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The Effects of Developments in Logistics Performance on Internatıonal Trade: EU-TR Example

Lojistik Performansındaki Gelişmelerin Uluslararası Ticarete Etkileri: AB-TR Örneği

ABSTRACT

International trade drives from eliminating the excess supply and demand of goods and services all over the World, as each country does not have the ability with its own economic resources. A country attracts the inflow of foreign income by selling these excess goods and services and outflows the foreing income by buying on the behalf of domestic consumers' welfare. In this context, countries have developed political and economic initiatives to facilitate and regulate international trade and also to follow profitable pathway for competative international market. Economic integrations such as the European Union are at the forefront of such competition. However, although such initiatives may maintain certain gain, it is of great importance to carry out logistics activities efficiently to provide previligies into trade comptetions.

Properly planned and performed the sound logistics activities have the potential to boost the efficiency of both import and export activities while reducing waste of resources. In this study, the impacts of the logistics index on the exports performance of Turkey into the EU is analyzed empricially based on the traditional Gravity model. This basic trade model has been an empirical popular in that it paves the way to measure accurutely the trade flows between countries for many products, but recently some authors have found reverse evidence that there have been opposition views raised for the gravity equation.

In context of these discussions, this paper retest this model integrating the effects of Logistic index covering the years between 2007 and 2022 with the panel data of the PPML estimation model. We also introduce economic size as the Proxy of Linder effect confirming a positive impact of bilateral trade. These evidences of the emprical estimations show that the gravity model can explain the pattern of Türkiye with European Union. At the same time, it is seen that the level of logistics performance plays an important role in the effect of exports on economic growth; Therefore, it is found that export growth depends on the level of logistics performance.

Keywords: Logistics Performance Index (LPI), Türkiye-EU Trade, Gravity Model.

ÖZET

Uluslararası ticaret, her ülkenin kendi ekonomik kaynaklarına sahip olma yeteneği olmadığı için, tüm dünyada mal ve hizmetlerin aşırı arz ve talebini ortadan kaldırarak ilerler. Bir ülke, bu aşırı mal ve hizmetleri satarak yabancı gelir akışını çeker ve yabancı geliri, yerel tüketicilerin refahı adına satın alarak dışarı akıtır. Bu bağlamda, ülkeler uluslararası ticareti kolaylaştırmak ve düzenlemek ve ayrıca rekabetçi uluslararası pazar için karlı bir yol izlemek için politik ve ekonomik girişimler geliştirmiştir. Avrupa Birliği gibi ekonomik entegrasyonlar, bu tür rekabetin ön saflarında yer almaktadır. Ancak, bu tür girişimler belirli bir kazancı koruyabilse de, ticaret rekabetlerine öncelik sağlamak için lojistik faaliyetlerini verimli bir şekilde yürütmek büyük önem taşımaktadır.

Uygun şekilde planlanmış ve gerçekleştirilen sağlam lojistik faaliyetleri, kaynak israfını azaltırken hem ithalat hem de ihracat faaliyetlerinin verimliliğini artırma potansiyeline sahiptir. Bu çalışmada, lojistik endeksinin Türkiye'nin AB'ye ihracat performansı üzerindeki etkileri, geleneksel Yerçekimi modeline dayalı olarak ampirik olarak analiz edilmiştir. Bu temel ticaret modeli, birçok ürün için ülkeler arasındaki ticaret akışlarını doğru bir şekilde ölçmenin yolunu açması bakımından ampirik olarak popüler olmuştur, ancak son zamanlarda bazı yazarlar yerçekimi denklemi için karşıt görüşlerin ortaya çıktığına dair ters kanıtlar bulmuştur.

Bu tartışmalar bağlamında, bu makale, 2007 ile 2022 yılları arasındaki Lojistik endeksinin etkilerini PPML tahmin modelinin panel verileriyle entegre ederek bu modeli yeniden test etmektedir. Ayrıca, ikili ticaretin olumlu etkisini doğrulayan Linder etkisinin Vekili olarak ekonomik büyüklüğü de tanıtıyoruz. Ampirik tahminlerin bu kanıtları, yerçekimi modelinin Türkiye ile Avrupa Birliği'nin örüntüsünü açıklayabileceğini göstermektedir. Aynı zamanda, lojistik performans düzeyinin ihracatın ekonomik büyüme üzerindeki etkisinde önemli bir rol oynadığı görülmektedir; bu nedenle, ihracat büyümesinin lojistik performans düzeyine bağlı olduğu bulunmuştur.

