

Received: 11 Jan. 2026; Revised: 04 Feb. 2026; Accepted: 08 Sep. 2026

<https://doi.org/10.22306/al.v13i3.803>

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak

Kafkas University, Faculty of Economics and Administrative Sciences, Department of International Trade and Logistics, Kars, Türkiye, ozlemalbayrak@kafkas.edu.tr (corresponding author)

Melis İrem Babür

Kafkas University, Institute of Social Sciences, Master's Student Department of International Trade and Logistics, Kars, Türkiye, melisirem78@gmail.com

Keywords: transportation, logistics, supply chain management, economic growth, ARDL models.

Abstract: Transportation activities are among the most influential factors shaping economic growth and development. Since freight mobility and transport infrastructure play a strategic role in sustaining economic activity, understanding how different transport modes contribute to economic performance has become a critical research issue. This research aims to evaluate Poland, a significant economy in Central and Eastern Europe, and Türkiye, a bridge between Europe and Asia, and to reveal the role of transportation modes and supply chain integration in the development of economic growth in the Central and Eastern European region. The study employs the Autoregressive Distributed Lag (ARDL) modeling approach to capture both short-run and long-run relationships between transportation modes and economic growth, given that the variables exhibit different orders of integration. Annual time-series data covering the period 1995-2024 are used for both countries. The novelty of this research lies in its simultaneous, mode-specific comparison of Türkiye and Poland under a consistent methodology, providing new empirical evidence on the transport–growth nexus. Reveal that maritime transport contributes positively to long-term economic growth in Türkiye, while its effect in Poland is limited and negative. Rail transport emerges as the most influential and positively associated mode for economic growth in both countries. In contrast, air transport exhibits a negative and statistically significant effect only in Türkiye, whereas road transport shows no significant relationship in Türkiye but displays a short-term negative and subsequent positive effect in Poland. These results offer valuable insights for policymakers in designing efficient and sustainable transport strategies.

1 Introduction

Economic growth is one of the indicators that show how developed a country is. The reduction of trade barriers and the increased permeability of borders due to globalization have resulted in an increase in international trade, making the shipment of produced goods a strategic endeavor. Conceptually, logistics was previously considered only as a transport or shipping activity. Today, it encompasses various modes and directly contributes to economic development. Therefore, people now view logistics as the key to economic growth and competitiveness. Logistics has entered the business world's agenda in the 21st century in terms of developing capabilities in resource and organizational movements to achieve goals [1].

According to Ricardo, the expansion of foreign trade will not directly increase the quantity of value in a country; however, it will contribute very strongly to an increase in the quantity of goods and, consequently, in the total benefits derived [2], while Krugman emphasizes that trade gains are derived from efficient economies of scale in an integrated market [3]. The decrease in unit costs with increased production volume encourages trade and necessitates cross-border movement of goods. In this context, the efficient operation of logistics systems becomes a fundamental condition for benefiting from economies of scale. Reducing logistics infrastructure costs, shortening delivery times, and improving service quality positively affect both international trade volume and economic growth. However, rising actual costs of transportation are forcing companies to prioritize the utilization of vehicle capacity [4]. The main objective of this study is to comparatively examine the short-term and long-term effects of road, rail, sea, and air transportation on economic growth in Poland, a major economy in Central and Eastern Europe, and Türkiye, which occupies a strategic position between Europe and Asia. In this context, the study aims to contribute to the development of more effective and sustainable logistics and transportation strategies for policymakers by highlighting the different impacts of transportation modes on economic growth.

The logistics performance of countries is evaluated based on many different factors. The Logistics Performance Index (LPI), developed by the World Bank, is one such indicator. The LPI classifies countries according to sub-factors such as customs procedures, infrastructure quality, ease of international shipments, quality and adequacy of logistics services,

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

traceability, and on-time delivery. The LPI was first published in 2007, with Türkiye ranking 34th. Its most recent ranking in 2023 was 38th.

Türkiye's geopolitical location confers logistical advantages. Türkiye's territories in Asia and Europe, along with its three coastlines and numerous neighboring countries, contribute to its advantages in various logistics modes. Located at the center of Europe–Asia–Middle East, Türkiye has the potential to become a regional logistics hub. In this regard, one of its most significant competitors among European countries is Poland. Poland is, after all, a European Union country and occupies a strategic position on the Trans-European Transport Network (TEN-T) corridors. According to LPI indicators, Poland rose from 40th place in 2007 to 28th place in 2023. This score indicates a considerable improvement in Poland's logistics performance, but Türkiye's declined. These indicators show that Poland has improved its integration with the European Union through the digitization of customs processes and infrastructure investments in rail and intermodal transport. These results offer practical insights for policymakers in designing efficient and sustainable transport strategies.

While there are numerous studies in the literature on logistics and logistics elements, supply chain management, logistics costs, modes of transport there is a need for more empirical and comparative studies that comprehensively evaluate logistics performance in relation to international trade and economic indicators, particularly for developing countries. This study aims to examine logistics performance indicators in the context of transportation modes and investigate the extent to which they affect countries' economic growth.

This study consists of five main sections. The first section is an introduction outlining the conceptual framework of the study, the second section is a literature review, the third section is the methodology, the fourth section is the analysis and results, and the final section is the discussion and conclusions. Microsoft Excel and EViews software were used in conducting this research.

2 Literature review

One of the key factors affecting economic growth is logistics activities. Various empirical studies reveal that improvements in logistics performance support both trade volume and economic growth [5,6]. Logistics performance is an significant factor that facilitates countries' integration into the global supply chain and increases their competitive power. Logistics cost advantage is linked to logistics performance [7], performing logistics operations on a small scale increases unit costs and leads to inefficiency [8]. With globalization, the improvement of logistics performance has become an indicator of countries' competitiveness. Therefore, logistics performance is an essential tool to monitor and develop, and it holds strategic importance in terms of international competition. The Logistics Performance Index, issued by the World Bank since 2007, has rendered countries' logistics performance a quantitatively comparable factor. The LPI evaluates countries in six dimensions: efficiency of customs procedures, quality of technical elements of transport and logistics, affordability of international shipments, quality and adequacy of logistics services, traceability of shipments, and timeliness of shipments [9,10]. Despite certain advances in the field of logistics, Türkiye lags behind its potential in the global rankings of LPI indicators [11,12].

