DOI: 10.47743/eurint-2025-LAZ • November 2025 • VOLUME 12

Research on the determinants of bilateral trade between Romania and its major trading partners: panel data analysis based on the GLS gravity model

Jingxin Hu ✉
Dimitar A. Tsenov Academy of Economics, Svishtov, Bulgaria

Abstract: Based on the gravity model theory, this paper studies the determinants of bilateral trade flows between Romania and its main trading partners from 2010 to 2023. The research goal is to explore the role of economic size, geographical distance, institutional arrangements and foreign direct investment stock in promoting trade. To this end, this paper constructs an extended gravity model, using the generalized least squares method (GLSAR) and introducing a first-order autoregressive correction to deal with serial correlation and improve estimation accuracy. The model introduces variables such as GDP lagged term, FDI lagged term, geographical distance, border relations, Schengen membership and EU membership. The results show that economic size and geographical proximity are the core factors determining trade flows, while institutional integration and investment also have a significant driving effect on trade relations.

Keywords: bilateral trade, gravity model, panel data, economic integration, trade determinants

Introduction

As an important economy in Central and Eastern Europe and a member of the European Union, Romania's economy is highly dependent on foreign trade. Bilateral trade plays a key role in promoting Romania's economic growth and employment (Gherman & Ștefan, 2015). In particular, trade between Romania and its major trading partners has continued to expand over the past decade. These major partners include Germany, Italy, Hungary, Poland, Bulgaria and China. Germany and Italy are Romania's largest export markets, accounting for about one-third of Romania's total exports.

The research subjects were selected based on the principles of interpretability and representativeness. First, Romania's seven largest trading partners were

✉ International Economic Relations, Dimitar A. Tsenov Academy of Economics, Bulgaria, email: bg.jingxin@gmail.com.

included, balancing long-term market share and stability to cover major bilateral flows. Second, geographical proximity and supply chain coupling were emphasized to reflect the actual constraints of intra-regional division of labor and cross-border logistics.

Neighbouring countries such as Hungary and Bulgaria are also important trading partners for Romania in the region. These nations have strong supply chain collaboration and industrial linkages with Romania, and in recent years, China, a major player in the world economy, has grown in importance as a trading partner. Romania's export performance is significantly affected by the demand of its major EU trading partners, consistent with the fact that around three-quarters of Poland's goods exports were destined for the EU market in 2024. To better understand how trade supports Romania's own development and to establish successful foreign economic policies, it is crucial that we do in-depth research on the bilateral trade between Romania and the aforementioned key trading partners.

The goal of this study is to analyse the main factors that affect Romania's bilateral trade flows with Germany, Italy, Hungary, Poland, Bulgaria and China. The following research questions will be addressed in this paper: First, do factors such as economic size and foreign investment significantly promote Romania's trade with these countries? Second, what is the impact of factors such as geographical distance and bordering on bilateral trade? Third, do regional integration factors (such as the Schengen area and EU membership) further enhance the level of bilateral trade? This study uses the gravity model, which is popular in international commerce, as an analytical framework to address these issues.

Research on bilateral trade between Romania and its major trading partners is not only of academic value, but also of practical significance. Trade theory and existing research emphasize that trade is an important engine of growth for emerging economies. In the recovery process after the financial crisis, many EU countries, including Romania, have taken export promotion as an important strategy for economic growth (Gherman & Ștefan, 2015). Baier & Bergstrand (2007) systematically analyzed the role of free trade agreements in promoting the trade volume of member countries. In their review, Head & Mayer (2014) called the gravity model a „workhorse" model for international trade research and pointed out that it is applicable to various bilateral trade scenarios. Davidescu et al. (2022) used a panel data gravity model to simulate Romania's export trends during the epidemic and verified the predictive ability of the extended gravity model. In the context of European integration, Simionescu (2018) investigated the effect of foreign direct investment (FDI) on Romania's exports and noted that trade and investment can have a complementary relationship.

Since Romania joined the EU in 2007, the trade environment has undergone profound changes, and trade ties with neighbouring EU countries have become closer. At the same time, China's rising position in the global trade system has also brought new trade opportunities and challenges to Romania. Through this study, we

will have a clearer understanding of the factors driving Romania's foreign trade, thereby providing a scientific basis for Romania to consolidate its economic and trade relations with major partners.

The first chapter of this paper constructs an extended gravity framework and explains the data, GLSAR estimation and various variables; the second chapter presents the core results and diagnosis; the third chapter interprets the results and proposes policy implications such as infrastructure upgrades and strategic FDI; finally, the contributions and limitations are summarized and the future development direction is pointed out.

1. Methodology and data

This study uses the gravity model as a basic analytical tool to examine Romania's bilateral trade with its partner countries. Jan Tinbergen, a Nobel Prize winner in economics, first proposed the gravity model in 1962. He used the concept of universal gravitation in classical physics and compared two countries to two mass objects, and the trade flow between the two countries is similar to their „gravity". The size of this „gravity" is inversely proportional to the physical distance between the two countries and directly proportional to the economic size of the two countries (Tinbergen, 1962).

Since Tinbergen's pioneering research, the gravity model has become the „workhorse" of empirical trade analysis. Early extensions added price and exchange rate effects to explain the value elasticity of trade flows (Bergstrand, 1985). Subsequently, scholars systematically explained multilateral resistance, pointing out that the accessibility of a country to other global markets will systematically affect the measurement of bilateral trade barriers. Anderson & van Wincoop (2003) formalized this idea into a structural gravity model, proving that if multilateral resistance is ignored, coefficient estimates will be biased.

In its most basic form, the logarithmic linear expression of the Gravity Model is as follows:

$$\ln T_{ij} = \alpha + \beta_1 \ln GDP_i + \beta_2 \ln GDP_j - \beta_3 \ln Distance_{ij} + \varepsilon_{ij}$$

Among them, T_{ij} represents the trade volume between country i and country j, GDP_i and GDP_j represent the economic size of the two countries, $Distance_{ij}$ represents the geographical distance between the two countries, and ε_{ij} is the error term. This form demonstrates the fundamental reasoning that bilateral trade has a negative correlation with geographic distance and a positive correlation with economic scale.

