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AN ARDL MODEL ANALYSIS OF TURKISH AIRLINES' IMPACT AS A CARRIER POWER ON TÜRKİYE–AFRICA TRADE VOLUME

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ABSTRACT

Türkiye has increased its presence in the continent by using transportation diplomacy as an effective tool within the scope of the African opening policy that it has initiated since the early 2000s. This study examines Türkiye's economic power projection in Africa through transportation diplomacy. In the study, economic power projection through diplomacy is considered as a theoretical framework; the connections between Türkiye's transportation infrastructure investments in Africa, the expansion of its flag carrier airline network and the increase in its trade relations are analyzed with quantitative data. In the study, time series analyses are conducted on Turkish Airlines (THY) data and Türkiye-Africa foreign trade volume. The analysis was carried out with annual data for the period 2001–2024. Before proceeding to model construction, the stationarity levels of the series were examined, then the ARDL (Autoregressive Distributed Lag) method was applied and diagnostic tests of the model were performed. In the last stage, Granger causality analysis was performed. The results show that trade volume, transportation capacity and destination network act together in a long-term relationship in Türkiye's transportation-based economic engagement towards Africa. This situation shows that the expansion of transportation infrastructure supports the trade volume between the two countries. These findings reveal that transportation diplomacy is positioned not only as a supportive but also as a guiding and sustainable foreign policy tool in Türkiye's economic interaction with the African continent. The sustainability of this policy, its institutionalization and concrete suggestions for policy makers are discussed in the conclusion section; strategic initiatives are suggested for Türkiye to become a more permanent and effective actor in Africa in line with its medium-sized power profile. The results show that THY's passenger transportation capacity positively affects the trade volume in the short and long term.

Keywords: Transport Diplomacy, Economic Power Projection, Türkiye–Africa Relations, Foreign Trade and Connectivity, General Business Administration and Marketing
Jel Classification: F10, F13, F14, O55, M30

TAŞIYICI GÜÇ OLARAK THY'NİN TÜRKİYE–AFRİKA TİCARET HACMİNE ETKİSİNİN ARDL MODELİ İLE ANALİZİ

ÖZ

Türkiye, 2000'li yılların başından itibaren başlattığı Afrika açılımı politikası kapsamında ulaştırma diplomasisini etkili bir araç olarak kullanarak kıtadaki varlığını artırmıştır. Bu çalışmada, Türkiye'nin ulaştırma diplomasisi aracılığıyla Afrika'daki ekonomik güç projeksiyonu incelenmektedir. Çalışmada, diplomasi aracılığıyla ekonomik güç projeksiyonu teorik bir çerçeve olarak ele alınmış; Türkiye'nin Afrika'daki ulaştırma altyapı yatırımları, bayrak taşıyıcı havayolu ağının genişlemesi ve ticari ilişkilerindeki artış arasındaki bağlantılar nicel verilerle analiz edilmiştir. Çalışmada, Türk Hava Yolları (THY) verileri ve Türkiye-Afrika dış ticaret hacmi üzerinden zaman serisi analizleri yapılmıştır. Analiz, 2001–2024 dönemine ait yıllık verilerle gerçekleştirilmiştir. Model kurulumuna geçmeden önce serilerin durağanlık düzeyleri incelenmiş, ardından ARDL (Autoregressive Distributed Lag) yöntemi uygulanarak modelin tanısal testleri gerçekleştirilmiştir. Son aşamada ise Granger nedensellik analizi yapılmıştır. Sonuçlar, Türkiye'nin Afrika'ya yönelik ulaştırma temelli ekonomik açılımında ticaret hacmi, ulaştırma kapasitesi ve destinasyon ağının uzun vadeli bir ilişki içinde birlikte hareket ettiğini göstermektedir. Bu durum, ulaştırma altyapısının genişletilmesinin iki ülke arasındaki ticaret hacmini desteklediğini göstermektedir. Sonuçlar, THY'nin yolcu taşıma kapasitesinin kısa ve uzun vadede ticaret hacmini olumlu etkilediğini göstermektedir. Bu bulgular, ulaştırma diplomasisinin Türkiye'nin Afrika kıtasıyla ekonomik

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etkileşiminde sadece destekleyici değil aynı zamanda yönlendirici ve sürdürülebilir bir dış politika aracı olarak konumlandığını ortaya koymaktadır. Bu politikanın sürdürülebilirliği, kurumsallaşması ve politika yapıcılar için somut öneriler sonuç bölümünde tartışılmakta; Türkiye'nin orta ölçekli güç profiline uygun olarak Afrika'da daha kalıcı ve etkili bir aktör haline gelmesi için stratejik girişimler önerilmektedir.