Türkiye and Poland are two major competitors in the logistics sector. Different countries approach the evaluation of logistics performance from different perspectives. [13] investigated the impact of the logistics sector on economic growth in Türkiye, while [14] examined the impact of the export-led growth hypothesis on the Polish economy. Logistics performance indicators such as the LPI should be evaluated alongside macroeconomic and sectoral indicators. [15] emphasizes that liberalizing aviation, improving customs quality, and reducing corruption are each consistent with the proposition that they contribute to greater economic development. In general, logistics performance studies in the global and Turkish contexts are presented in Table 1 for worldwide logistics performance assessments and Table 2 for logistics performance assessments in Türkiye.

Table 1 Logistics performance assessment studies worldwide

Authors	Main Variables	Key Findings
[16]	GDP, infrastructure, LPI, international logistics	Türkiye and Poland can become significant logistics centers in Asia-Europe trade thanks to their strategic locations and development potentials.
[17]	Port service quality, system components, competitiveness, logistics processes	Quality port services and process management reduce transportation costs and increase competitiveness.
[18]	LPI, customs clearance, infrastructure, logistics qualification, tracking and monitoring	The LPI development of the two countries has diverged; this situation aims to explain the reasons for the changes in development.
[19]	Sustainable development, growth, indicators, innovation	There are differences in sustainability across EU regions. Local-level data access is significant for effective policy-making.
[20]	LPI, GCI, international transportation, tracking, timeliness	GCI has a significant impact on LPI. Improvements are needed in these areas for competitive strength.

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

[21]	LPI, planning, quality control	The LPI may be insufficient. The Lithuanian example highlights the importance of information infrastructure and planning.
[22]	LPI, logistics performance indicators	LPI was used to compare the logistics performance of EU countries.

Table 2 Logistics performance evaluation studies in Türkiye

Authors	Main Variables	Key Findings
[11]	Logistics, quality, tracking, shipping, scheduling, infrastructure, customs clearance	Although Türkiye has made some progress, there has been no significant change in the global rankings; legal and technical improvements are recommended.
[13]	Transportation, storage, GDP	A unidirectional causal relationship has been found between economic growth and the logistics sector.
[14]	Export, foreign trade	The positive impact of exports on economic growth in Poland has been highlighted, and policy recommendations have been presented.
[23]	LPI, Liner Shipping Connectivity Index (LSCI), Enabling Trade Index (ETI), Availability and Quality of Transport Infrastructures (AQTI).	A country's integrated logistics performance is generally significantly, albeit to a limited extent, influenced by the logistics performance of neighboring countries.
[24]	Logistics, transport modes, geographical location	Logistics villages have been classified according to their geographical and infrastructure characteristics; a multi-criteria analysis has been proposed for the future.
[25]	Customs clearance, infrastructure, strategy	The strategic importance of logistics has been emphasized; the increasing importance of air transport has been mentioned.
[12]	Customs Clearance, LPI	Despite advancements in 2023, Türkiye continues to underperform in relation to its potential.

The impact of logistics performance on economic growth is a crucial subject that requires investigation on a country-specific level. Sea transport [26] rail transport [27], road [28] and air [29] freight transport indicators, along with infrastructure variables such as road length, allow for a more concrete measurement of countries' logistics capacities. Türkiye and Poland should be evaluated in terms of logistics performance indicators among European countries. These two countries can be considered as two European countries competing with each other in terms of international trade and logistics leadership. Türkiye stands out with its geopolitical position, which provides multimodal transport advantages from China and Asia to Europe, while Poland is an significant logistics transit country with TEN-T corridors. Therefore, the comparative analysis of Türkiye and Poland's logistics performance and the impacts of this performance on economic growth is an significant research topic in revealing logistics competition dynamics.

3 Methodology

3.1 Data set and model

In this study, annual time-series data covering the period 1995-2024 are employed for both countries. The time span is limited to approximately thirty years primarily due to data availability constraints, particularly for Poland. Economic growth is represented by Gross Domestic Product (GDP) measured in constant 2015 prices, which is used as the dependent variable. The independent variables representing logistics activity indicators include maritime freight transport measured in twenty-foot equivalent units (TEU) (DYT), rail freight transport measured in million ton-kilometers (DMT), road network length measured in kilometers (KYU), road freight transport measured in million ton-kilometers (KYT), and air freight transport measured in million ton-kilometers (HYT). The data were obtained from national statistical institutions, namely GUS [44] and Tuik [46], as well as from the World Bank databases [45]. To ensure data consistency and preserve the structural integrity of the econometric model, missing observations were completed using the linear interpolation method where necessary. Specifically, interpolation was applied to the following series: maritime cargo throughput for Türkiye (1995-1996); railway length in Poland (1995-1997); rail freight transport in Poland (2024); maritime cargo throughput in Poland (1996-1998); road freight transport in Poland (2024); and road network length in Poland (1995-1998 and 2024).

3.2 Econometric analysis

In econometric data analysis, the most important step in determining the research methodology is identifying the stationarity levels of the series. Accordingly, before proceeding to the empirical analysis, the KPSS test, developed by [30] to assess stationarity, was applied to determine the stationarity properties of the time series included in the dataset.

To examine the effects of logistics elements on economic growth in both countries, the ARDL (Autoregressive Distributed Lag) cointegration analysis was employed. This approach allows the use of series with different orders of integration within the same model, provided that the variables are integrated of order $I(0)$ or $I(1)$, while variables integrated of order $I(2)$ are not permitted. ARDL models combine the lagged values of the dependent variable and the lagged values of the independent variables within a single equation and can be applied to both $I(0)$ and $I(1)$ datasets. The selection of the appropriate ARDL model was based on the AIC and BIC information criteria. First, the ARDL models were estimated, and subsequently, long-run relationships were evaluated within the framework of the ECM (Error Correction Model). In this analysis, a negative and statistically significant ECT (Error Correction Term) indicates the existence of a long-run cointegration relationship. All analyses were conducted using the EViews software package.

3.2.1 KPSS stationarity analysis

The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test, which is widely used to examine the stationarity properties of time series, was developed in 1992 by [30]. The most distinctive feature of this test is that its fundamental assumption regarding stationarity differs markedly from those of conventional tests—particularly the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests [31]. In the KPSS framework, the null hypothesis (H_0) is specified as *the series is stationary*. When the calculated test statistic exceeds the corresponding critical values, the null hypothesis is rejected, leading to the conclusion that the series is non-stationary [32]. Moreover, the KPSS test is reported to provide stronger performance in small samples ($n < 50$) compared to the ADF and PP tests [32,33].