With the development of the theory, the modern gravity model has gradually added more explanatory variables, such as common language, trade agreements, bordering, whether it belongs to a regional economy and other virtual variables,

which further enhances the explanatory power and predictive ability of the model (Anderson & van Wincoop, 2003). Many empirical studies have proved the effectiveness of the gravity model in explaining bilateral trade patterns, and it is a „workhorse" model for trade research (Head & Mayer, 2014). Therefore, the use of the gravity model can help us systematically examine the factors that affect Romania's trade flows with partner countries and quantify the direction and magnitude of each factor.

This study refers to these classic model structures. In order to more precisely identify the factors influencing bilateral trade flows between Romania and its main trading partners, it employs the generalized least squares method (GLSAR) for estimation and introduces institutional variables like FDI, EU membership, and Schengen membership. This is done on the basis of the traditional gravity model in conjunction with the features of panel data.

In the framework of the gravity model, this paper takes the total bilateral trade between Romania and its major partner countries as the explained variable. The core independent variables include the economic scale indicators of both parties and other expansion factors.

The following is the model's log-linear form:

$$\begin{aligned}\ln(\mathrm{TRADE}_{it}) = \alpha + \beta_1 \ln(\mathrm{GDP\_ROM}_{t-1}) + \beta_2 \ln(\mathrm{GDP\_PARTNER}_{t-1}) \\ + \beta_3 \ln(\mathrm{FDI\_PARTNER}_{t-1}) + \beta_4 \ln(\mathrm{DIST}) + \beta_5 \mathrm{BORDER}_i \\ + \beta_6 \mathrm{EU\_membership}_i + \beta_7 \mathrm{SCHENGEN}_i + \varepsilon_{it}\end{aligned}$$

Where：

$\boldsymbol{ln(TRADE_{it})}$ indicates the total bilateral commerce between Romania and trading partner nation i in year t, expressed as a natural logarithm;

$\boldsymbol{ln(GDP\_ROM_{t-1})}$ represents the natural logarithm of Romania's GDP in year t−1;

$\boldsymbol{ln\ (GDP\_PARTNER_{t-1})}$ represents the natural logarithm of the GDP of the trading partner country in year t−1, representing its economic size;

GDP is a measure of economic scale. In order to reduce the endogenous impact and consider the lagged effect of economic scale on trade, the first-period lagged value of GDP, that is, the GDP data of the previous year, is used as the explanatory variable in the model. This treatment can avoid the deviation caused by the mutual influence of trade and GDP in the current year, and it is also in line with the economic intuition that there is a certain lag in trade demand and supply. In the study of related gravity models, lagged GDP is often used to explain the current trade flow to ensure that the direction of causality is clearer (Egger & Pfaffermayr, 2004).

$\boldsymbol{ln\ (FDI\_PARTNER_{t-1})}$ represents the natural logarithm of the stock of foreign direct investment (lagged one period) of trading partners in Romania;

The FDI variable is introduced because investment exchanges may promote trade - foreign investment in Romania may drive the import of raw materials and parts and the export of finished products, showing the complementary relationship

between trade and investment. In the context of European economic integration, trade and FDI have certain complementarity, and the increase of regional investment is often accompanied by an increase in trade volume (Straathof et al., 2008). Including FDI stock in the gravity model has a solid theoretical and empirical basis. In a gravity model study based on panel data, Baltagi et al. (2015) simultaneously estimated bilateral commodity exports and FDI stock as system equations. The results showed a significant positive correlation between the two, indicating that FDI can directly drive bilateral trade volume through intra-industry trade division and production network effects. FDI usually promotes the import of intermediate inputs and drives the export of final products, thereby enhancing trade links; including it in the model can not only capture the economic integration effects beyond GDP and geographical distance, but also improve the explanatory power and robustness of the estimate. Therefore, using the lagged FDI stock as an explanatory variable in the GLS/GLSAR framework is not only feasible, but also has important policy implications for the empirical results.

$\boldsymbol{ln}(\boldsymbol{DIST})$ symbolizes the geographical distance between Romania and its commercial partner expressed as a natural logarithm;

One of the most important factors in the gravity model is geographic distance. The geographical distance data comes from the GeoDist database of the French Economic Research Center CEPII (CEPII, 2011), where the bilateral distance is calculated based on the geographical center of each country in kilometres. Longer distances usually mean higher transportation costs and information asymmetry, which inhibits bilateral trade (Tinbergen, 1962).

The variable $\boldsymbol{BORDER_i}$ is used to indicate whether the country borders Romania, with a value of 1 if the country borders Romania and a value of 0 if the country does not border Romania;

$\boldsymbol{EU\_membership_i}$ is a binary variable used to determine EU membership, with a value of 1 for member states and 0 for non-member states;

Romania and most of its major trading partners belong to the EU internal market. EU membership means a customs union and a unified trade policy, which greatly reduces trade barriers between member states. To assess the effect of EU membership, a dummy variable is created. It equals 1 if the partner country is an EU member, and 0 otherwise.

$\boldsymbol{SCHENGEN_i}$ is a dummy variable indicating whether the country is a member of the Schengen Agreement. If yes, it takes 1, otherwise it takes 0;

The Schengen Area allows the movement of people and goods while reducing border checks. Although Romania has not officially joined the Schengen area during the study period (2010–2023), partner countries such as Germany, Italy, Hungary, and Poland are Schengen members. This paper sets a dummy variable to capture the possible trade facilitation effect of the Schengen mechanism. It takes 1 when the partner country belongs to the Schengen area, otherwise it takes 0.

$\boldsymbol{\varepsilon_{it}}$ is the error term.

