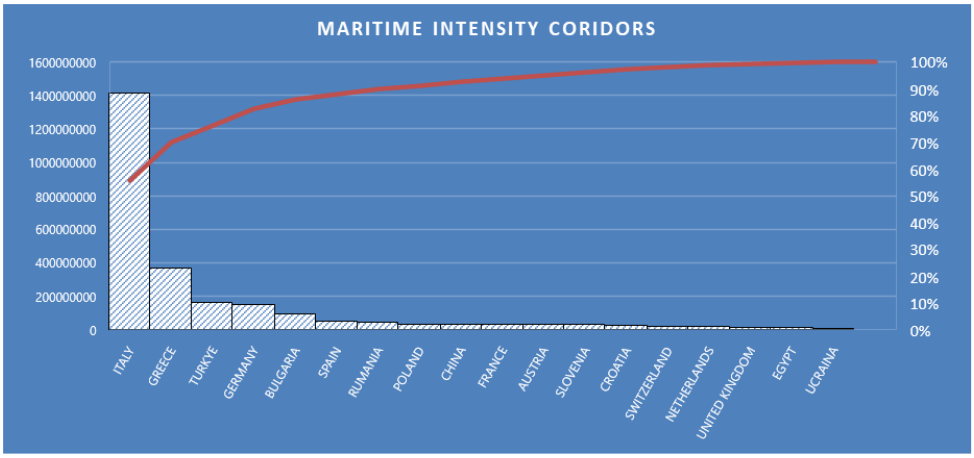


Figure 4. Maritime intensity corridors
Source: Adopted by authors

The results based on the matrix of trade volumes and distance, as well as on the MGI, demonstrated that the trade potential of Albania on the maritime route is mainly concentrated in two main corridors:

- The Mediterranean Corridor of short distances where the distance suits the trade and the trade intensity is quite high. From a logistical point of view, such a concentration is regulated through the services of RoRo shipping lines and container ship services.
- The second corridor is that of long distances, where trade volumes are high. In this case, competition depends on port efficiency, consolidation of transport tariffs and reliable maritime connections.

The greatest potential for the expansion of maritime trade are Mediterranean partners such as Turkey, Spain, France, Egypt, Israel as far as the medium-term strategy is concerned. This is because the distances are short, and the transport is feasible. To maximize trade with these countries, it is necessary to:

a. Strengthen Ro/Ro service and container ship service.

b. Improve port performance indicators such as turnaround time, dwell time, and service reliability

c. Reduce non-physical barriers.

Another important element is the diversification of the maritime trade. Albania should apply an approach based on maritime corridors. For this purpose, from a political point of view, it should adopt a strategy in accordance with the different sectors of the economy. On the other hand, cooperation with global operators of maritime lines in efforts for joint logistics and investment in prioritizing container processing capacities. Through these measures, the distance factor is reduced and on the other hand, trade is improved in relation to the predicted gravity of these markets, laying the foundations for long-term trade growth.

5. Conclusions

This study confirms that Albania's bilateral trade with partner countries follows the logic of the gravity model. The analysis was based on log–log models estimated with the OLS method, which evidenced that the economic size of the partner (GDP) has a positive and statistically significant effect on trade flows, while geographical distance has a negative and statistically significant effect.

The analysis of the results of the gravity model showed that:

1% increase in the partner country's GDP is associated with an increase of about 0.43–0.45% in Albania's trade flows.

1% increase in geographical distance is associated with a decrease of about 0.85% in trade.

The signs and magnitudes of the coefficients are fully consistent with the theoretical predictions of the gravity model and with the existing literature. They are consistent with the theoretical approach of Anderson & van Wincoop (2003), as well as with empirical evidence for Albania and the region (Merko et al., 2022; Korsita et al., 2023).

Multicollinearity analysis showed that the inclusion of Albania's GDP in Model 1 created strong collinearity signals, due to the limited cross-country variation of this variable in the panel. However, comparing Model 1 with Model 2 (where ln_gdp_alb was excluded) showed that the main results remain consistent. This increases the reliability of the conclusions and suggests that the "gravity message" – economic size increases trade, while distance acts in the opposite direction, i.e. decreases it – is robust in the Albanian context.

Due to the non-inclusion of additional institutional variables (tariff or regional integration), the model explains about 19–20% of the variation in trade ($R^2 \approx 0.197$). This result shows that, in addition to GDP, other institutional and structural factors also play a key role in determining trade flows.

In conclusion, the study confirms that:

1. Albania's trade is significantly affected by the economic size of its partners.
2. Distance remains an important structural obstacle to trade expansion.
3. The gravity model constitutes a valuable analytical framework for guiding trade policy and port development strategies.

6. Recommendations

Based on the above conclusions, given that the GDP of the partner country has a significant impact on trade, Albania's trade policy should be oriented towards:

- Deepening relations with large and fast-growing economies.
- Expanding presence in EU markets, which combine high economic size and relative geographical proximity (UNCTAD 2023).
- Identifying potential markets with high GDP, but currently with a low weight in Albanian trade.

At the same time, given that distance has a strong negative effect, it is recommended:

- Further investment in the capacities of Porto Romano and in new container terminals.
- Modernizing port infrastructure through the application of automation, robotization and artificial intelligence, in order to increase processing efficiency and reduce operational costs (Notteboom & Rodrigue 2005) (Wilmsmeier & Hofmann 2008).
- Digitalizing customs and logistics processes to reduce transit time and costs.
- Improving intermodal connections (road-rail-port) (Tinbergen 1962).