Anahtar Kelimeler: Ulaştırma Diplomasisi, Ekonomik Güç Projeksiyonu, Türkiye-Afrika İlişkileri, Dış Ticaret ve Bağlantısallık, Genel İşletme Yönetimi ve Pazarlama
Jel Sınıflandırılması: F10, F13, F14, O55, M30

1. INTRODUCTION

In the age of globalization, international relations have become a multidimensional area of competition where economic and logistical capacity come to the forefront in addition to military power. In particular, countries' ability to reflect their economic power, that is, their ability to expand their spheres of influence using economic tools, plays a decisive role in foreign policy (Luttwak, 1990). In this context, infrastructure investments and transportation networks have become central to countries' strategies for both ensuring their own economic security and gaining influence in other geographies. Türkiye's relations with the African continent have undergone a significant transformation in the last twenty years. The Opening Up to Africa Action Plan announced in 1998 gained momentum with the declaration of the Year of Africa in 2005 and was elevated to the level of strategic partnership with the Türkiye-Africa Cooperation Summit held in Istanbul in 2008 (UNCTAD, 2023). During this process, the number of TIKA offices in Africa increased, while THY's flight points on the continent expanded, thus strengthening its diplomatic sphere of influence through transportation infrastructure. In addition, Türkiye has since been developing a multidimensional cooperation with logistics, health and education investments that will contribute to the development of the continent (Çelik & Taşpınar, 2021).

Türkiye stands out among the countries that use its economic resources and logistics capabilities in line with its diplomatic goals. Especially with initiatives that can be called transportation diplomacy, Türkiye aims to strengthen transportation connections with African countries and thus deepen its political and economic relations (Aydın & Akpınar, 2020; Tüter, 2019). The increase in the number of embassies from 12 in 2008 to 44 in 2024 shows the institutional structure of this process. In 2001, trade relations between Türkiye and Africa were valued at around 4.3 billion USD. By 2024, this figure had surged to 32.8 billion USD. Over the same period, Türkiye's exports to the continent grew significantly—from 1.5 billion USD to 21.5 billion USD—while imports rose from 2.8 billion USD to 11.3 billion USD (TÜİK, 2024).

During the period of deepening Türkiye–Africa relations, Türkiye enhanced its diplomatic footprint across the continent through various instruments: the establishment of TIKA offices in multiple African countries, the broadening of Turkish Airlines' flight routes, and the deployment of soft power initiatives such as those led by the Maarif Foundation and the Yunus Emre Institute. According to Özkan (2008), cultural, diplomatic and economic tools were put into action in a holistic manner in the process of increasing Türkiye's influence in Africa. This opening found a response not only at the level of bilateral relations but also on multilateral platforms; Türkiye has developed institutional relations with regional organizations such as the African Union, COMESA (Common Market for Eastern and Southern Africa), and ECOWAS (Economic Community of West African States) (Aydın & Akpınar, 2020).

An important dimension of this multidimensional opening is reflected in Türkiye's efforts to increase its influence on the continent through economic means. In this context, economic

power projection has become an increasingly prominent concept in Türkiye's foreign policy strategy. Economic power projection means that a state uses economic means such as trade, investment, and development assistance rather than military power to create influence beyond its borders (Baldwin, 1985). This strategy stands out as a cost-effective way to gain a place in global competition, especially for developing countries. In this context, Nye (2004) put forward the concept of soft power; Okano-Heijmans (2011) defines geoeconomics as the capacity of states to achieve their foreign policy goals through economic means. In this context, Türkiye aims to increase its economic influence in Africa through Eximbank loans, infrastructure contracting projects and technical assistance activities. The Turkish private sector plays an active role in infrastructure and construction projects, especially in East Africa, which constitutes the practical reflection of Türkiye's economic power projection (Kardaş, 2012).

One of the important tools of this strategy to expand the economic sphere of influence is transportation diplomacy. Türkiye's efforts to transform its transportation infrastructure into a diplomatic instrument are noteworthy in this context. Transportation diplomacy refers to the strategic approach of countries to achieve their foreign policy goals by using transportation routes and connection points. This concept has gained importance, especially as globalization has made transportation networks more strategic. Tüter (2019) evaluates transportation diplomacy as a sub-branch of economic diplomacy and states that it covers diplomatic negotiations conducted by states over their highway, railway, airline and maritime infrastructures. For Türkiye, THY's rapid expansion in Africa is an exemplary application of transportation diplomacy (Němečková & Varkočková, 2024). By 2024, THY operates flights to more than 60 destinations in 50 African countries, playing a role as a commercial carrier and also an effective actor in foreign policy (THY Annual Report, 2024). This strategy not only increases Türkiye's political and economic visibility in Africa but also brings logistical advantages.