Table 1. Variable Definitions and Data Sources

Variable Name	Description	Unit/Format	Data Source
ln_trade	Annual bilateral trade volume between Romania and partner countries	Current USD (log-transformed)	UN Comtrade
ln_gdp_romania_lag 1	Romania's GDP in the previous year	Current USD (log-transformed)	IMF
ln_gdp_partner_lag1	Partner country's GDP in the previous year	Current USD (log-transformed)	IMF
ln_fdis_partner_lag1	Partner country's stock of FDI in Romania in the previous year	Current USD (log-transformed)	UNCTAD
ln_distance	Geographical distance between Romania and the partner country	Kilometers (log-transformed)	CEPII GeoDist
schengen_partner	Whether the partner country is a member of the Schengen Area	Dummy variable (1 = Yes, 0 = No)	EU Official Website
border	Whether the partner country shares a border with Romania	Dummy variable (1 = Yes, 0 = No)	Author's compilation (based on geographic data)
eu_membership	Whether the partner country is an EU member	Dummy variable (1 = Yes, 0 = No)	EU Official Website

Source: author's representation

To eliminate the dimensional differences between different variables and improve the comparability of regression coefficients, this paper standardizes continuous variables (including GDP, FDI, distance, etc.). The specific method is to perform Z-score standardization on the original variables, that is, subtract the meaning of each variable and divide it by the standard deviation. The standardized variables are used for regression analysis to ensure the stability of the model and avoid the imbalanced impact of some variables on the regression results due to excessive magnitude (Gelman & Hill, 2007). At the same time, this also means that

the interpretation of the regression coefficient needs to be based on the „unit standard deviation".

The data used in this paper are annual panel data from 2010 to 2023, covering Romania and seven trading partners: Germany, Italy, Hungary, Poland, Bulgaria, China, and Turkey. Data on bilateral volume of trade from the United Nations (UN) Commodity Trade Database (UN Comtrade). Macroeconomic indicators, i.e., GDP and population, are taken from IMF, and foreign direct investment (FDI) data are sourced from UNCTAD. From these sources, a balance panel data set was created. The cross-section are country pairs, which are constituted by Romania and its trading partners, and the time frame goes from 2010 to 2023, providing 14 annual observations per pair.

The subsequent are the causes why GLS with serial correlation is considered as a robust model estimation in panel information as the problems of serial correlation and heteroskedasticity Usually exist in the panel datasets. The GLSAR method corrects for autocorrelation in the residuals through iterative estimation, and possibly may give relatively unbiased and efficient parameter estimates (Egger, 2001). GLSAR estimates the autocorrelation coefficient first, and then corrects the data for it, then fits the regression. This process allows us to trim the model building using underlying assumptions for the model that are closer to data properties, therefore providing more dependable standard errors to either estimate coefficient and importantly improves the reliability of the statistical inference (Wooldridge, 2013).

2. Empirical results and analysis

This study uses a GLS gravity model to regress the panel data concerning Romania and its main traded countries over 2010-2023. The model is well-sized, with an R^2 of 0.824 and an adjusted R^2 of 0.809. The F-statistic is 54.27, which is highly significant ($p < 0.001$) showing that the explanatory variables explain well the differences in trade flows and carrying the overall statistical significance of the regression. The significant result of the Durbin-Watson statistic of about 2 also showed that no serious autocorrelation exists in the residuals of the model and thus, the model is robust. An additional p-value related to normality in the residuals is provided from the Jarque-Bera test; this *p* is 0.639, such that the residuals are approximately normal, and basic assumptions of the regression analysis are adequately satisfied.

To test whether there is a serious multicollinearity problem between model variables, this study reports the condition number, which is 13.7. According to the conventional judgment standard (Belsley et al., 1980), when the condition number is less than 30, it can be considered that the model collinearity problem is not serious. Therefore, although there is a certain correlation between the explanatory variables

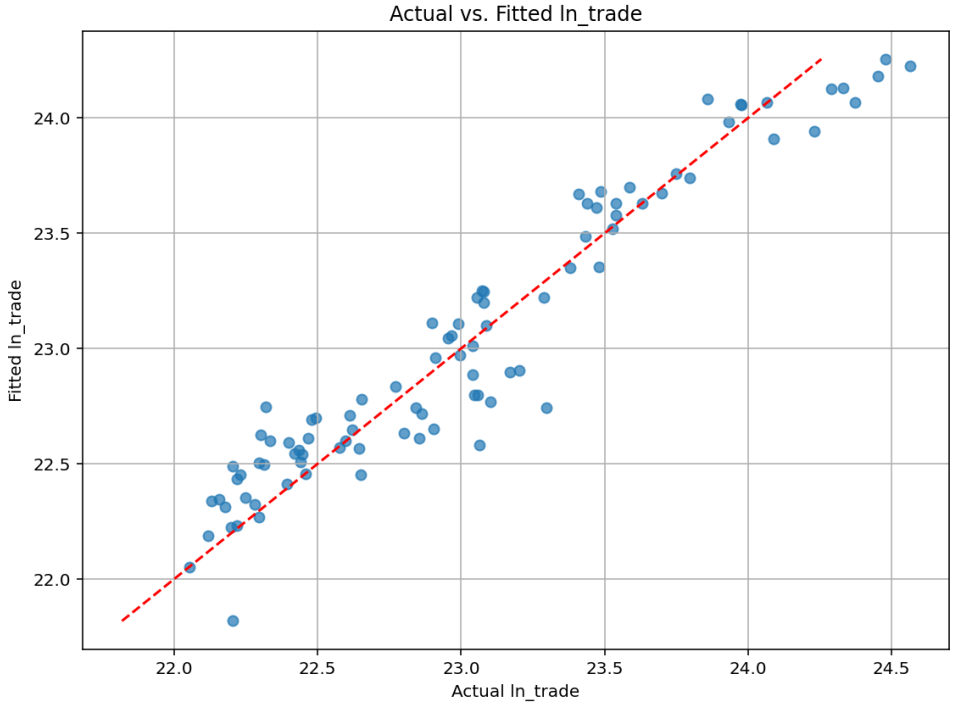
in this model, it is within an acceptable range and will not cause substantial interference to the stability of the regression results.