3.2.2 Autoregressive Distributed Lag model and Error Correction model

One of the effective methods used to analyze cointegration relationships among different factors or variables is the Autoregressive Distributed Lag (ARDL) model. The ARDL approach was initially introduced by [34] and was later adapted to cointegration analysis through the development of the bounds testing approach by [35]. The ARDL model allows the simultaneous identification of both long-run and short-run relationships among variables. In studies examining cointegration, the ARDL framework enables the joint analysis of series with different orders of integration—specifically $I(0)$ and $I(1)$ within the same model. Moreover, the ARDL approach is recognized as a flexible and reliable method in small samples, as emphasized by [35,36]. Due to these properties, the ARDL model differs from traditional cointegration techniques such as those proposed by [37,38] and is generally considered to provide more efficient and robust results. Here, the selection of the appropriate model refers to determining the optimal lag length for each variable included in the analysis. For this purpose, the Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) are employed. Once the appropriate model is selected and the cointegration relationship is established, the long-run coefficients and the Error Correction Model (ECM) are estimated to calculate the rate at which short-run deviations converge to the long-run equilibrium [34,36]. The Error Correction Model (ECM) was initially developed by [37] in conjunction with the concept of cointegration. This approach aims to explain the dynamics of short-run fluctuations within the same analytical framework [37,38]. The formal expressions of these models are presented in Equations (1) and (2) [34-36].

$$Y_t = \alpha_0 + \sum_{i=1}^p \varphi_i Y_{t-i} + \sum_{j=1}^k \sum_{l=0}^q \beta_{jl} X_{j,t-l} + \varepsilon_t \quad (1)$$

Y_t denotes the dependent variable, $X_{j,t}$ represents the independent variables, p and q_j indicate the lag lengths, and ε_t refers to the error term. This model has a dynamic structure that incorporates both the lagged values of the dependent variable and the lagged values of the explanatory variables.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p-1} \varphi_i * \Delta Y_{t-i} + \sum_{j=1}^k \sum_{l=0}^{q_j-1} \beta_{jl} * \Delta X_{j,t-l} + \lambda ECT_{t-1} + \varepsilon_t \quad (2)$$

In this equation, Δ denotes the first-difference operator (used to achieve stationarity), ECT_{t-1} represents the error correction term from the previous period (reflecting deviations from the long-run equilibrium), and λ denotes the error correction coefficient. A negative and statistically significant value of λ indicates that short-run disequilibria are corrected toward the long-run equilibrium.

4 Empirical findings

4.1 Empirical findings for Türkiye

According to the results of the KPSS stationarity analysis for the Türkiye datasets, some of the series are integrated of order $I(0)$, while others are $I(1)$. The results of the stationarity analysis are presented in Tables 3 and Table 4.

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

Table 3 Stationarity test results at level for Türkiye

Variable	Test Statistic	Critical (1%)	Value (5%)	Critical (10%)	Value	Result(KPSS)
TlnGDP	0.7615	0.739	0.463	0.347		Not stationary
TlnDMU	0.8162	0.739	0.463	0.347		Not stationary
TlnDMT	0.8039	0.739	0.463	0.347		Not stationary
TlnDYT	0.8419	0.739	0.463	0.347		Not stationary
TlnKYT	0.5151	0.739	0.463	0.347		Stationary
TlnKYU	0.6842	0.739	0.463	0.347		Not stationary
TlnHYT	0.7161	0.739	0.463	0.347		Not stationary

Table 4 First-difference stationarity test results for Türkiye

Variable	Test Statistic	Critical (1%)	Value (5%)	Critical (10%)	Value	Result(KPSS)
ΔTlnGDP	0.1294	0.100	0.739	0.463	0.347	Stationary
ΔTlnDMU	0.3309	0.100	0.739	0.463	0.347	Stationary
ΔTlnDMT	0.1661	0.100	0.739	0.463	0.347	Stationary
ΔTlnDYT	0.4101	0.073	0.739	0.463	0.347	Stationary
ΔTlnKYT	0.4312	0.064	0.739	0.463	0.347	Stationary
ΔTlnKYU	0.0739	0.100	0.739	0.463	0.347	Stationary
ΔTlnHYT	0.1698	0.100	0.739	0.463	0.347	Stationary

Since the datasets are stationary at different levels and none of the series is integrated of order I(2), the ARDL approach was employed for the cointegration analysis. According to the AIC criterion, the appropriate ARDL specification was determined as ARDL(1, 1, 0, 0, 0). The model is presented in Equation (3), and the estimation results of this model are reported in Table 5.

$$TLNGDP = C(1) * TLNGDP(-1) + C(2) * TLNDMT + C(3) * TLNDMT(-1) + C(4) * TLNDYT + C(5) * TLNHYT + C(6) * TLNKYT + C(7) \quad (3)$$

Table 5 ARDL (1, 1, 0, 0, 0) model for Türkiye

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TlnGDP(-1)	0.707*	0.116	6.087	0.000
TlnDMT	0.466	0.307	1.518	0.143
TlnDMT(-1)	-0.677*	0.258	-2.617	0.015
TlnDYT	0.744*	0.283	2.622	0.015
TlnHYT	-0.138*	0.042	-3.255	0.003
TlnKYT	0.049	0.0537	0.920	0.367
C	-4.099*	1.793	-2.285	0.032
R-squared	0.971	Durbin-Watson stat		2.117
Adjusted R-squared	0.963			
F-statistic	124.437			
Prob(F-statistic)	0.000			

(%1, ** %5, ***%10 significant) (R²: 0.963)

The results of the ARDL model indicate that economic growth in Türkiye is positively and statistically significantly influenced by its own lagged values. In addition, a positive and significant relationship is identified between economic growth and the one-period lag of rail freight transport, as well as air freight transport in its contemporaneous form. Another noteworthy finding is that the constant term in the model is negative and statistically significant. Detailed results for the long-run and short-run coefficients are reported in Table 6.