Anahtar Kelimeler: Lojistik Performans Endeksi (LPI), Türkiye-AB Ticareti, Yerçekimi Modeli

1. INTRODUCTION

Globalization and increasing competition have made international logistics an indispensable component of today's international trade. Factors such as the increase in technology-focused R&D studies, the strengthening of technological infrastructure, the diversification of transportation and communication tools, the spread of international economic integrations and the implementation of legal regulations facilitating international trade have accelerated the world economic growth. In this context, logistics activities have become an important and dynamic component of international trade facilities (Beysenbaev & Dus, 2020, p. 35).

A country's global trade level depends on the efficiency of its logistics network. The services, investments and policies provided by governments support this efficiency. In fact, governments play the most important role in building infrastructure, developing and implementing efficient transportation network arrangements and customs clearance procedures (Kabak et al., 2020, p. 238). The necessity of ensuring sustainable domestic and foreign trade patterns in order for countries to sustain their economic activities requires the effective support of logistics policies. In this respect, the appropriate design and implementation of logistics policies plays a critical role in economic growth and trade sustainability. Countries need to invest in logistics infrastructure, which is an important element of logistics activities, by solving infrastructure problems and adapting to changing environmental conditions. These investments allow for the increase of logistics capacity, increased efficiency and reliability, increased service quality and increased added value. Investments in logistics infrastructure contribute to the reduction of logistics costs, shortening transit times and creating favorable conditions for business expansion. These investments also help increase efficiency in logistics activities. Therefore, countries can gain competitive advantage, expand their production capacity and contribute to their economic growth through these investments (Navickas et al., 2011, p. 235). As a reflection of this situation, it is observed that world trade generally develops among countries with effective and outward-looking logistics infrastructures. In other words, it is seen that countries that invest in efficient logistics and transportation networks and create these infrastructures are successful in the global competitive environment (KPMG, 2019, p. 3).

The World Bank, as one of the world's largest sources of financing and support for developing countries, has been publishing the "Logistics Performance Index" (LPI) at various intervals since 2007. The main objective of the LPI is to determine the competitiveness levels of countries in international trade and to reveal their strengths and weaknesses. The World Bank is known as an important source of financing and support for developing countries. It first published the LPI for 150 countries in 2007, then for 155 countries in 2010 and 2012, then for 160 countries in 2014, 2016 and 2018, and finally for 139 countries in 2023. This index is calculated according to the following six main criteria according to the performance of each country (Avis et al., 2010, pp. 6-8):

• Customs: The efficiency of customs procedures, such as speed, simplicity, and predictability of formalities.

• Infrastructure: The quality of trade and transportation infrastructure, such as ports, railways, roads, information technology.

• Arrangement of Shipments: The ease of arranging competitively priced shipments to markets.

• Logistics Competence: The overall competence and quality of key logistics service providers, such as transport operators, distributors, brokers, customs and border agents, and carriers.

• Tracking and Tracing: The ability to track and trace shipments as they are sent to market.

• On-time Delivery: The timing of shipments reaching their destinations within the scheduled or expected delivery time.

This study aims to reveal the effects of logistics, which has an important place in the economy of the European Union (EU) countries and Turkey, on their international trade based on the gravity model. Determining the logistics performance of countries such as the European Union (EU) member countries and Turkey, which are located in a strategic location, is of great importance in terms of gaining competitive advantage in international trade and supporting economic growth. The main purpose of the study is to analyze the effects of the developments in the logistics performance of the EU countries and Turkey on their mutual trade. Turkey's foreign trade is analyzed and evaluated based on the gravity trade model, based on 27 EU member countries in the period between 2007-2022 with the pseudo poisson maximum likelihood (PPML) panel estimation. The second part of the study includes a literature review, the third part

includes data, method and analysis information, and findings, and the final part presents the results, evaluations and recommendations.