Table 2. Summary Statistics of the GLS Regression Model

R^2	F-statistic	p-value	Durbin-Watson statistic	Jarque-Bera p-value	Condition Number
0.824	54.27	< 0.001	1.94	0.639	13.7

Source: author's representation based on summary table of the GLS Regression Model

Figure 1. Comparison of Actual and Fitted ln_trade Values

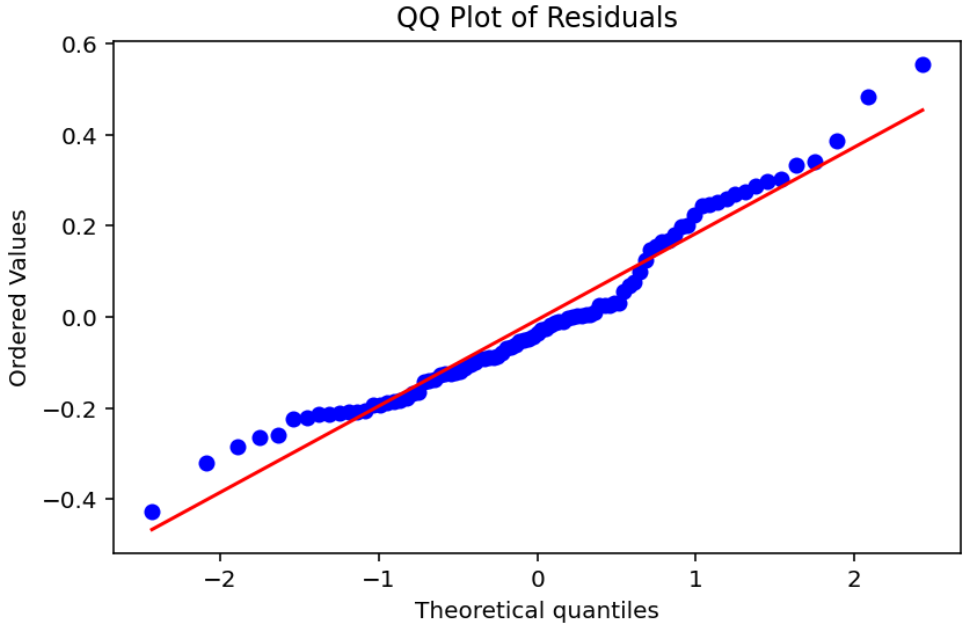


Source: author's representation based on model output

Figure 1 illustrates the relationship between the logarithmic values of actual trade volumes and the model's predicted outcomes. As shown in the figure, the majority of data points align closely with the red dashed line, which represents the ideal fit. This visual alignment suggests that the model performs well in capturing the observed trade dynamics. This is also consistent with the regression results. The R^2 of the model reaches 0.824, indicating that about 82.4% of the trade volume fluctuations can be explained by the selected variables in the model.

The regression results show that the impact of most core variables on Romania's bilateral trade flows is consistent with the expectations of the gravity model. The figure below shows the main results of the model.

Figure 2. GLSAR model residual normality QQ plot



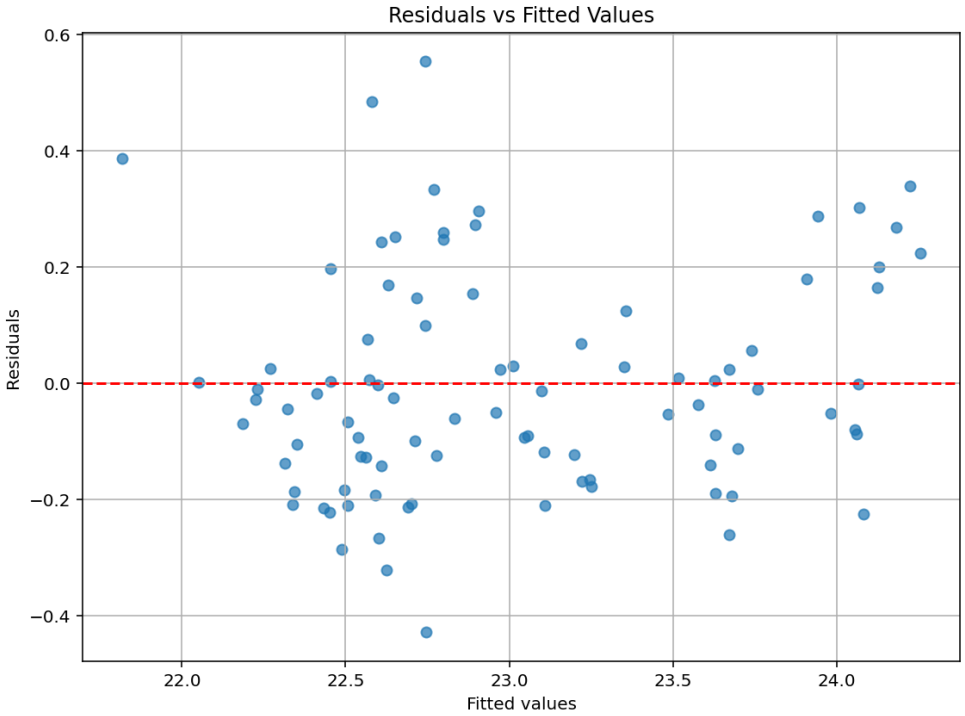
Source: author's representation based on model output

Figure 2 shows the QQ plot of the residuals of the GLSAR model in this study, which is used to test the normality assumption of the residuals. Most of the points in the figure are distributed along the reference line (45°) in the middle, indicating that the residuals are approximately normally distributed in the middle range; there are only slight deviations at the upper and lower quantiles, suggesting that there is a slight thick tail or peak phenomenon in the tail, but the degree of deviation is small. Combined with the statistical results of the Jarque–Bera test (JB = 0.895, p = 0.639) and the Omnibus test (Omnibus = 1.105, p = 0.576), it can be considered that the residuals generally meet the normal distribution assumption, thereby ensuring the validity of the coefficient estimation and the reliability of the significance inference.