Table 6 Long-Run and Short-Run coefficients of the selected model

Long-Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TlnDMT	-0.712	0.894	-0.806	0.428
TlnDYT	2.543*	0.691	3.677	0.001
TlnHYT	-0.472**	0.214	-2.204	0.038
TlnKYT	0.169	0.203	0.830	0.419
C	-14.005***	7.923	-1.767	0.091

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

Short-Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D (TlnDMT)	0.466**	0.205	-0.806	0.033
CointEq(-1)	-0.292*	0.050	-5.755	0.000
R-squared	0.515	Durbin-Watson stat		2.117
Adjusted R-squared	0.497			

(%1. ** %5. ***%10 significant). (F istatistik: 4.710*)

An examination of the long-run coefficients reveals that economic growth in Türkiye is positively and statistically significantly influenced by maritime freight transport, whereas air transport exerts a negative and statistically significant effect on growth. The results of the Error Correction Model (ECM) indicate that, in the short run, rail transport has a positive and statistically significant impact on economic growth. Moreover, the ECM coefficient, being negative and statistically significant in line with theoretical expectations, suggests that the system converges back to its long-run equilibrium at a speed of approximately 29%. The results of the diagnostic tests conducted to assess the reliability of the model indicate no evidence of autocorrelation, heteroskedasticity, or deviations from normality. These findings support the stability and validity of the estimated model (Table 7).

Table 7 Diagnostic test results

Test	Statistic	$\chi^2(p \text{ değeri})$	Result
Breusch–Godfrey LM	0.150	0.927	No autocorrelation.
Breusch-Pagan-Godfrey	11.180	0.083	No heteroskedasticity
Jarque–Bera	4.12	0.127	The series are normally distributed

Moreover, as illustrated by the CUSUM and CUSUMSQ curves presented below, the model remains within the 5% significance level confidence bounds, indicating that the ARDL model is stable (Figure1).

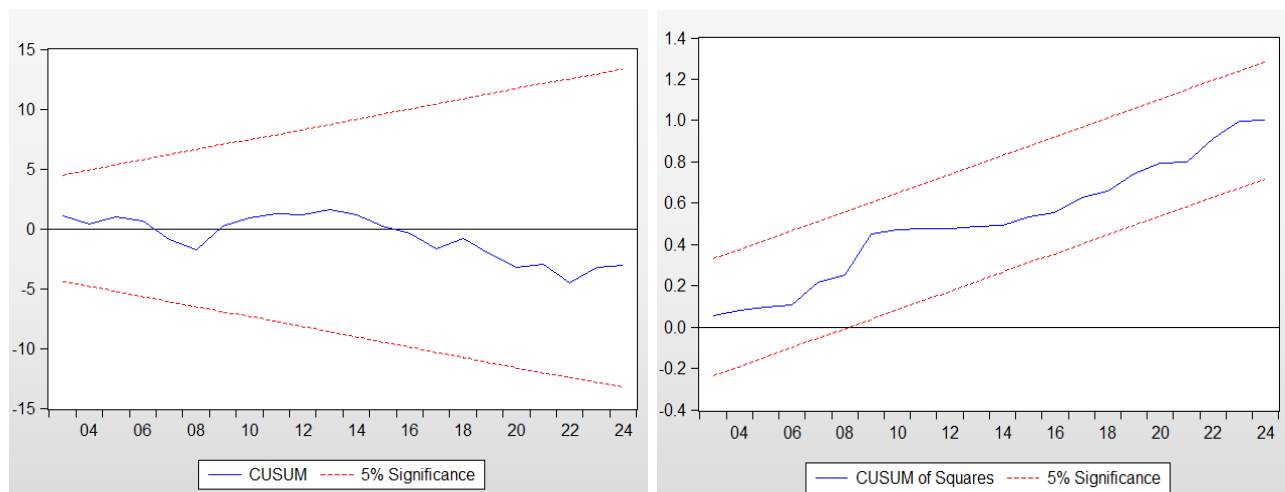


Figure 1 Cusum and Cusum² graphs for Türkiye

4.2 Empirical findings for Poland

According to the results of the KPSS stationarity analysis, none of the series for Poland is stationary at level, and most of the series become stationary after taking the first difference. The results of the stationarity analysis are presented in Tables 8 and 9.

Table 8 KPSS stationarity test results at level for Poland

Variable	Test Statistic	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Result(KPSS)	Variable
PlnGDP	0.81	0.01	0.74	0.46	0.35	Not stationary
PlnDMT	0.20	0.10	0.74	0.46	0.35	Stationary
PlnDYT	0.80	0.01	0.74	0.46	0.35	Not stationary
PlnKYT	0.83	0.01	0.74	0.46	0.35	Not stationary
PlnKYU	0.83	0.01	0.74	0.46	0.35	Not stationary
PlnHYT	0.62	0.02	0.74	0.46	0.35	Not stationary

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

Table 9 First-difference stationarity test results for Poland

Variable	Test Statistic	Critical Value (1%)	Critical Value (5%)	Critical Value (10%)	Result(KPSS)	Variable
ΔPlnGDP	0.11	0.10	0.74	0.46	0.35	Stationary
ΔPlnDMT	0.40	0.08	0.74	0.46	0.35	Stationary
ΔPlnDYT	0.35	0.10	0.74	0.46	0.35	Stationary
ΔPlnKYT	0.34	0.10	0.74	0.46	0.35	Stationary
ΔPlnKYU	0.11	0.10	0.74	0.46	0.35	Stationary
ΔPlnHYT	0.05	0.10	0.74	0.46	0.35	Stationary

Due to the fact that the series exhibit stationarity at different levels, the ARDL model was selected as the analytical method. Based on the AIC criterion, the most appropriate model for the Poland dataset was identified as ARDL(4, 0, 3, 2), and the corresponding model is presented in Equation (4). The estimation results of the selected model are reported in Table 10.

$$\begin{aligned} \text{PlnGDP} = & C(1) * \text{PlnGDP}(-1) + C(2) * \text{PlnGDP}(-2) + C(3) * \text{PlnGDP}(-3) + C(4) * \text{PlnGDP}(-4) + \\ & C(5) * \text{PlnDYT} + C(6) * \text{PlnDMT} + C(7) * \text{PlnDMT}(-1) + C(8) * \text{PlnDMT}(-2) + C(9) * \text{PlnDMT}(-3) + \\ & C(10) * \text{PlnKYT} + C(11) * \text{PlnKYT}(-1) + C(12) * \text{PlnKYT}(-2) + C(13) + C(14) * @TREND \end{aligned} \quad (4)$$