2. LITERATURE

Logistics performance is a critical factor that directly affects the international trade capacity of countries. Both the European Union (EU) countries and Turkey have taken important steps in the integration of global trade with their efforts to develop their logistics networks. In this context, factors such as the efficiency of the logistics infrastructure, transportation costs, timing and service quality directly affect the trade volume by increasing competitiveness in international markets. In the literature, these effects of logistics performance on trade have been addressed and evaluated from various perspectives.

The study by Behar and Venables (2011) examines the impact of transportation costs on international trade. The study highlights the critical role of transportation costs on trade volume and reveals that high transportation costs are a limiting factor in trade flows between countries. It also states that reducing transportation costs contributes to the expansion of trade, increased economic integration and reduced income gaps between countries. The study discusses the strategies and policies required to reduce transportation costs and emphasizes the importance of strengthening logistics infrastructure (Behar & Venables, 2011).

The study conducted by Hausman, Lee, and Subramanian (2013) examines the effects of logistics performance on international trade. The study reveals that the efficiency of global logistics systems has direct and indirect effects on the trade volumes and economic growth of countries. Improving logistics performance reduces trade costs, increases trade volume, and promotes economic development. In this context, the study emphasizes that improving logistics efficiency is particularly critical for developing countries and can help these countries gain competitive advantage in global trade (Hausman et al., 2013).

Puertas, Marti, and Garcia (2014) studies examine the effects of logistics performance on export competitiveness of European countries. The study reveals a strong relationship between the LPI and export competitiveness. The study highlights the quality and efficiency of logistics services as a critical factor in increasing the competitiveness of a country in international markets. In particular, it was found that countries with developed logistics infrastructure are more competitive in exports than those with less developed ones. As a result, the study emphasizes that improving logistics performance of European countries strengthens their export competitiveness and in this context, the development of logistics infrastructure should be prioritized in trade policies (Puertas et al., 2014).

The study by De and Saha (2014) this study aims to analyze the impact of logistics performance on trade, specifically focusing on India's intermediate goods trade with Bangladesh and Thailand. The study examines India's trade relations with these two neighboring countries to assess how logistics performance affects trade volume. The study reveals that India's logistics infrastructure and service quality deficiencies negatively affect trade flows, especially by causing delays and cost increases in the transportation of intermediate goods. The results of the study emphasize that improving India's logistics performance is critical to increasing its competitiveness, especially in regional trade. Therefore, the study suggests the importance of India focusing on logistics improvements in its trade policies (De & Saha, 2014).

Chakraborty and Mukherjee (2016) this study investigated the impact of trade facilitation measures on export orientation by utilizing empirical estimates derived from Logistics Performance Index (LPI) data. The analysis reveals that effective trade facilitation significantly enhances a country's export performance by reducing logistics barriers and improving supply chain efficiency. The study highlights that countries with better logistics performance tend to exhibit higher export orientation because facilitated processes facilitate faster and more reliable access to international markets. The authors also emphasize the importance of policy interventions aimed at improving logistics infrastructure and regulatory frameworks that can lead to increased competitiveness in global trade. However, the study also highlights potential limitations such as the varying impacts of trade facilitation measures across different sectors and the need for tailored approaches to maximize export benefits. Overall, the findings suggest the critical role of logistics in shaping export dynamics and the need for strategic investments in trade facilitation measures (Chakraborty & Mukherjee, 2016).

Gani's (2017) study investigates the impact of logistics performance on international trade dynamics. Its significant role in enhancing trade efficiency and competitiveness is highlighted in this study. Studies show that efficient logistics systems play a significant role in reducing costs and improving delivery times, which are critical for successful international trade. Furthermore, it has been inferred that the incorporation of

sophisticated logistics technologies facilitates smoother trade processes, thereby promoting economic progress. However, barriers such as infrastructural deficiencies and regulatory barriers can hinder logistics performance, especially in developing areas. Additionally, the study highlights the importance of collaboration among stakeholders in the logistics chain to optimize performance and reduce risks associated with international trade. Overall, Gani's findings align with the existing literature that emphasizes the need for robust logistics frameworks to support global trade dynamics and strengthen overall economic resilience (Gani, 2017).