In order to evaluate the distribution characteristics of the model residuals and the presence or absence of heteroskedasticity, Figure 3 shows the relationship between the residuals and the fitted values in the estimation results of the generalized least squares autoregression model (GLSAR). This figure is one of the classic residual diagnostic graphs, with the horizontal axis representing the fitted values of the model and the vertical axis representing the corresponding residuals. From the

image, most of the data points are randomly distributed near the zero residual axis (red dotted line), without showing any systematic trend or funnel-shaped pattern, which indicates that the error term of the model generally meets the homoskedasticity assumption.

Figure 3. Residual vs. fitted value plot



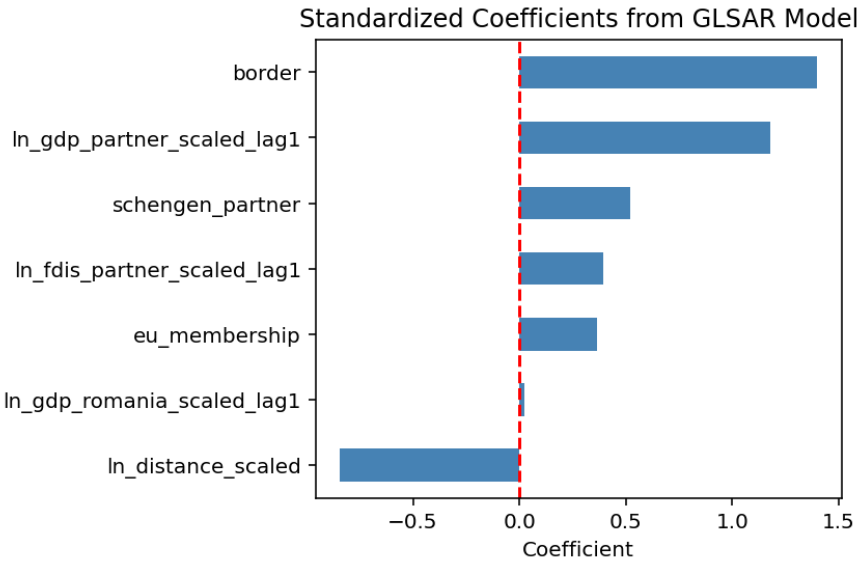
Source: author's representation based on model output

Further observation shows that the fluctuation range of the residual value is mainly concentrated in the range of ±0.4, and there are no extreme outliers, which indirectly verifies the robustness of the model. In addition, the vertical diffusion of the residual is roughly balanced in different fitting value intervals, and does not show a significant expansion or contraction trend, which means that the different value intervals of the explanatory variables do not lead to systematic changes in the error variance.

Figure 4 presents the standardized regression coefficients for the variables included in the model, highlighting their relative influence on trade volume. Among them, the „border" variable exerts the strongest effect, suggesting that, despite high trade volumes with certain non-neighbouring countries such as Germany and Italy, geographic proximity still plays a key role in shaping trade relationships. The

variable „ln_gdp_partner" ranks next in importance, indicating that the economic size of a partner country is also a significant driver of bilateral trade flows. The variable with the strongest negative impact is „ln_distance", which is also in line with the expectations of the gravity model: the greater the distance, the higher the trade costs and the lower the trade volume.

Figure 4. Standardized Coefficients from the GLSAR Gravity Model



Source: author's representation

Ln_gdp_partner_lag1: The coefficient is 1.1797 and passes the significance test, which means that the larger the economic size of the partner country, the higher the trade volume with Romania. This is consistent with the traditional gravity model, that is, trade flows are positively correlated with economic size. With other variables unchanged, when the lagged GDP of the partner country increases by one standard deviation, the logarithmic trade volume between Romania and that country increases by 1.18 units on average, reflecting that external demand is an important driving force for Romania's exports.

Ln_distance: The coefficient is -0.8440 and is highly significant, indicating that when the distance increases by one standard deviation, the logarithmic trade volume decreases by 0.844 units on average. Longer geographical distances increase transportation costs and trade barriers, thereby inhibiting bilateral trade. This result supports the law of „distance hinders trade", that is, Romania prefers to trade with geographically closer countries, and closer neighbors are often more ideal trading partners.

Border: The coefficient is 1.3996 and significant, which shows that sharing a border can significantly increase bilateral trade volume. The results show that if the partner country borders Romania, the trade volume is on average about 4.05 times higher than that of non-border countries. Neighboring countries often have more convenient transportation connections and closer historical and cultural ties, so the border effect promotes bilateral trade and has a strong driving force for trade.

Table 3. Regression Results from the GLSAR Gravity Model

Variable	Coefficient	Std. Error	*T-Value*	P-Value	95% Confidence Interval	Interpretation
LN_GDP_PARTNER_LAG1	1.1797	0.157	7.531	0.000	[0.868, 1.491]	Significant positive impact
BORDER	1.3996	0.162	8.625	0.000	[1.077, 1.722]	Significant positive impact
SCHENGEN_PARTNER	0.5209	0.122	4.282	0.000	[0.279, 0.763]	Significant positive impact
LN_DISTANCE	-0.8440	0.084	10.03	0.000	[-1.011, -0.676]	Significant negative impact
LN_GDP_ROMANIA_LAG1	0.0241	0.026	0.923	0.359	[-0.028, 0.076]	Not significant
EU_MEMBERSHIP	0.3647	0.145	2.509	0.014	[0.075, 0.654]	Significant positive impact
LN_FDIS_PARTNER_LAG1	0.3952	0.102	3.864	0.000	[0.192, 0.599]	Significant positive impact

Source: author's representation

Schengen_partner: coefficient is 0.5209, indicating a significant positive effect. If the partner country is a Schengen country, the trade volume is about 68.3% higher on average, indicating that if the trading partner belongs to the Schengen area, it will help increase its trade with Romania. The Schengen membership of the partner country may indirectly promote trade by simplifying personnel exchanges and improving logistics efficiency. Romania's accession to the Schengen area is expected to have an additional positive boost to its trade with Schengen countries.