Table 10 Model ARDL (4,0,3,2) model for Poland

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
PlnGDP(-1)	0.436**	0.220	1.981	0.071
PlnGDP(-2)	0.489**	0.240	2.041	0.064
PlnGDP(-3)	0.210	0.224	0.940	0.316
PlnGDP(-4)	-0.634*	0.205	-3.090	0.009
PlnDYT	-0.430	0.256	-1.676	0.119
PlnDMT	1.082*	0.285	3.798	0.002
PlnDMT(-1)	0.151	0.278	0.545	0.595
PlnDMT(-2)	-0.291	0.243	-1.220	0.254
PlnDMT(-3)	-0.708**	0.325	-2.177	0.050
PlnKYT	-0.481***	0.259	-1.854	0.088
PlnKYT(-1)	1.000**	0.308	-3.240	0.007
PlnKYT(-2)	-0.407	0.286	-1.419	0.181
C	13.781**	6.019	2.295	0.041
@TREND	0.026	0.016	1.692	0.122
R-squared	0.994	Durbin-Watson stat		2.082
Adjusted R-squared	0.987			
F-statistic	153.437			
Prob(F-statistic)	0.000			

(%1. ** %5. ***%10 Significant) (R²: 0.987)

According to the results of the ARDL analysis, economic growth exhibits a relationship in the same direction with its past values; however, this effect is statistically significant and negative only at the fourth lag. In addition, a positive and statistically significant relationship is identified between economic growth and rail freight transport. Nevertheless, at the third lag of rail freight transport, the direction of the relationship turns negative. The road transport variable displays a positive effect in the contemporaneous period, while its lagged effect is negative. Another noteworthy finding is that the constant term is positive and statistically significant. Detailed results regarding the long-run and short-run coefficients (ECM model) are presented in Table 11.

Table 11 Long-Run and Short-Run coefficients of the selected model

Long-Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
PlnDYT	-0.863***	0.417	-2.070	0.0607
PlnDMT	0.466	0.618	0.753	0.4655
PlnKYT	0.225	0.391	0.575	0.5755

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

Short-Run Coefficients				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
C	13.788*	2.697	5.112	0.0003
@TREND	0.0263*	0.006	3.859	0.0023
D(PlnGDP(-1))	-0.065	0.135	-0.484	0.6374
D(PlnGDP(-2))	0.423*	0.138	3.063	0.0098
D(PlnGDP(-3))	0.633*	0.137	4.619	0.0006
D(PlnDMT)	1.081*	0.165	6.544	0.0000
D(PlnDMT(-1))	1.001*	0.200	4.994	0.0003
D(PlnDMT(-2))	0.709*	0.211	3.345	0.0058
D(PlnKYT)	-0.481**	0.184	-2.600	0.0233
D(PlnKYT(-1))	0.407**	0.155	2.608	0.0229
CointEq(-1)*	-0.498*	0.098	-5.060	0.0003
R-squared	0.515	Durbin-Watson stat		2.117
Adjusted R-squared	0.497			

(%1, ** %5, ***%10 Significant, F statistic: 5.119***)

According to the long-run coefficients, maritime freight transport has a statistically significant and negative effect on economic growth in Poland. The results of the Error Correction Model (ECM) indicate that economic growth is negatively related to its lagged value in the previous period; however, this relationship turns positive over time. In the short run, rail freight transport and its lagged values exert a statistically significant and positive impact on economic growth. In contrast, road freight transport has a negative and significant effect on economic growth in the short run, while the one-period lag of this variable reverses the direction of the effect to positive.

Moreover, the ECM coefficient being negative and statistically significant, in line with theoretical expectations, indicates that the model returns to its long-run equilibrium at an approximate speed of 50%. Diagnostic tests conducted to assess the reliability and stability of the model confirm that the core assumptions are satisfied. According to the test results reported in Table 12, no statistical problems such as autocorrelation, heteroskedasticity, or deviations from normality were detected. These findings support the validity and stability of the model.

Table 12 Diagnostic test results

Test	Statistic	$\chi^2(p \text{ değeri})$	Result
Breusch–Godfrey LM	2.162	0.335	No autocorrelation.
Breusch-Pagan-Godfrey	11.893	0.619	No heteroskedasticity
Jarque–Bera	0.719	0.620	The series are normally distributed

Moreover, as illustrated by the CUSUM and CUSUMSQ curves presented below, the model remains within the confidence bounds at the 5% significance level, indicating that the ARDL model is stable.

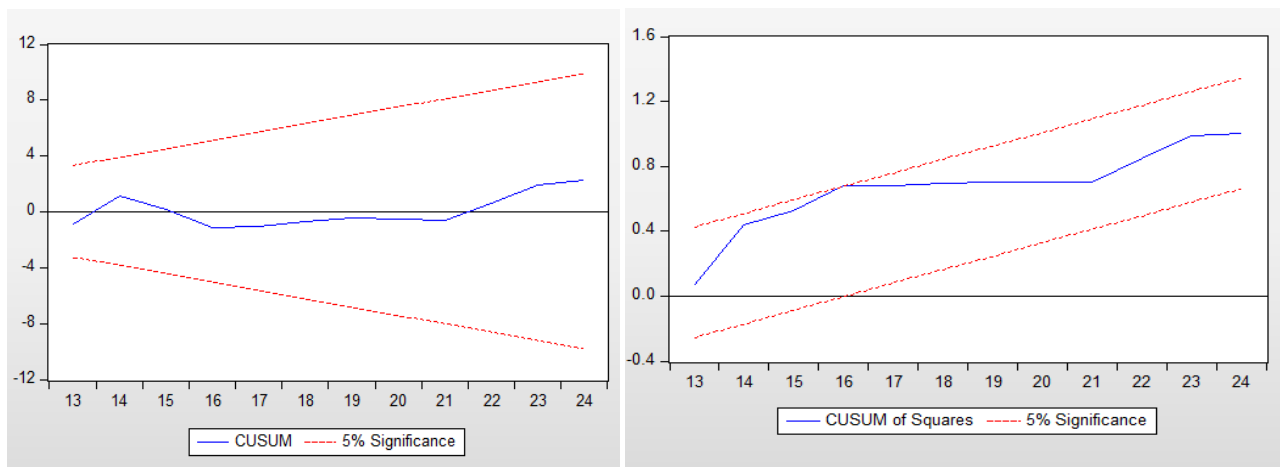


Figure 2 Cusum and Cusum² graph for Poland

5 Conclusions

The main aim of this study is to examine the impacts of logistics activities on the economic development of countries. In this context, the cointegration analysis method was used with time series data for Türkiye and Poland. To determine the cointegration method to be used, the stationarity levels of the data sets were analyzed using the KPSS test, and it was concluded that the series were stationary at different levels ($I(0)$ and $I(1)$). The ARDL cointegration analysis, which is suitable for series with such characteristics, was used. Accordingly, separate ARDL models were estimated for both countries, and short- and long-term dynamics were analyzed. The data sets used in the analysis consist of a 29-year time series covering the period 1995–2024 for both countries. The limitation in data length arose mainly due to the limited availability of statistical sources in Poland. Although the aim was to obtain a time series covering approximately 30 years, missing observations for some years were completed using linear interpolation.