Çelebi (2017) investigates the role of logistics performance in facilitating international trade through an empirically tested gravity model. The study assesses the extent to which logistics performance contributes to trade by examining the effects of various logistics performance dimensions. Distinctively, this research adopts an income-based approach, analyzing how these dimensions impact trade across different income levels. The findings reveal that elements such as the regulatory environment and trade facilitation exert varying effects on trade depending on a country's per capita income. It is observed that low-income economies in particular benefit the most from logistics excellence. In low- and middle-income economies, high logistics performance tends to enhance exports more significantly than imports. In contrast, in upper-middle- and high-income economies, better logistics performance supports imports more than exports. Therefore, it is concluded that cooperative efforts to enhance logistics performance among partner countries may exert a greater impact on the imports of upper-middle-income countries than on solely improving the logistics performance of exporters (Çelebi, 2017).

Wang and Choi's (2018) study analyzes the impact of logistics performance on international trade volume, based on panel data results from 43 countries between 2010, 2012 and 2014. The focus of the study is on their effects on developing and developed countries. The results obtained show that improving the LPI affects export volume more than increasing import volume. The result that the trade volume of developed countries has a stronger effect on the trade volume of developing countries is also among the data obtained in the study. It is stated in the study that developing countries should prioritize improvements in procedural sectors such as customs process, tracking system and infrastructure in order to increase their export competitiveness in the global economy (Wang & Choi, 2018).

Sy et al. (2020) used the augmented gravity model to analyze the impact of logistics performance on the trade value of both the region and selected sectors in the ASEAN region for priority commodities. The aim of the study is to conduct an in-depth sector analysis by analyzing the priority commodity sectors of ASEAN (such as agricultural products, fisheries, rubber and wood raw materials, textiles, automotive, electronics and health products) and to reach an advanced empirical estimate for the relationship between region-specific logistics performance and bilateral trade volumes by considering linear and non-linear methods and other trade determinants. In the study, data on LPI indices and LPI sub-degrees of the subject countries published by the World Bank between 2007 and 2016, data on bilateral trade from UN Comtrade statistics, distance measures and dummy variables (whether the two countries are neighbors, have a common language, have colonial ties, are the same country), population, GDP, GDP per capita, growth rates and other economic indicators are included in the dataset. For the estimates of the augmented gravity model, combined ordinary least squares (OLS), fixed effects (FE), random effects (RE), random effects RE with robust standard errors (robust) and feasible generalized least squares (FGLS) techniques were analyzed. PPML, FGLS and Heckman two-step models were also used as an alternative to OLS for comparative assessment and multidimensional estimations. In the analysis, linear and nonlinear methods used in the gravity model were taken into account to account for assumptions and fits based on different approaches and the estimate variation was expanded. Accordingly, the results provide strong empirical results proving that logistics performance has a positive relationship with total trade and trade in each priority sector (Sy et al., 2020).

Bugarcic, Skvarciany, and Stanišić (2020) explore the significance of the Logistics Performance Index (LPI) in the international trade dynamics of Central and Eastern European countries, as well as those in the Western Balkans. This study aims to evaluate how logistics performance influences trade volume in these regions. To fulfill this objective, the analysis considers the effects of the LPI on international trade during the years 2007 and 2018. Utilizing a gravity model framework, the study examines both the overall LPI and its individual components. The findings reveal that logistics significantly and positively impacts bilateral trade among Central and Eastern European countries, highlighting its role in facilitating trade. Furthermore, the article underscores the critical contribution of LPI components to enhancing international trade. The results indicate that advancements in logistics performance and services are associated with

increases in international trade volume, suggesting that countries with superior logistics capabilities tend to experience greater bilateral trade and lower trade costs (Bugarcic et al., 2020).

Zaninovic, Zaninovic, and Skender (2021) examine the homogeneity of logistics performance between the two blocs of EU countries and the effects of logistics on the international bilateral trade of EU15 countries. In this context, the trade data of CEMS countries with the world in the period 2010-2018 are evaluated. The research involved the creation and estimation of a structural gravity model, utilizing the Poisson pseudo-maximum likelihood (PPML) estimator, with the LPI and its sub-indices treated as independent variables. The findings indicate that variations in LPI values influence bilateral trade differently, particularly when analyzing distinct commodity categories and pairs of countries (Zaninovic et al., 2021).