EU_membership: The coefficient is 0.3647 and significant, indicating that when the trading partner is also a member of the EU, the bilateral trade volume is significantly higher than the trade with non-EU countries, and the trade volume increases by about 44% on average. After Romania joined the EU, many trade

barriers such as tariffs have been eliminated with member states, and common market regulations and standards have also facilitated the circulation of goods. Therefore, the „EU effect" brought about by EU integration has significantly improved Romania's foreign trade level.

Ln_fdis_partner_lag1: The coefficient is 0.3952 and significant, indicating that an increase in the stock of direct investment from partner countries to Romania will lead to an increase in bilateral trade in the following year. For every one standard deviation increase in the stock of FDI from partner countries to Romania, the bilateral trade volume in the following year increases by about 0.40 units, indicating that the hypothesis that investment promotes trade holds true. FDI may promote trade by establishing cross-border supply chains and improving local production capacity. This is consistent with the findings of Simionescu (2018): Romania has attracted a large amount of foreign investment since joining the EU, and countries with larger exports are more inclined to invest in Romania. This shows that trade and investment have a complementary relationship, and an open investment environment can further expand trade channels.

The coefficient of Romania's own lagged GDP is positive but not statistically significant, suggesting that fluctuations in Romania's economic size have no notable marginal effect on bilateral trade within the framework of this model. This result may be attributed to Romania's relatively small and stable economy. Once partner country demand and other factors are controlled for, the influence of Romania's GDP appears diminished. Therefore, compared to internal supply capacity, external demand and structural factors provide a stronger explanation for trade fluctuations (Miron et al., 2019).

These empirical results are generally consistent with the expectations of the classical gravity model. Overall, the model explains most of the variation in Romania's foreign trade flows, confirming the important role of economic size, distance, and institutional factors in bilateral trade.

3. Discussion and implications

The empirical results underscore that the external trade of Romania reflects the classical gravity form: the larger and closer in distance two economies are, the greater their trade connection. Consistent with conventional theory, volumes of bilateral trade are positively correlated with the economic size of the partners countries, but are negatively correlated with geographical distance (Tamaș & Miron, 2021). The higher the distance between Romania and a trading partner, the lower is the trade intensity and the less the two countries are related by trade. In practice this means that richer European markets suck in more Romanian exports and trade with more distant countries is snuffed out by the tyranny of distance. In conclusion, this gravity decomposition shows that external demand conditions and distance are first-order determinants of Romania's trade, precisely as Tinbergen's gravity model

would expect. These results suggest the importance of maintaining the growth of its exports will depend crucially on economic developments in larger markets notably in Europe and in overcoming geographical trade barriers.

Regional integration and institutional quality are also crucial. Membership of the EU has traditionally given Romania a significant trade boost with other member states. In this specification, the EU membership dummy is positive and statistically significant, consistent with higher trade via harmonized standards, a common external tariff, and streamlined border formalities that reduce compliance and waiting costs. Similarly, the Schengen Agreement, is predicted to act as a facilitator to trade, and for Romania recently joining the Schengen area, its exports will receive an added fillip. Apart from agreements, the institutional factor is equally important. The poor governance and regulation quality can foster or inhibit trade. For example, Davidescu et al. (2022) find that Romanian exports are affected by government effectiveness and control of corruption. Tamaș & Miron (2021) determine, in the context of an augmented gravity model that different governance indices (rule of law, regulatory quality, control of corruption, etc.) would imply huge increases in exports. More specifically, improved Corruption Control in Romania is linked to higher Exports, while low corruption and strong institutions in partners sustain Imports. These institutional channels embody the notion that stable and transparent policies minimize trading frictions.

Thus, EU integration and institutional development have complementary effects: by aligning Romania's regulations and legal standards with those of its neighbors, integration has encouraged trade, while further institutional reforms can amplify this benefit. In practice, trade agreements and common markets have helped explain why about three-quarters of Romania's trade is now with other EU members, and why further convergence in regulations or currency union could raise bilateral flows even more. However, as some studies note, the gains are not automatic. For example, deeper EU integration has sometimes been shown to influence FDI flows even more than trade flows (Straathof et al., 2008, cited in Simionescu 2018). In sum, this finding supports the view that institutional improvement, like reducing corruption, enhancing regulatory quality and deeper regional integration, maintaining open market linkages with the EU and neighbors, strengthen Romania's trade beyond what simple size and distance would predict.

Foreign direct investment (FDI) is another key channel linking Romania with the world. By facilitating production of tradable goods domestically, FDI can alter trade patterns. High inflows of FDI, especially in manufacturing and technology, often raise a country's exports and imports (through local demand for intermediate inputs). Recent firm-level research finds that FDI in Romania has tended to boost the quality of its exports. Bajgar & Javorcik (2020) report that the involvement of multinational companies in upstream industries correlates with improved export quality from Romanian firms. In other words, foreign investment in inputs and component industries enables local producers to upgrade and sell more sophisticated

products abroad. They also notice smaller, positive impacts of FDI in downstream sectors. The implication is that attracting strategic FDI can have spillover effects on domestic exporters, improving Romania's competitiveness.