This study aims to guide policymakers in strategic decisions for the logistics sector, rather than focusing on the current logistics capabilities of Türkiye and Poland. The comparative analysis of these two countries highlights the increasing competition in their logistics sectors. Poland stands out in the European logistics network in many different ways. The Baltic–Adriatic and North–South corridors, which are part of the Trans-European Transport Network (TEN-T) project, pass through Poland, providing a strategic advantage. In addition, European Union funds, customs facilities, and free movement opportunities also strengthen Poland's hand in this sector. In 2007, Türkiye ranked 34th and Poland 40th in the LPI ranking, but by 2023, Türkiye had fallen to 38th place while Poland had risen to 26th place. On the other hand, Türkiye is located on the mandatory transit route for Asia–Europe trade due to its geopolitical position. It stands out with its strategic role on the Trans-Caspian International Transport Corridor (Middle Corridor), strong maritime infrastructure, and vast domestic market potential.

The results obtained from the ARDL models created for both countries differ according to transport modes. The results can be summarized as follows based on variables:

- Both countries' own lagged values influence economic growth. In Türkiye, growth shows a positive and significant correlation with its one-period lagged value. This shows that the growth process exhibits strong continuity and inertial structure. For Poland, economic growth was found to be unidirectional and significant in the first, second, and fourth periods and counter-directional and significant in the fourth period. This indicates that despite short-term fluctuations, the economy tends towards equilibrium in the long term, and cyclical shocks subside over time.
- In Türkiye, maritime transport has a positive and significant impact on economic growth in the long term. In Poland, however, this correlation was found to be negative and significant. In Türkiye, the study shows that port infrastructure, which supports foreign trade volume, contributes to growth. In Poland, however, it states that maritime transport does not hinder growth; rather, due to the country's geographical location and limited port capacity, it makes an indirect and relatively weak contribution to growth.
- The correlation between rail transport and economic growth in Türkiye was found to be positive in the short and long term but inversely related with a one-period lag. In Poland, rail transport is positive and significant in the short term but insignificant in the long term. In Türkiye, high infrastructure costs and capacity constraints limit growth in the short term but increases in production and foreign trade mean that railways contribute positively to growth in the long term. In Poland, railway investments, particularly through EU funds and the TEN-T corridors, are effective in the short term, but their contribution to long-term growth remains limited. These results are consistent with other research findings [39–41].
- The negative and statistically significant long-term impact of air transport on economic growth in Türkiye indicates that limited cargo carrying capacity and high cost structure restrict its contribution to growth. In Poland, however, no strong relationship was found between air transport and economic growth, suggesting that the divergence from previous studies may be largely due to methodological differences [42,43].
- In Türkiye, no significant correlation was found between road transport and economic growth in the short or long term. The saturation of road transport, rising environmental costs, and high oil prices can explain this result (Santos, 2018). However, Poland found a negative and significant correlation in the short term, and a positive and significant correlation with a lag period. This data indicates that investment costs suppressed growth in the initial period but subsequently contributed to growth through increased production.
- The fact that the error correction coefficients are negative and statistically significant for both countries indicates that the models strongly revert to long-term equilibrium [35,37,38]. The following period eliminates approximately 49% of deviations in Türkiye and 29% in Poland. The positive trend coefficient found to be significant in the Polish model indicates that changes in the demographic structure and production transformations support economic growth [40,41].

Overall, the findings offer actionable insights for policymakers and logistics stakeholders in Central and Eastern Europe by highlighting the importance of multimodal transport strategies in enhancing and the results show that economic

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

growth in Türkiye is positively correlated with maritime transport, while in Poland it is negatively correlated; in both countries, rail transport plays a decisive role in economic development. Türkiye's strategic position on maritime transport and the Middle Corridor, as well as Poland's strong infrastructure in the EU logistics network, shape the logistics dynamics of the two countries in different directions. Road transport stands out as a complementary factor in Türkiye and a delayed and cyclical one in Poland. supply chain integration and resilience under increasing geopolitical and economic uncertainty. Future research should expand the scope of data sets, conduct detailed analyses at the regional level, and diversify modeling approaches. With improved data quality, it will be possible to obtain more robust econometric estimates.

Acknowledgement

This study is based on the author's doctoral/master's thesis entitled "The Impact of Logistics Performance Indicators on Economic Development: A Comparative Analysis of Türkiye and Poland Using the ARDL Method", submitted to the Institute of Social Sciences, Kafkas University.