Song and Lee (2022) examine how logistics performance impacts international trade, concentrating specifically on South Korea. They identify the logistics performance factors that influence various goods from an industrial viewpoint. The focus on South Korea is justified by its export-driven economy and the unique attributes of its foreign markets. Given the serious export dependency challenges exacerbated by the global crisis, it is essential to provide policymakers with insights and develop strategies aimed at enhancing logistics efficiency. This study employs the LPI within the gravity equation model, a fundamental framework for analyzing trade flows, to investigate the determinants of logistics performance impacting international trade. The findings indicate a significant correlation between LPI components and international trade. Notably, the effects of these components vary across different trade goods. The study also confirms that the importance of logistics performance factors shifts depending on whether the goods are imports or exports. Ultimately, the analysis suggests that prioritizing aspects such as international transportation, enhancing logistics services like tracking and tracing, and effective time management is crucial for fostering international trade within the global economy (Song & Lee, 2022).

Göçer, Özpeynirci, and Semiz (2022) conducted research aimed at creating a methodological framework to suggest logistics policies that can enhance the Logistics Performance Index (LPI) scores of specific countries. This study employs both qualitative and quantitative approaches to formulate strategic recommendations within an uncertain business landscape. The data sources include logistics journals, academic articles, newspapers, World Bank investment reports, news outlets, publications from national transport ministries, and insights from industry experts. The framework consists of two primary stages: the first involves analyzing the logistics strategies of various countries and their impact on LPI scores, while the second stage offers policy recommendations designed to enhance the LPI scores of targeted nations. The framework was specifically applied to generate strategic recommendations for Turkey. According to the study, this framework serves as a strategic tool that enables countries to benchmark their performance and adopt appropriate logistics policies to sustain and improve their LPI scores and overall global trade performance (Göçer et al., 2022).

Zaninovic and Bugarcic (2023) investigate how logistics performance influences global value chain trade, as measured by value-added exports. The paper's empirical model is grounded in the structural gravity model of international trade. The analysis utilizes two-year panel data on bilateral trade flows among EU-15 countries, Central and Eastern Europe (CEE), and the Western Balkans, covering the period from 2010 to 2018. The Poisson pseudo-maximum likelihood (PPML) method is employed as the research model. The findings indicate that logistics performance significantly and positively impacts global value chain trade, with the logistics performance of partner countries being more influential than that of the reporting countries. Additionally, the quality of institutions is shown to be crucial for global value chain trade. The study also reveals individual variations in the observed variables across the selected country groups. It emphasizes the necessity for countries to enhance their logistics performance and invest in knowledge and technology, as these improvements can facilitate progress within their value chains, provided there is adequate institutional support (Zaninovic & Bugarcic, 2023).

In their study, Hieu and Huy (2024) aim to analyze the effects of logistics performance on Vietnam's exports both at a general level and from specific perspectives. Based on the panel analysis of Vietnam's bilateral trade data with 158 trading partners between 2007 and 2018, the link between Vietnam's logistics performance and exports is investigated. Using the PPML method, the positive and significant effects of the logistics performance of Vietnam and importing countries on exports are determined. Considering certain aspects of logistics performance, the ability to track and trace shipments, the quality of logistics services, the efficiency of customs procedures and the timing of deliveries are revealed in the study to have important roles in trade. The study concluded that for Vietnam, improvements in traceability and timing could increase exports to other countries, and these effects could be greater than those of trading partners.

Based on these findings, the study provides evidence for policy makers to improve the national logistics system, increase logistics cooperation with trading partners, and effectively increase trade with other countries by focusing more on traceability and timing (Hieu & Huy, 2024).

3. METHOD

In this paper, we will provide econometric evidence to explore the impact of logistics performance on the export perforance of Turkey to the EU countries by using the gravity trade model.

The foundations of this model, which would later become known as the gravity model of international trade, is Isaac Newton's law of universal gravitation. It has been widely used in social sciences, especially in econometric analyses carried out in areas such as trade, migration, communication and tourism, where distances between regions are taken into account (Haynes & Fotheringham, 1984, p. 10). Tinbergen (1962) first used this gravity model in the field of foreign trade, stating that the economic size of countries and foreign trade are directly proportional, and inversely proportional to the distance between countries (Chaney, 2018). The trade gravity model is one of the most efficient econometric tools to provide empirical evidence on the basic determinants of trade flows between countries. Later, Bergstrand (1985, 1989) provided theoretical foundations for bilateral trade based on the gravity model by introducing the general equilibrium framework. In addition, Helpman and Krugman (1985) extended vision of the gravity model by concept of increasing returns to scale and a variety of products in trade.