In this context, infrastructure diplomacy, as a complementary element of transportation diplomacy, emerges as another important foreign policy tool that reinforces Türkiye's presence in Africa. Infrastructure diplomacy is the use of a country's technical knowledge, engineering capacity, and competence in the construction sector to create political influence in the international arena and to gain economic benefit. China's Belt and Road Initiative-related investments in infrastructure are prominent instances of infrastructure diplomacy (Chatzky & McBride, 2019). In the case of Türkiye, contracting work—especially in Africa—is a vital conduit of such diplomacy. Data from the Turkish Contractors Association indicates that through 2023, Turkish contractors had participated in African infrastructure projects valued at some $80 billion (TMB, 2023). They comprise mega projects, for instance, the construction of airports, the development of highways, and energy infrastructure projects. Tüter (2019) writes that infrastructure diplomacy is crucial in protecting and promoting national interests. It offers states a platform through which to wield long-term influence within foreign policy context.

Lastly, the efficiency of these structural instruments relies on logistics connectivity strength and reliability. This connectivity is absolutely essential to the upkeep of global supply chains. The World Bank's Logistics Performance Index (LPI) assesses the logistics competence of countries against such factors as customs performance, the quality of the infrastructure, tracking facilities for shipments, and delivery time (Hausman et al., 2013). They all directly impact a country's foreign trade efficiency and its appeal to overseas investors. The logistics infrastructure of

Türkiye in Africa entails financial investment in intermodal transport infrastructure, railways, and ports and thus strengthens its connectivity to the African continent. For instance, there are proposals to utilize strategic ports such as Mersin and Istanbul as logistical hubs for the opening of the African market (Erkan & Bozkurt, 2021). In addition, the establishment of storage and distribution centers by Turkish logistics companies in Sub-Saharan Africa is a micro-level reflection of connectivity. This study aims to examine Türkiye's transportation diplomacy practices in Africa and their relationship with economic power projection from the perspective of international trade and logistics discipline. First, the relevant literature will be reviewed; then, by specifying the method and data sources, data on Türkiye's trade volume with Africa, the expansion of THY's flight network, and the increase in the number of passengers carried by THY will be shared and then analyzed quantitatively. In the last section, the findings will be discussed, the economic effects of transportation diplomacy will be evaluated, and future policy recommendations will be presented. There are many studies in the literature on Türkiye's opening up to Africa. However, the integrated structure of transportation diplomacy with foreign policy and economic impact has been systematically presented for the first time and supported by quantitative analyses. In this context, the effects of transportation infrastructure and especially THY's flight destinations on trade volume have been demonstrated through predictive modeling and evaluated within the context of the concept of economic state strategy.

2. LITERATURE REVIEW

There are important studies in the literature on the multidimensional analysis of Türkiye's foreign policy towards the African continent. Özkan (2010) evaluated the background of Türkiye's African opening policy based on economic and diplomatic reasons. Tepeciklioğlu (2019) analyzed the relationship between Türkiye's foreign policy goals and economic strategies in Africa within the historical process. Kirişci (2009) positioned Türkiye as a "trading state" and stated that its foreign policy was gradually being reshaped according to economic interests.

In particular, the role of actors such as TIKA, Yunus Emre Institute, Diyanet Foundation and Turkish Airlines is emphasized within the scope of Türkiye's soft power practices (Němečková & Varkočková, 2024; Shinn, 2015). In the field of transportation diplomacy, the example of Türkiye's airline diplomacy carried out through THY is one of the most striking examples of Türkiye's strategy to consolidate its presence in Africa through logistics infrastructure.