References

- [1] KARATAŞ, İ.A.: Bazı Avrupa Ülkeleri ile Türkiye'nin Lojistik Sektörünün Karşılaştırmalı Analizi, *Akademik Yaklaşımlar Dergisi*, Vol. 8, No. 1, pp. 1-22, 2017. <https://izlik.org/JA93CP35NA> (Original in Turkish)
- [2] RICARDO, D.: *Principles of Political Economy and Taxation*, John Murray, London, 1817.
- [3] KOKOVIN, S., PAVEL M., IGOR, B.: Increasing returns, monopolistic competition, and international trade: Revisiting gains from trade, *Journal of International Economics*, Vol. 137, 103595, pp. 1-22, 2022. <https://doi.org/10.1016/j.jinteco.2022.103595>
- [4] PIECYK, M.I., MCKINNON, A.C.: *Analysing global energy trends in road freight transport*, 2009 Annual Conference of the Logistics Research Network, University of Liverpool, pp. 1-8, 2009.
- [5] KHADIM, Z., BATOOL, I., AKBAR, A., POULOVA, P., AKBAR, M.: Mapping the moderating role of logistics performance of logistics infrastructure on economic growth in developing countries, *Economies*, Vol. 9, No. 4, 177, pp. 1-12, 2021. <https://doi.org/10.3390/economies9040177>
- [6] GANI, A.: The logistics performance effect in international trade, *The Asian Journal of Shipping and Logistics*, Vol. 33, No. 4, pp. 279-288, 2017. <https://doi.org/10.1016/j.ajsl.2017.12.012>
- [7] YILDIZ, S.E.: PDLYaklaşımının Milli Savunma Sanayinde Uygulanabilirliği, *Uluslararası İktisadi ve İdari Bilimler Dergisi*, Vol. 2, No. 2, pp. 178-192, 2017. <https://izlik.org/JA94CR43BL> (Original in Turkish)
- [8] BAYRAKTUTAN, Y., ÖZBİLGİN, M.: Türkiye'de iller düzeyinde karayolu yük trafiği dağılımının analizi, *Çukurova Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Vol. 17, No. 2, pp. 81-92, 2013. <https://izlik.org/JA27LD79YL> (Original in Turkish)
- [9] ARVIS, J.F., SASLAVSKY, D., OJALA, L., SHEPHERD, B., BUSCH, C., RAJ, A.: *Connecting to Compete, Trade Logistics in the Global Economy: The Logistics Performance Index and Its Indicators*, World Bank, Washington DC., [Online], Available: <https://www.utikad.org.tr/images/BilgiBankasi/thelogisticsperformanceindexanditsindicators-6261.pdf>, [07 Aug 2025], 2014.
- [10] World Bank Group: Search Data, [Online], Available: <https://data360.worldbank.org/en/search>, [01 Oct 2025], 2025.
- [11] PELİT, İ.: Türkiye'nin lojistik performans endeksinin incelenmesi, Analysis of Türkiye's Logistics Performance Index, *Uluslararası Ekonomi ve Yenilik Dergisi* Vol. 9, No. 1, pp. 37-49, 2023. <https://doi.org/10.20979/ueyd.1185216> (Original in Turkish)
- [12] YAPRAK, H.: Lojistik Performans Ölçütleri ve 2007-2023 Yılları Arasında Türkiye'nin Performansı, Logistics Performance Measures and Turkey's Performance between 2007-2023, *Kahramanmaraş Sütçü İmam Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Vol. 14, No. 2, pp. 19-35, 2024. <https://doi.org/10.47147/ksuibf.1539599> (Original in Turkish)
- [13] YURDAKUL, E.M.: Türkiye'de Lojistik Sektörü Ve Ekonomik Büyüme Arasındaki İlişkinin Var Analizi İle İncelenmesi, Examination of relationship between logistics sector and economic growth in Turkey through var analysis, *Sosyal Ekonomik Araştırmalar Dergisi*, Vol. 20, No. 40, pp. 174-185, 2020. <https://doi.org/10.30976/susead.707425> (Original in Turkish)
- [14] YURDADOĞ, V., BAL, H., ALBAYRAK, M.: İhracata Dayalı Büyüme Hipotezi: Polonya Ekonomisi Üzerine Ampirik Bir Araştırma, Export-led growth hypothesis: an applied analysis on the Polish economy, *Çukurova Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, Vol. 28, No. 2, pp. 31-44, 2019. <https://doi.org/10.35379/cusosbil.588408> (Original in Turkish)
- [15] KASARDA, J.D., GREEN, J.D.: Air Cargo as an Economic Development Engine: A Viewpoint, *Journal of Air Transport Management*, Vol. 11, No. 6, pp. 459-462, 2005. <https://doi.org/10.1016/j.jairtraman.2005.06.002>