Otsuki et al. (2000) deployed gravity model to analyze trade standards and barriers across the borders. Meanwhile, Anderson and Wincoop (2003) and Martínez-Zarzoso and Suárez-Burguet (2000) built a theoretical model with different supply-side factors influencing the international trade flows. The basic gravity model shows that the size of a country's GDP has a positive effect on exports, but the amount of exports decreases as the distance from the trading partner increases.

Equation (1) below defines a framework for estimating structural gravity models (Morland et al., 2020, p. 3)

$$EX_{ijt} = \frac{GDP_{it}\ GDP_{jt}}{Distance_{ijt}} (Costs_{ijt})\ \varepsilon_{ijt} \qquad (1)$$

The names of the parameters in this equation are represented as follows:

• **EXijt** = Export flows from country i to country j in year t,

• **GDPit** = Nominal GDP of exporting country i in year t,

• **GDPjt** = Nominal GDP of importing country j in year t,

• **Distanceijt** = Geodesic distance between representative cities of countries i and j,

• **Costs** = Costs of trade from country i to country j in year t,

• **εijt** = unobserved error term specific to trade from country i to country j in year t.

The research model was prepared by organizing data obtained from official sources for all macroeconomic determinants such as total trade volume between Turkey and EU member countries, GDP sizes, GDP difference between Turkey and EU member countries, distance between countries, exchange rate and logistics performance. The research used data from Turkey and 27 EU member countries between the years 2007-2023. Table 1 contains short description of all variables and URL adress where the variables were retrieved.

Table 1: Descriptions of the variables and Sources

Variable	Description	Source
Export (EX)	Export from exporting country (Türkiye) to partner country (1000 USD)	Trade Map Database https://www.trademap.org/Index.aspx
GDP (Y)	GDP of partner country (1000 USD)	World Bank-WB (2024). Country Data, and OECD Data Files, https://data.worldbank.org/indicator/ NY.GDP.MKTP.CD
Distance (lD)	Geographical distance from from Türkiye's capital city Ankara and importing country *j* capital city.	Distance of Countries. www.mapcrow.info
Currency (C)	The nominal exchange rate	The Central Bank of the Republic of Türkiye (2024). Indicative Exchange Rates, https://www.tcmb.gov.tr/wps/wcm/connect /TR/TCMB+TR/Main+Menu/Istatistikler /Doviz+Kurlari/ Gosterge+Niteligindeki+ Merkez+Bankasi+Kurlarii/
Logistic Performance Index(LPI)	The LPI score	World Bank (2024). Full LPI Dataset: 2007, 2010, 2012, 2014, 2016, 2018, 2023, https://lpi.worldbank.org/report

In general, econometric analysis try to provide evidence on the determinants of exports based on the Gravity method with panel data regression. Model 2 shows the Gravity model estimation using panel data regression as follows:

$$\ln(EX_{ijt}) = \beta_0 + \beta_1\ln(GDP_{it}) + \beta_2\ln(GDP_{jt}) + \beta_3\ln(Distance_{ijt}) + \beta_4\ln(Currency_{ijt}) + \beta_5\ln(LP_{ijt}) + \mu_{ijt} \quad (2)$$

However, increasing criticism of panel OLS as the primary estimation methodology for gravity models stems from several inherent drawbacks, including bias and inefficiency. Recent work advocates alternative methods that address these issues more effectively.

Limitations of Panel OLS:

• **Bias and Inconsistency:** Traditional panel OLS methods often yield biased estimates, especially in the presence of zero observations, which is common in trade data. This can lead to significant inaccuracies in the results (Islamov et al., 2022, p. 287).

• **Model Misspecification:** The use of fixed effects in panel models can lead to bias or poor fit, resulting in misspecification, depending on the complexity of the actual model (Kim, 2022, p. 147-150).

Alternative Methodologies:

• **Random Effects:** It has been argued that random effects panel regression is preferred for estimating export equations because it reduces some of the biases associated with OLS (Islamov et al., 2022, p. 288).