All these measures contribute to reducing the "economic distance", even when the geographical distance remains unchanged.

Another important finding of the study is that proximity to key regional and European partners constitutes a structural advantage. Given this fact, Albania should:

- Deepen regional economic integration (Western Balkans).
- Make maximum use of existing trade agreements.
- Negotiate agreements that reduce non-tariff barriers.

In conclusion, this study provides clear evidence that Albania's trade structure is in line with the fundamental principles of the gravity model: economic size attracts trade, while distance inhibits it. In a context where Albania is transforming its port infrastructure and increasing regional integration, the results of this paper provide a solid analytical basis for designing trade policies and strategic investments in the transport and logistics sector.

7. Limitations of the Study

Although the paper confirms the validity of the gravity model for Albania's trade, it presents several limitations.

First, the model used only includes the basic variables of the gravity model (partner's GDP, Albania's GDP and distance). Modern literature suggests the inclusion of additional variables such as:

- Trade agreements,
- Common border,
- Common language,
- Tariffs and non-tariff barriers,
- Institutional quality,
- Logistics performance indicators.

The omission of these variables may create the problem of "omitted variable bias" and limits the explanatory power of the model ($R^2 = 0.197$).

Second, the analysis was performed with linear regression (OLS). Contemporary gravity model literature recommends the use of the Poisson Pseudo-Maximum Likelihood (PPML) method, which better addresses heteroskedasticity, allows the inclusion of zero flows and provides more consistent estimates.

Third, the study does not include fixed effects for countries or years, which are used to capture multilateral resistance according to Anderson & van Wincoop (2003). The absence of these effects may limit the full compliance with the theoretical specification of the model.

Also, in Model 1, strong multicollinearity was evidenced between the constant and ln_gdp_alb, which required the construction of Model 2 as an alternative specification. Although the results remained stable, this indicates limitations in the structure of variation of panel data, especially for a small economy like Albania.

Finally, the study treats trade relations in an aggregated manner. The analysis would be more complete if it were carried out by:

- Economic sectors,
- Type of goods,
- Sea-based versus land-based trade.

A sectoral breakdown could reveal different elasticities for different product categories.

Despite these limitations, the results provide a strong basis for further, more advanced research in the context of Albanian trade.

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8.1 AI Use Statement

The authors declare that no artificial intelligence tools were used in the preparation, writing, analysis, or editing of this manuscript. The content of the manuscript was prepared entirely by the authors.

References

Albanian Institute of Statistics (INSTAT). (2022). Albania in figures 2022. https://www.instat.gov.al/media/12769/albania-in-figures-2022.pdf

Albanian Institute of Statistics (INSTAT). (n.d.). Official website. https://www.instat.gov.al/

Anderson, J. E., & van Wincoop, E. (2003). Gravity with gravitas: A solution to the border puzzle. American Economic Review, 93(1), 170–192. https://doi.org/10.1257/000282803321455214

Anisiji, C. Z., et al. (2025). Gravity model analysis of Nigeria's bilateral trade. Journal of Maritime Research, 21(1), 332–342. https://www.jmr.unican.es/jmr/article/download/1031/991/4353

Egger, P. (2002). An econometric view on the estimation of gravity models and the calculation of trade potentials. The World Economy, 25(2), 297–312. https://doi.org/10.1111/1467-9701.00432

Head, K., & Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In G. Gopinath, E. Helpman, & K. Rogoff (Eds.), Handbook of international economics (Vol. 4). Elsevier.

Korsita, B., Cania, L., Lazaj, A., & Prendi, L. (2023). An application of the gravity model: Exploring foreign direct investment in the Balkan region. Review of Economics and Finance, 21, 2036–2041. https://www.researchgate.net/publication/376831173_An_Application_of_the_Gravity_Model_Exploring_Foreign_Direct_Investment_in_the_Balkan_Region

Leitão, N. C. (2024). Gravity model and international trade: A survey of the literature. Administrative Sciences, 14(9), Article 219. https://doi.org/10.3390/admsci14090219

Merko, F., Prendi, L., & Memaj, F. (2022). A panel data analysis of Albania's trade: The gravity model approach. Informatica Economică, 29(2). https://doi.org/10.14665/1614-4007-29-2-005

Metalla, O., Keci, E., & Klemo, M. (2020). Durres container terminal cargo demand analyses and reallocation of terminal. International Journal of Advanced Research in Engineering and Technology, 11(12), 2215–2223. https://doi.org/10.34218/IJARET.11.12.2020.209

Notteboom, T., & Rodrigue, J.-P. (2005). Port regionalization: Towards a new phase in port development. Maritime Policy & Management, 32(3), 297–313. https://doi.org/10.1080/03088830500139885

ResearchGate. (n.d.). The log of gravity. https://www.researchgate.net/publication/281020612_The_Log_of_Gravity

Santos Silva, J. M. C., & Tenreyro, S. (2006). The log of gravity. Review of Economics and Statistics, 88(4), 641–658.

Tinbergen, J. (1962). Shaping the world economy. Twentieth Century Fund.

United Nations Conference on Trade and Development (UNCTAD). (2023). Review of maritime transport 2023. United Nations. https://unctad.org/publication/review-maritime-transport-2023

Wilmsmeier, G., & Hoffmann, J. (2008). Liner shipping connectivity and port infrastructure as determinants of freight rates in the Caribbean. Transport Policy, 15(2), 71–79. https://www.researchgate.net/publication/5223519_Liner_Shipping_Connectivity_and_Port_Infrastructure_as_Determinants_of_Freight_Rates_in_the_Caribbean