At the aggregate level, foreign-owned companies contribute a large share of Romania's trade flows. While up-to-date official numbers are limited, previous studies show that FDI-backed firms were responsible for over two-thirds of Romania's exports in the late 2000s (Zaman & Vasile, 2012). Notably, this also meant they accounted for the bulk of imports in sectors such as retail and trade. For example, Zaman & Vasile (2012) find that between 2007 and 2009, FDI firms held 70.8% of Romanian exports and 59.2% of imports, but nevertheless generated a trade deficit. While more recent data are needed, it is likely that foreign-affiliated enterprises remain influential.

To capitalize on FDI for trade, Romania needs to ensure that inward investment supports export capacity. This involves maintaining a stable, investor-friendly environment– in line with the institutional effects above – and fostering sectors with global value chain links. It also implies encouraging partnerships between multinational and local firms. The positive link between FDI and export quality suggests policies to attract greenfield investment in high-tech and R&D could pay off in higher exports. Conversely, measures should be taken to avoid „trapped" FDI that only imports final goods. In sum, FDI influences Romania's trade both directly (through the volume of goods foreign firms sell) and indirectly, and thus represents a crucial factor that complements the gravity drivers.

In a bilateral gravity model, one typically includes both partners' GDP. Partner GDP measures external demand, while Romania's own GDP represents its supply capacity. However, the coefficient on Romania's GDP can be tricky to interpret, especially in panel estimations with fixed effects. In some specifications, Romania's aggregate GDP variation is absorbed and its direct coefficient may be estimated imprecisely. Indeed, sectoral studies have found unexpected results for this term. For example, Tamaș (2020) reports that in a gravity model of Romania's electronics trade, the coefficient on Romania's GDP turned out negative in some regressions. This counterintuitive finding likely reflects statistical issues rather than an economic „negative size" effect.

In practice, the key point is that Romania's market size sets an upper bound on trade but adds little explanatory power once other factors are controlled. The partner's GDP typically emerges as the dominant demand driver, whereas Romania's GDP mostly reflects aggregate supply changes over time. For example, if Romania's economy grows, one might expect exports to rise, but this tends to happen only if that growth is in tradeable sectors or triggered by foreign demand. The literature on structural gravity suggests interpreting the GDP terms with care: fixed effects may sweep out exporter-time effects, and multilateral resistance may obscure a simple GDP coefficient. Thus, in this model Romania's GDP is included for completeness, but its coefficient should be viewed conditionally. Instead of focusing on this

coefficient, it is more informative to note that other results – higher partner GDP, shorter distance, better institutions – remain robust drivers of bilateral trade. In summary, while Romania's economic size matters in theory, the gravity results emphasize the relative sizes: Romania exports more to partners whose economies are large relative to its own, and vice versa.

3.1. Policy Implications

The above findings have clear implications for Romania's trade and economic policy. First, deepening ties with neighboring EU countries remains essential. The evidence indicates that share of trade with close EU partners is disproportionately high; hence policies should aim to reduce any remaining non-tariff barriers, harmonize standards, and take full advantage of single-market membership. Romania's recent Schengen entry should, for example, make cross-border trade in services and goods more fluid. Bilateral or regional agreements to improve border procedures can further amplify the gravity gains.

Second, infrastructure investment must become a priority. As highlighted, Romania's lagging road, rail, and port infrastructure actually increases transport distances and costs. Policymakers should therefore accelerate EU-funded projects to modernize transport networks. This includes not only building new motorways and rail links, but also improving the efficiency of customs and port terminals. Investments in the Danube corridor and Black Sea ports, such as dredging the Sulina Channel and upgrading the Port of Constanta, will pay off handsomely by reducing transport times. Improving infrastructure will reduce the negative effects of distance and enable Romania to integrate more fully into European supply chains.

Third, the importance of institutional reform and governance cannot be ignored. Lowering corruption and reducing the administrative burden will reduce trade costs and increase the quality of FDI it receives. This may mean digitising clearance of goods, enhancing judicial contract enforcement, and providing policy predictability. The experience indicates that to the extent that these gains are realized, very small changes in governance indices may lead to significant increases in exports. In addition, Romania can attract FDI in sectors that are complementary to domestic industry by creating a transparent investment environment (Bajgar & Javorcik, 2020).

Fourth, promoting strategic FDI and export-oriented investment pays off. Policy should not only seek to raise the amount of FDI but to direct it to high-value-added industries. This could be achieved by providing tax incentives or subsidies for projects with export potential or technology „spillovers". Simultaneously, support measures for domestic exporters can help local firms serve foreign demand. For instance, the focus of trade promotion activities could include countries in which Romania already has investment relationships utilizing companies' existing business contacts.

Finally, macroeconomic stability continues to matter. As external demand is a major force, sound fiscal and monetary policies that maintain stable growth and currency conditions will enhance Romania's appeal as a trade partner. While this gravity analysis abstracts from short-run fluctuations, broader assessments warn that reliance on consumption-driven growth can widen trade deficits. Therefore, policies that boost productive rather than purely consumption will support a healthier trade balance over time.

In sum, the analysis reveals that Romania's trade patterns are driven by well-known gravity forces, but also by integration decisions and by the institutional context. Economic policy in Romania needs to continue to build strong links to both neighbouring countries and major exporters, need to invest in the physical infrastructure that is the basis for these links and the increase in trade, and need to improve the business environment in order to attract productive investment. These will help Romania take advantage of its strategic location in Europe and get back to economic growth that is related to the overall growth of the countries with which we trade.

Conclusion

Drawing on an augmented gravity-model specification, this study provides a systematic picture of the multifaceted determinants shaping Romania's bilateral trade with its seven main partners during 2010–2023.

First, the strongly positive coefficient on partner GDP confirms that external demand remains the key driver of Romanian exports; trade dynamics are tightly synchronized with the business cycles of core EU economies. Second, distance and border effects continue to act as „geographical valves": a 1% reduction in distance significantly raises trade flows, while sharing a common border multiplies trade volumes thanks to lower costs and cultural proximity. Third, the combined benefits of EU and Schengen membership are evident: common tariffs, regulatory alignment, and the abolition of border checks reduce both visible and „institutional" trade frictions. Fourth, the positive elasticity of lagged FDI stock indicates that investment and trade are complementary within global value chains—multinational firms that set up operations in Romania import intermediate inputs and export finished goods, expanding flows in both directions.