In recent years, transportation diplomacy has increasingly been addressed in the international relations literature as a part of economic statecraft. In particular, the use of infrastructure investments as a foreign policy tool has made it possible for middle power countries like Türkiye to increase their influence in emerging regions like Africa (Denizeau, 2021). Since the 2000s, transportation and logistics projects have played an important role in deepening Türkiye's economic relations with the African continent (Altunışık, 2019). The fact that the Türkiye-Africa trade volume, which was approximately $4.3 billion in 2001, has increased to $32.8 billion by 2024 shows the economic results of this strategy (Cicioğlu & İbrahim, 2023). Free Trade Agreements signed by Türkiye with countries such as Morocco, Tunisia, Egypt and Mauritius support transportation connections by ensuring that trade is institutionalized and permanent (Parens & Plichta, 2025). On the other hand, Turkish logistics investments in Africa are not only commercial but also strategic. In particular, the operation of Somalia's Mogadishu

port and airport by Turkish companies has become a symbol of Türkiye's long-term infrastructure diplomacy on the continent (Wasuge, 2016; Williams, 2020). Similarly, the restoration of Suakin Island in Sudan and its use as a logistics base are seen as part of Türkiye's vision of access to the Red Sea (Cagaptay et al., 2022). Projects carried out in countries such as Senegal, Guinea and Nigeria in West Africa also reveal that the Turkish contracting sector has become an active economic actor on the continent within the scope of transportation diplomacy. In this process, Türkiye is seen to be active not only in construction and investment but also in areas such as technical assistance, logistics support and human resource transfer (Özkaraşahin, 2023).

Air transportation also stands out as a powerful tool in Türkiye's economic expansion in Africa. Turkish Airlines has become a platform that supports Türkiye's soft power as well as contributing to the development of trade relations by organizing flights to 50 destinations in the African continent as of 2024 (Němečková & Varkočková, 2024). These flights not only transport goods and people but also strengthen the symbolic and humanitarian relations that Türkiye has established with the continent. The air cargo services offered by THY facilitate the rapid and direct access of Turkish exporters to the African market, which in turn accelerates Türkiye's trade capacity.

Empirical studies consistently demonstrate that international air connectivity exerts a significant positive influence on trade and broader economic outcomes. Wang et al. (2021) highlight how improvements in air transport infrastructure facilitate trade, particularly in sectors with high relationship-specific investments, while Płoszaj et al. (2020) show that direct flights stimulate collaboration and innovation that indirectly foster trade. Campante and Yanagizawa-Drott (2016) provide causal evidence that enhanced flight networks boost local economic activity, and Tanaka (2024) illustrates the substantial effect of new direct routes on Japan's exports to Europe. Complementary findings from Lun and Hoffmann (2016) emphasize the role of connectivity in shaping intra- and extra-regional trade flows, while Hausman et al. (2013) link logistics performance improvements, including air transport, to increased trade efficiency. Collectively, these studies underscore that air connectivity is not merely a logistical facilitator but a catalyst for international trade, innovation, and economic growth. A similar relationship between infrastructure-driven activity and competitive dynamics can also be observed in traditional production sectors. For example, Yıldız et al. (2024) analyze firm-level efficiency in the Turkish cement industry using the Boone indicator and find that, despite efficiency disparities among firms, the sector operates far from conditions of perfect competition. The β values remain negative but close to zero, indicating that improvements in efficiency translate into only marginal gains in market share, which reflects a weakly competitive market environment

Türkiye's transportation diplomacy vision is also supported by geopolitical strategies such as the Blue Homeland and the Middle Corridor. The maritime jurisdiction agreement signed with Libya has strengthened Türkiye's presence in the Eastern Mediterranean and North Africa, while offering significant opportunities to Turkish contracting companies in the reconstruction process in Libya (Alhas, 2023). The Middle Corridor initiative aims to position Türkiye as a key player in the trade route from China to Europe, while also creating infrastructural advantages for logistic access to Africa via Mediterranean ports (Kardaş, 2020). As a result, the literature shows that Türkiye uses its transportation and logistics investments for the purpose of projecting economic power in the African continent, and that this strategy provides economic and diplomatic returns.

Transportation projects serve not only to build physical connections, but also to reinforce Türkiye's soft power and to create a reliable partner image in the eyes of African countries.