- [16] ACAR, A.Z., BENTYN, Z., KOCALOĞLU, B.: Comparing the development of Turkey and Poland as potential logistic hubs in context of international logistics, *International Journal of Logistics Systems and Management*, Vol. 35, No. 3, pp. 410-424, 2020. <https://doi.org/10.1504/IJLSM.2020.10015972>
- [17] NICOLAE, F., BUCUR, M., COTORCEA, A.: Port performance evaluation. Case study: Ports in the Black Sea basin, *IOP Conference Series: Earth and Environmental Science*, Vol. 172, No. 1, 012004, 2018. <https://doi.org/10.1088/1755-1315/172/1/012004>
- [18] BENTYN, Z.: *Comparing Of Logistic Performance In Turkey And Poland. Explaining Divergence In Development*, In: M. Özşahin (Ed.), New Strategic, 2021. <https://doi.org/10.15405/epsbs.2021.12.04.23>
- [19] CHEBA, K., BRELIK, A., SZOPIK-DEPCZYNSKA, K., OLESZCZYK, N., IOPPOLO, G.: Mapping sustainability: A comparative analysis proposal across EU countries and regions, *Journal of Environmental Management*, Vol. 362, 121236, pp. 1-10, 2024. <https://doi.org/10.1016/j.jenvman.2024.121236>
- [20] ÇEMBERCI, M., CIVELEK, M.E., CANBOLAT, N.: The moderator effect of Global Competitiveness Index on dimensions of Logistics Performance Index, *Procedia - Social and Behavioral Sciences*, Vol. 195, pp. 1514-1524, 2015. <https://doi.org/10.1016/j.sbspro.2015.06.453>
- [21] BAUER, M., MUKHAMETOV, A., TRIFONOV, P.: Relationship between the state of the country's logistics and perishable goods' output: Dairy industry, *The TQM Journal*, Vol. 35, No. 7, pp. 1799-1814, 2023. <https://doi.org/10.1108/TQM-04-2022-0131>
- [22] GÖRNIK, G.: Selected Logistics Development Level Indicators – a Review and Comparative Analysis in European Union Countries, *Comparative Economic Research Central and Eastern Europe*, Vol. 25, No. 1, pp. 127-144, 2022. <https://doi.org/10.18778/1508-2008.25.08>
- [23] MANAVGAT, G., DEMIRCI, A., KORKMAZ, O., KOLUMAN, A.: Global scale integrated logistics performance analysis and its spillover effect, *LogForum*, Vol. 19, No. 2, pp. 245-262, 2023. <https://doi.org/10.17270/J.LOG.2023.826>
- [24] BAKI, R.: Avrupa Birliği Ülkeleri ile Türkiye'deki Lojistik Köy Uygulamaları ve Uygun Kuruluş Yeri Seçimi, *Sosyal Bilimler Enstitüsü Dergisi*, Vol. 5, No. 2, pp. 148-162, 2018. <https://doi.org/10.30803/adusobed.424132> (Original in Turkish)
- [25] TUNCA, H.Ö.: Stratejik Planlama Kapsamında Türkiye'de Lojistik ve Havayolu Lojistiği, *Havacılık ve Uzay Çalışmaları Dergisi*, Vol. 5, No. 2, pp. 41-61, 2022. <https://doi.org/10.52995/jass.1144700> (Original in Turkish)
- [26] HARALAMBIDES, H.E.: Gigantism in container shipping, ports and global logistics: a time-lapse into the future, *Maritime Economics & Logistics*, Vol. 21, No. 1, pp. 1-60, 2019. <https://doi.org/10.1057/s41278-018-00116-0>
- [27] BOŠNJAKOVIĆ, M., SANTA, R., ČONDRIĆ, M.C.: The Role and Significance of Rail Transport in the Decarbonisation of the EU Transport Sector, *Smart Cities*, Vol. 9, No. 4, 64, pp. 1-24, 2026. <https://doi.org/10.3390/smartcities9040064>
- [28] BANISTER, D., BERECHMAN, Y.: Transport investment and the promotion of economic growth, *Journal of Transport Geography*, Vol. 9, No. 3, pp. 209-218, 2001. [https://doi.org/10.1016/S0966-6923\(01\)00013-8](https://doi.org/10.1016/S0966-6923(01)00013-8)
- [29] GRAHAM, A.: *Managing Airports: An International Perspective*, 5th ed., London, Routledge, 2020. <https://doi.org/10.4324/9781315269047>
- [30] KWIATKOWSKI, D., PHILLIPS, P.C.B., SCHMIDT, P., SHIN Y.: Testing the Hypothesis of Stationarity against the Alternative of a Unit Root: How Sure are we that Economic Time Series Have a Unit Root?, *Journal of Econometrics*, Vol. 54, pp. 159-178, 1992. [https://doi.org/10.1016/0304-4076\(92\)90104-Y](https://doi.org/10.1016/0304-4076(92)90104-Y)
- [31] ENDERS, W.: *Applied Econometric Time Series*, 4th ed., United States, Wiley, 2014.
- [32] HARRIS, R., SOLLIS, R.: *Applied Time Series Modelling and Forecasting*, Germany, Wiley, 2003.
- [33] MADDALA, G.S., KIM, I.M.: *Unit roots, cointegration, and structural change*, United Kingdom, Cambridge University Press, 1998.
- [34] PESARAN, M.H., PESARAN, B.: *Working with Microfit 4.0: Interactive econometric analysis*, United Kingdom, Oxford University Press, 1997.
- [35] PESARAN, M.H., SHIN, Y., SMITH, R.J.: Bounds testing approaches to the analysis of level relationships, *Journal of Applied Econometrics*, Vol. 16, No. 3, pp. 289-326, 2001. <https://doi.org/10.1002/jae.616>
- [36] NARAYAN, P.K.: The saving and investment nexus for China: Evidence from cointegration tests, *Applied Economics*, Vol. 37, No. 17, pp. 1979-1990, 2005. <https://doi.org/10.1080/00036840500278103>
- [37] ENGLE, R.F., GRANGER, C.W.J.: Co-integration and error correction: Representation, estimation, and testing, *Econometrica*, Vol. 55, No. 2, pp. 251-276, 1987. <https://doi.org/10.2307/1913236>
- [38] JOHANSEN, S.: Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control*, Vol. 12, No. 2-3, pp. 231-254, 1988. [https://doi.org/10.1016/0165-1889\(88\)90041-3](https://doi.org/10.1016/0165-1889(88)90041-3)
- [39] EMİRKALDI, H., BALCI, H.: Türkiye'de Karayolu Ve Demiryolu Yolcu Ve Yük Taşımacılığı İle Ekonomik Büyüme İlişkisi: Panel Veri Analizi, *Kafkas Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*, Vol. 14, No. 28, pp. 977-998, 2023. <https://doi.org/10.36543/kauibfd.2023.039> (Original in Turkish)

The impact of logistics performance on economic growth: a comparative ARDL analysis for Türkiye and Poland

Özlem Karadağ Albayrak, Melis İrem Babür

- [40] KOMORNICKI, T., SMĘTKOWSKI, M.: New Transport Infrastructure and Regional Development of Central and Eastern Europe, *Sustainability*, Vol. 15, No. 6, 5263, pp. 1-24, 2023. <https://doi.org/10.3390/su15065263>
- [41] GAJEWSKI, P., TCHOREK, G.: What drives export performance of firms in Eastern and Western Poland?, *European Planning Studies*, Vol. 25, No. 12, pp. 2250-2271, 2017. <https://doi.org/10.1080/09654313.2017.1355890>
- [42] AYDIN, U., ULENGIN, B.: Analyzing air cargo flows of Turkish domestic routes: A comparative analysis of gravity models, *Journal of Air Transport Management*, Vol. 102, 102217, pp. 1-9, 2022. <https://doi.org/10.1016/j.jairtraman.2022.102217>
- [43] HUDEREK-GLAPSKA, S.: Economic Benefits of Market Liberalization: Evidence from Air Transport in Poland, *Journal of International Studies*, Vol. 3, No. 1, pp. 49-58, 2010. <https://doi.org/10.14254/2071-8330.2010/3-1/6>
- [44] Statistics Poland (GUS), Transportation and Communication Statistics, [Online], Available: <https://stat.gov.pl/en/topics/transport-and-communications> [07 Aug 2025], 2025.
- [45] World Bank, World Development Indicators, [Online], Available: <https://databank.worldbank.org/source/world-development-indicators/Series/NE.TRD.GNFS.ZSand-communications> [08 Aug 2025], 2025.
- [46] Turkish Statistical Institute (TÜİK), Ulaştırma ve Haberleşme İstatistikleri, [Online], Available: <https://data.tuik.gov.tr/Kategori/GetKategori?p=ulastirma-ve-haberlesme-112>, [09 Aug 2025], 2025. (Original in Turkish)

Review process

Single-blind peer review process.