The policy implications are obvious. Romania could deepen its economic links with its neighbors to harness its EU single-market status and its forthcoming full participation in Schengen, press ahead with cross-border corridor projects, digitalize border-processing procedures and modernize its ports to cut logistics costs and reduce effective economic distance, reinforce investor confidence through stronger rule of law, anti-corruption efforts, and more efficient administration, and thus attract FDI to high-value manufacturing and technology intensive services, and the help domestic firms integrate into regional value chains by offering training in

skills and technology upgrades to create more secure and responsive links to the region. Lastly, given that the current study only includes macro-level indicators and medium-N data, future research could use sectoral-level data or nonlinear and dynamic panel methodologies to further examine the interaction between trade, investment, and institutional determinants and offer more detailed insights into Romania's long-term trade strategy.

Although this study tries to reduce the endogeneity problem by using lag terms and robustness tests, it still cannot completely rule out the possible two-way causality between FDI and bilateral trade volume and the bias caused by common unobserved shocks; therefore, the size of the coefficient should be mainly regarded as correlation rather than strict causal effect, and it is necessary to be cautious when interpreting it. Nevertheless, the sign direction and relative magnitude of the empirical results remain consistent under different models and subsamples, indicating that FDI and trade still show positive interaction in deepening Romania-major partner economic integration. Future research can further identify causal mechanisms by combining instrumental variables or system equations on a larger sample or industry level.

References

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

Baier, S. L., & Bergstrand, J. H. (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics, 71*(1), 72–95. https://doi.org/10.1016/j.jinteco.2006.02.005

Bajgar, M., & Javorcik, B. (2020). Climbing the rungs of the quality ladder: FDI and domestic exporters in Romania. *Economic Journal, 130*(628), 937–955. https://doi.org/10.1093/ej/ueaa003

Baltagi, B. H., Egger, P., & Pfaffermayr, M. (2015). Panel data gravity models of international trade. In B. H. Baltagi (Ed.), *The Oxford Handbook of Panel Data* (pp. 608–642). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199940042.013.0020

Belsley, D. A., Kuh, E., & Welsch, R. E. (1980). *Regression diagnostics: Identifying influential data and sources of collinearity*. Wiley. https://doi.org/10.1002/0471725153

Bergstrand, J. H. (1985). The gravity equation in international trade: Some microeconomic foundations and empirical evidence. *The Review of Economics and Statistics, 67*(3), 474-481.https://doi.org/10.2307/1925976

CEPII. (2011). *GeoDist: CEPII's Geographical Distance Database*. CEPII – Centre d'Études Prospectives et d'Informations Internationales. https://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=6

Davidescu, A. A., Popovici, O. C., & Strat, V. A. (2022). An empirical analysis using panel data gravity models and scenario forecast simulations for the Romanian exports in the context of COVID-19. *Economic Research - Ekonomska Istraživanja, 35*(1), 1254–1274. https://doi.org/10.1080/1331677X.2021.1907205

Egger, P. (2001). SUR estimation of error components models with AR(1) disturbances and unobserved endogenous effects (WIFO Working Paper No. 171). Austrian Institute of Economic Research (WIFO). https://hdl.handle.net/10419/128717

Egger, P., & Pfaffermayr, M. (2004). Distance, trade and FDI: A Hausman–Taylor SUR approach. *Journal of Applied Econometrics, 19*(2), 227–246. https://doi.org/10.1002/jae.721

Gelman, A., & Hill, J. (2006). *Data analysis using regression and multilevel/hierarchical models*. Cambridge University Press. https://doi.org/10.1017/CBO9780511790942

Gherman, A. M., & Ștefan, G. (2015). Exports – trends and impacts on Romania's economic growth process. *Theoretical and Applied Economics, 22*(2(603, Summer), 43–54.

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, pp. 131–195). Elsevier. https://doi.org/10.1016/B978-0-444-54314-1.00003-3

International Monetary Fund. (2024). *World Economic Outlook Database*. https://www.imf.org/en/Publications/WEO/weo-database/2024/October

Miron, D., Cojocariu, C., & Tamas, A. (2019). Using gravity model to analyze Romanian trade flows between 2001 and 2015. *Economic Computation and Economic Cybernetics Studies and Research, 53*(2), 5–22. https://doi.org/10.24818/18423264/53.2.19.01

Simionescu, M. (2018). Effects of European economic integration on foreign direct investment: The case of Romania. *Economics & Sociology, 11*(4), 96–105. https://doi.org/10.14254/2071-789X.2018/11-4/6

Straathof, B., Linders, G. J., Lejour, A., & Möhlmann, J. (2008). *The internal market and the Dutch economy: Implications for trade and economic growth* (CPB Document No. 168). CPB Netherlands Bureau for Economic Policy Analysis.

Tinbergen, J. (1962). *Shaping the World Economy; Suggestions for an International Economic Policy*. https://hdl.handle.net/1765/16826

Tamaș, A., & Miron, D. (2021). The governance impact on the Romanian trade flows: An augmented gravity model. *Amfiteatru Economic Journal*, *23*(56), 276–289. https://doi.org/10.24818/EA/2021/56/276

United Nations Conference on Trade and Development (UNCTAD). (2024). *Foreign direct investment: Inward and outward flows and stock*. UNCTADstat. https://unctadstat.unctad.org/datacentre/dataviewer/US.FdiFlowsStock

Wooldridge, J. M. (2013). *Introductory econometrics: A modern approach* (5th ed.). South-Western Cengage Learning.

Zaman, G., & Vasile, V. (2012). Macroeconomic impact of FDI in Romania. *Procedia Economics and Finance*, *3*, 3–11. https://doi.org/10.1016/S2212-5671(12)00113-X