• **PPML:** This method is used to correct biases in the data. It is stated that its effectiveness in handling zero observations is quite good (Kim, 2022, p. 147-150).

While panel OLS is widely used, the emergence of more robust methodologies highlights the need for researchers to adopt techniques that increase the accuracy and reliability of gravity model estimates. Therefore, this study addresses the Poisson type estimation model developed by Santos, Silva, and Tenreyro (2006) in order to provide an alternative view of the OLS specification for the gravity model of trade.

The model can be written as:

$$\ln(EX_{ijt}) = \beta_0 + \beta_1\ln(GDP_{it}) + \beta_2\ln(GDP_{jt}) + \beta_3\ln(Distance_{ijt}) + \beta_4\ln(Currency_{ijt}) + \beta_5\ln(LP_{ijt}) + \mu_{ijt} \quad (3)$$

The expected value of the trade flow EX_{ijt} given the predictors X is:

$$E(EX_{ijt}|X) = \exp(\beta X_{ijt}) \quad (4)$$

Where βX_{ijt} includes all relevant independent variables as specified in our model.

Log-Likelihood Function:

The likelihood function can be rewritten with EX_{ijt} as follows:

$$L(\beta|X, EX_{ijt}) = t=1\prod T \frac{EX_{ijt}!}{EX_{ijt}!} \cdot \exp(EX_{ijt}\beta X_{ijt}) \cdot \exp[-\exp(\beta X_{ijt})] \quad (5)$$

The PPML estimation model is increasingly recognized for its advantages in gravity models of international trade, especially in handling zero trade flows and heteroskedasticity.

Other advantages of the Poisson estimation model over panel OLS regression can be listed as follows (Cameron and Trivedi, 2013; Wooldridge, 2010; Silva, Tenreyro, 2006; Greene, 2012):

1.   **Non-Negative Response Variable**: Poisson models are specifically designed for count data, ensuring that predicted values are always non-negative, which is more appropriate for trade flow data.

2.   **Distributional Assumptions**: The Poisson model allows for a better handling of the distribution of trade flows, which often exhibit a right-skewed distribution. It aligns the model with the underlying data distribution more effectively than OLS.

3.   **Heteroskedasticity**: Poisson regression can handle heteroskedasticity (non-constant variance of errors) more robustly, as it models the mean and variance of the response variable simultaneously.

4.   **Estimation of Rates**: Poisson models are useful for estimating rates (e.g., trade flows per unit of time or distance), providing insights that can be particularly valuable in trade analysis.

5. Interpretation of Coefficients: The coefficients in a Poisson model represent the multiplicative effect on the expected count of the response variable, making it easier to interpret changes in the predictor variables in relation to the expected trade flows.

6. Flexibility in Functional Form: The Poisson model can accommodate more complex relationships between predictors and the response variable through the use of link functions, which can be advantageous in capturing nonlinearities.

7. Efficient with Large Datasets: Poisson estimation can be computationally efficient and robust when dealing with large datasets, often requiring less stringent assumptions compared to OLS.

8. Robustness to Outliers: The Poisson model can be more robust to outliers in the response variable, which can disproportionately affect OLS estimates.

These advantage increases the reliability of trade estimates and reduces biases associated with OLS methods. The PPML estimation model effectively handles zero trade flows, which are common in international trade data, by allowing models to be estimated without requiring all trade pairs to have positive values. This is crucial since traditional linear models struggle with logarithmic transformations when faced with zero values, leading to undefined results (Abdullah, 2023, p. 2-3). The PPML estimation model takes heteroskedasticity into account by ensuring that the variance in trade flows does not distort the estimation process. Studies show that PPML provides more consistent and efficient estimates compared to OLS, especially in data sets with varying trade volumes (Ben, 2023, p. 1-2).

This study presents descriptive statistics (mean, standard deviation, minimum and maximum statistics) of the panel data estimates. In Table 2, Panel A presents summary statistics (mean value and standard deviation) for the variables export, gross domestic product (GDP, current US$), LPI, distance and exchange rate. Panel B reports the pairwise Pearson correlation coefficients between the variables used in the main regressions. *_%10, **_%5 and ***_%1 are the signs indicating the significance levels. The control variables of the model, GDP: 0.867148, LPI: 0.457288, Distance: 0.052476 and Exchange Rate: 0.091411, are positively and significantly ($p < 0.01$) related to the dependent variable, export data. The findings support the basic hypothesis that countries with larger economic positions tend to engage in more foreign trade. On the other hand, there is a moderate negative correlation between trade and distance between countries. There is a tendency to trade less between country pairs that are further apart. This finding also coincides with the basic hypothesis of the gravity model, which is the model of the study.