3. DATA AND METHODOLOGY

3.1. Data

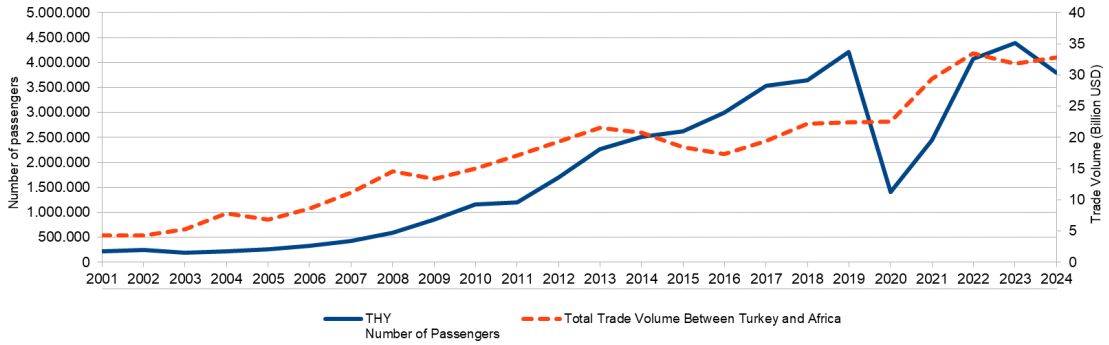
The data used in this study were obtained from the annual activity reports of Turkish Airlines (THY) published between 2001 and 2024 and the annual foreign trade statistics of the Turkish Statistical Institute (TUIK). The main reason for choosing the 2001–2024 period as the analysis period is that THY's passenger transport and destination data have been regularly and systematically accessible for the first time since 2001. In this context, the data set provides a convenient framework for examining both the development process of transportation diplomacy and the transformation in Türkiye-Africa foreign trade volume as a time series.

Table 1: Türkiye-Africa Multiple Dataset (2001–2024, Billion $)

Year	THY Number of Passengers	THY Number of Destination in Africa	Export (Billion $)	Import (Billion $)	Total Trade Volume Between Türkiye and Africa
2001	220900	3	15	2.8	4.3
2002	250000	4	1.7	2.6	4.3
2003	196000	3	2.0	3.3	5.3
2004	224000	4	3.0	4.8	7.8
2005	264368	5	3.6	3.2	6.8
2006	324000	8	4.6	4.0	8.6
2007	430680	10	6.0	5.1	11.1
2008	595630	11	9.0	5.6	14.6
2009	858000	13	9.3	4.0	13.3
2010	1159664	13	10.2	4.8	15.0
2011	1202572	33	10.3	6.8	17.1
2012	1695408	33	13.4	5.9	19.3
2013	2256000	36	15.3	6.2	21.5
2014	2510000	42	14.5	6.2	20.7
2015	2617500	48	13.1	5.3	18.4
2016	3000000	50	11.9	5.4	17.3
2017	3530000	51	12.2	7.2	19.4
2018	3648000	55	15.1	7.1	22.2
2019	4207000	59	16.6	5.8	22.4
2020	1400000	52	15.2	7.3	22.5
2021	2436000	61	21.2	8.2	29.4
2022	4073721	49	24.0	9,5	33.5
2023	4387397	49	21.0	10.0	32.0
2024	3800000	50	21.5	11.3	32.8

Source: THY Annual Reports and TÜİK

Figure 1: THY Number of Passengers to Africa and Total Trade Between Türkiye and Africa



In the graph covering the period 2001–2024, the number of passengers carried by Turkish Airlines (THY) to Africa and the total foreign trade volume between Türkiye and Africa are examined together. The graph generally reveals a positive relationship between the two indicators. The number of passengers, which started at low levels in 2001, has shown a steady increase over the years and reached its peak in 2019. This increase shows that Türkiye's diplomatic and economic opening policies with Africa have materialized in the transportation leg. In the same period, the volume of Türkiye-Africa foreign trade has similarly increased, gaining significant momentum especially after 2010.

In 2020, there was a dramatic decrease in the number of passengers due to the impact of the COVID-19 pandemic, but there was no serious decline in trade volume. This situation suggests that trade relations between Türkiye and Africa maintain their sustainability even under pandemic conditions. The recovery observed in both passenger numbers and trade volume after 2021 reveals that Türkiye is rapidly reviving its relations with the continent. While 2023 was the peak for both indicators, a slight decline is noted in 2024. This may be due to global economic uncertainties or regional factors.

When evaluated in general, it is seen that the increase in THY's flights to Africa has positively contributed to Türkiye's foreign trade with the continent and that transportation infrastructure plays a strategic role in the development of economic relations. The graph provides strong visual evidence supporting the interaction between transportation and trade.