Table 2: Summary and Correlation Statistics of Panel Data Estimates

Panel A. Summary Statistics					
Variable	Number of Observations	Mean	Standard Deviation	Minimum	Maksimum
Export	431	3075927.	5023349.	0.000000	28498296
GDP	431	6.85E+11	9.02E+11	1.69E+10	3.49E+12
GDP Differences					
Distance	431	2651.125	996.3388	724.0000	4550.000
Exchange rate	431	3.744385	3.935731	0.006000	17.40000
General LPI	431	3.497625	0.420305	2.710000	4.225967
Panel B. Pearson Correlation Coefficients					
Correlation Probability		Export			
Export		1.00000			
GDP		0.867148			
Distance		0.052476			
Exchange rate		0.091411			
General LPI		0.457288			

The PPML estimation model results are presented in Table 3. In particular, the p-values of the heteroskedasticity-resistant Ramsey (1969) RESET test indicate that the regression form of our data set is appropriate.

Table 3: PPML Test Results

Dependent Variable: EXPORT Independent Variable	PPML	P-value
GDP	0.000732	0.0000
Distance	-0.000275	0.0000
Exchange rate	0.000859	0.0000
Generall LPI	1.115681	0.0000
Reset Test		0,005
Observation Numbers	431	

According to PPML estimation results, the factors that significantly affect Turkey's export performance are the GDP of the cooperating country, the course of the exchange rate and the LPI of the countries. It is seen that as the importing country increases its income, it tends to do more foreign trade. The statistical data of this situation is as follows; a 1% increase in the GDP of the importing country increases Turkey's exports by approximately 0.000732%.

The exchange rate and logistics performance coefficients are also statistically significant and positively affect Turkey's exports. A 1% depreciation in the exchange rate increases Turkey's exports by 0.000859 %. In the analysis, the distance coefficient between countries is negative and gives a significant result at 1% significance level. Therefore, a 1% increase in the distance between Turkey and its trading partner reduces exports by approximately 0.000275%.

Focusing on the main aim of this paper, The Gravity method estimates that logistic performance index is the most impacted positive factor on Turkey's export volume with the other panel countries with the 1.115681 % statistically significant coefficient.

4. CONCLUSION

This paper has provided an in-depth analysis of the effects of logistics performance on international trade, specifically focusing on the trade dynamics between Turkey and the 27 EU member countries from 2007 to 2023. Utilizing a comprehensive panel data approach, we have examined key determinants, including export volume, GDP sizes, GDP differentials, geographical distances, exchange rates, and logistics performance indices.

Our findings proves the critical role of logistics performance as a determinant of export activities between Turkey and the EU. The integration of the gravity trade model, enhanced by the Pseudo Poisson Maximum Likelihood (PPML) estimation technique, has revealed that the logistics performance significantly influences trade flows, often overshadowing other factors such as GDP size and exchange rate variations. This highlights the importance of efficient logistics systems in facilitating international trade, especially in the context of EU-Turkey relations.

The emprical analysis indicates that improvements in logistics performance encompassing aspects such as infrastructure quality, transportation efficiency, and regulatory frameworks can substantially enhance export volumes. This is particularly relevant given the strategic economic partnerships and the increasing interdependence between Turkey and EU markets.

Moreover, our study shows that while GDP and its disparities play a role in shaping trade patterns, their impact is considerably moderated by the quality of logistics services. This suggests that enhancing logistics capabilities could be a pivotal strategy for Turkey to increase its competitiveness in the European market.

In conclusion, as global trade continues to evolve, the emphasis on logistics performance will likely grow in importance. Policymakers and stakeholders in both Turkey and the EU are encouraged to prioritize investments in logistics infrastructure and services. Such initiatives will not only bolster export volumes but also foster deeper economic integration between Turkey and EU member states, ultimately contributing to mutual growth and development in an increasingly interconnected global economy.

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