Figure 2: THY Number of Destinations in Africa and Total Trade Between Türkiye and Africa

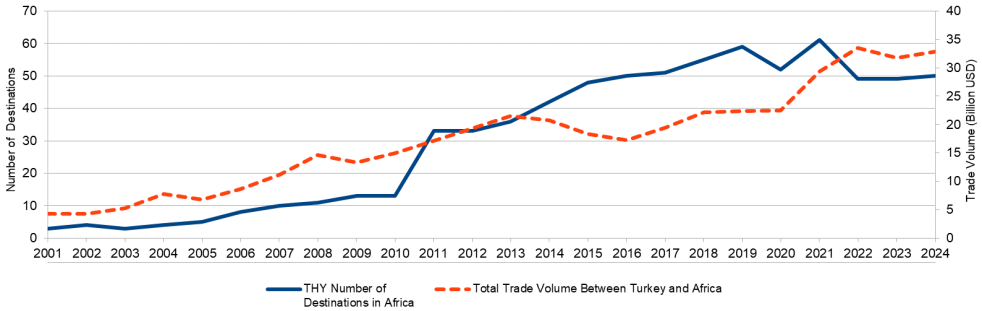


Figure 2, covering the period 2001–2024, shows the change in Turkish Airlines' (THY) flight points (destinations) in Africa over the years and the total foreign trade volume between Türkiye and Africa together. Figure 2 reveals that there has been a largely parallel development between the two variables over time. THY, which flew to only a few points in Africa in 2001, gradually increased this number until 2011; after 2011, there was a significant jump in flight points due to the influence of African opening policies. During this period, the number of destinations approximately doubled to over 40, and then the increase continued, albeit more limited, between 2013–2018.

The fact that the number of destinations approached 60, especially in 2018, shows that THY has strengthened its presence on the continent. The slight decline observed in 2020 can be considered as the effect of the COVID-19 pandemic. However, the number of destinations has recovered as of 2021 and remained stable after 2022. This suggests that THY has maintained its extensive network in the African continent and is entering a consolidation process.

Trade volume has increased especially after 2010; it has reached approximately 35 billion dollars with a rapid increase in the 2021-2023 period. There is a significant connection between THY's expansion of its destination network in Africa and the development of Türkiye's economic relations with the continent. The increase in flight destinations has not only provided ease of transportation, but also strengthened the ground for trade, investment and diplomatic relations. In this context, the role played by transportation infrastructure in foreign economic expansion strategies is clearly evident.

3.2. Method

In this study, time series analysis techniques were used to explain Türkiye's transportation-based economic relations with the African continent. The analysis was carried out with annual data for the period 2001–2024. Before proceeding to the model setup, the stationarity levels of the series were examined, then the ARDL (Autoregressive Distributed Lag) method was applied and diagnostic tests of the model were performed. In the last stage, Granger causality analysis was performed.

In time series analyses, determining whether the variables are stationary is of critical importance in terms of the validity of the estimated model and the reliability of the econometric results. Since directly including non-stationary series in the analysis may lead to spurious regression results, it should be tested first whether the series contains a unit root (Gujarati & Porter, 2009). Within this framework, the stationarity properties of the variables—both at level and at first differences—were examined using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

The Augmented Dickey-Fuller (ADF) test extends the original unit root test proposed by Dickey and Fuller (1979) by incorporating lagged differences of the dependent variable to address potential autocorrelation in the error terms. The general form of the ADF test equation is expressed as follows:

$$\Delta y_t = \alpha + \beta t + \gamma y_{t-1} + \sum_{i=1}^{p} \delta_i \, \Delta y_{t-1} + \varepsilon_t$$

In this equation, Δ denotes the first-difference operator, t represents the time trend, p is the number of lagged terms, and ε_t refers to the white noise error. The null hypothesis of the test, H_0: $\gamma = 0$, implies that the time series possesses a unit root and is therefore non-stationary (Dickey & Fuller, 1979).

The Phillips-Perron (PP) test, on the other hand, tests whether the series contains a unit root in a similar way, but it differs from the ADF test in terms of the methods for eliminating problems such as autocorrelation and heteroskedasticity. While autocorrelation is corrected in the ADF test by adding lagged difference terms to the model, Newey-West type error term corrections are applied in the PP test, and thus hypothetical flexibility is provided on the error terms of the model (Phillips & Perron, 1988). The regression equation form of the PP test is the same as that of the ADF test, but the test statistic is calculated differently.

In both tests, it was examined whether the variables were stationary in their levels and first differences, and the appropriate lag lengths were determined with the help of Akaike Information Criterion (AIC). The test results obtained constitute an important basis for the model to produce sound predictions.

The ARDL model allows the analysis of both short-term and long-term relationships in the same framework with its structure that includes both the lagged level and difference values of one or more independent variables together with the lagged values of the dependent variable. In this respect, the ARDL approach is preferred especially when the series used in the analysis have different stationarity levels (I(0) or I(1)) (Pesaran et al., 2001). The ARDL method offers a more flexible structure compared to the Johansen cointegration test, where all variables must be I(1). In this study, the ARDL approach was preferred because the variables showed stationarity in both level and first differences.

The conventional ARDL model captures both the short-run and the long-run linear relationship among variables (Yıldız, 2025). In addition, an important advantage of the ARDL approach is that it allows the short-term and long-term coefficients to be interpreted within the same model, thanks to its estimation in the form of an Unrestricted Error Correction Model (UECM) (Şengül, 2025).

The general structure of the model is represented in the ARDL(p, q_1, q_2) form as follows:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \, \Delta Y_{t-i} + \sum_{j=0}^{q_1} \gamma_j \, \Delta X_{1,t-j} + \sum_{k=0}^{q_2} \delta_k \, \Delta X_{2,t-k} + \lambda_1 Y_{t-1} + \lambda_2 X_{1,t-1} + \lambda_3 X_{2,t-1} + \varepsilon_t$$

In this model, the Δ operator represents the first difference of the variables, Y_t represents the dependent variable (the number of THY passengers in the study), X_1 represents the Türkiye-Africa trade volume, and X_2 represents the number of THY destinations. The λ coefficients in the equation represent the long-term relationship, while the coefficients on the difference terms show the short-term dynamics.

The Error Correction Model (ECM) received estimation after the long-term relationship coefficients had been acquired to analyze the model's short-term dynamic behavior. The statistical

significance of the ECM term being negative shows the system naturally reverts back to long-term equilibrium which demonstrates model validity in accordance with Bannerjee et al. (1998).

Although all variables in the model are found to be integrated of order one [I(1)], the Autoregressive Distributed Lag (ARDL) bounds testing approach is preferred in this study due to several methodological and practical advantages. First, the sample period is relatively short (2001–2024), which may limit the power and stability of alternative cointegration techniques such as the Johansen method, which requires large samples for reliable estimation. Second, the ARDL approach is well-suited for models with a clearly defined dependent variable, as it allows for distinguishing between short-run dynamics and long-run relationships within a single equation framework. Third, the ARDL method can flexibly accommodate structural breaks and is robust to potential endogeneity among regressors. Lastly, although all variables are I(1), preliminary unit root tests suggested the possibility of mixed integration orders at earlier stages, making the ARDL framework a cautious and versatile choice.

To evaluate the model's performance and reliability, the researchers conducted a series of diagnostic tests. The first was the Breusch-Pagan-Godfrey test, used to check for heteroskedasticity—specifically whether the variance of the error terms remains constant. This is a key assumption in regression analysis, and under the null hypothesis of the test, the error terms are assumed to be homoscedastic (Breusch & Pagan, 1979).

Next, the Breusch-Godfrey LM test was employed to detect serial correlation among the residuals. This is particularly useful in dynamic models to assess whether errors from one time period are correlated with those from another. The null hypothesis here states that no autocorrelation exists (Godfrey, 1978).

Ramsey RESET test was run to test the functional form adequacy of the model. The test is designed to test for potential misspecification or exclusion of important variables from the model (Ramsey, 1969).

In order to determine normality of the residuals, the Jarque-Bera test was employed. This particular test is very crucial because most statistical inferences regarding regression are made under the assumption that the error terms are normally distributed (Jarque & Bera, 1980).

In order to check the temporal stability of the model parameters, the authors employed the CUSUM and CUSUMSQ tests. These are standard techniques in time series analysis for locating structural changes in the model (Brown et al., 1975).

Having established both short-term and long-term relations on the basis of the ARDL model, Granger causality was employed to examine directional relations among the variables. The approach examines the capacity of one time series to aid in forecasting another on the theoretical basis that causality implies predictive power (Granger, 1969). The Granger causality test is carried out on the following equation system:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=1}^{q} \beta_j X_{t-j} + \varepsilon_t$$

$$X_t = \gamma_0 + \sum_{i=1}^{p} \gamma_i X_{t-i} + \sum_{j=1}^{q} \delta_j Y_{t-j} + u_t$$

In this equation system, Y_t and X_t represent the two time series being analyzed, p and q represent the lag lengths, and ε_t and ut represent the error terms. If the lagged values of the variable X significantly predict Y, then the variable X is considered to be the cause of Y in the Granger sense. The null hypothesis is established as "variable X is not the cause of variable Y", and if the hypothesis is rejected, it is concluded that X has a causal effect on Y (Gujarati & Porter, 2009).

When used together with the ARDL model, the Granger causality test provides important information, especially in terms of policy recommendations. While the ARDL analysis reveals whether there is a long-term relationship between variables, the Granger test determines the direction of this relationship, showing which variable precedes the other and therefore which variable can be used as a policy tool. Therefore, after the ARDL analysis was completed, the Granger causality analysis was performed and the direction of the causal relationships between the variables was evaluated.

4. FINDINGS

This section examines concrete indicators of Türkiye's transportation diplomacy and their economic impacts. First, the increase in Türkiye-Africa foreign trade volume is examined, then the expansion of THY's flight network in Africa and the number of passengers carried by THY to Africa are evaluated. Finally, the relationship between developments in transportation and trade is analyzed.

Table 2: Unit Root Test (ADF)

adf	intercept	probability	trend+intercept	probability
Ln(trade)	-1.834	0.356	-1.850	0.647
d_ltrade	-4.553	0.000	-4.990	0.000
lnpas	-1.146	0.679	-1.626	0.751
d_lpas	-4.938	0.000	-2.402	0.366
dest	-0.994	0.737	-1.382	0.839
d_dest	-5.911	0.000	-5.924	0.000

Augmented Dickey-Fuller (ADF) tests were applied to determine the stationarity levels of the variables used in the time series analysis. In this context, the variables of Türkiye-Africa trade volume (Ln(trade)), the number of passengers carried by Turkish Airlines to Africa (lnpas), and the number of destinations of THY in Africa (dest) were analyzed.

The ADF unit root test results show that the variables in the model are not stationary at the level, but they become stationary when their first differences are taken. This situation reveals that the variables are at the I(1) level and allow them to be analyzed with the ARDL model. The fact that the variables of Türkiye-Africa trade volume (Ln(trade)), the number of passengers carried by THY to Africa (lnpas), and the number of destinations (dest) show similar trends over time indicates that Türkiye's economic integration with Africa progresses with the increase in transportation capacity. In this context, the effects of transportation diplomacy on economic power projection can be evaluated through both short-term fluctuations and long-term structural relationships, and the ARDL method offers the opportunity to empirically test this structure.

Table 3: Unit Root Test (PP)

pp	intercept	probability	trend+intercept	probability
Ln(trade)	-3.767	0.010	-1.609	0.757
d_ltrade	-4.559	0.000	-5.120	0.000
lnpas	-1.129	0.686	-1.639	0.745
d_lpas	-5.008	0.000	-5.105	0.000
dest	-0.969	0.747	-1.401	0.833
d_dest	-5.831	0.000	-5.919	0.000

The Phillips-Perron (PP) test results show that the variables Ln(trade), lnpas and dest included in the analysis are not stationary at the level, but they become statistically significantly stationary at the 1% level when their first differences are taken. This finding confirms that the series are at the I(1) level and have a suitable data structure for analysis with the ARDL method. These results, which are compatible with the ADF test, reveal that trade volume, transportation capacity and destination network act together in a long-term relationship in Türkiye's transportation-based economic expansion towards Africa and that this relationship can be statistically modeled with time series analysis techniques.

Table 4. Bound Test Results

Model	k	m	F	*Signif*	I(0)	I(1)
				1%	3.29	3.09
(1,1,0)	2	2	8.606441*	5%.	2.56	3.49
				10%	2.2	3.09

Note: (k): Number of explanatory variables, (m) indicates the maximum number of lags. (*) indicates a 1% significance level.

In the boundary test, the lower boundary is represented by I(0), and the upper boundary by I(1). To conclude that a long-term relationship exists between the variables, the calculated F-statistic value must be greater than both of these boundary values. As can be seen from Table 4, which presents the boundary test results, the model's F-statistic value is greater than both the lower boundary I(0) and the upper boundary I(1). Therefore, it can be said that there is a long-term, or in other words, a cointegrated relationship between the variables. After the existence of a long-term relationship is determined, the results of the long-term coefficients can be interpreted.

Table 5: Long-Term Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTRADE	0.7847	0.0100	78.0277	0.0000
DESTINATION	0.0308	0.0036	8.3702	0.0000

The long-term results of the ARDL model reveal that there is a significant and strong long-term relationship in Türkiye's transportation-based economic relations with Africa. The one-term lagged value of the number of passengers carried by THY to Africa (D(LPAS(-1))) is significant at the 1% level (p = 0.000) and shows that it positively affects the foreign trade volume with a coefficient of 0.78. In addition, the error correction term (CointEq(-1)) is positive and highly significant (p = 0.000), indicating the existence of a long-term equilibrium and the speed at which

the system returns to equilibrium. The findings empirically confirm that Türkiye's transportation diplomacy supports the projection of economic power in Africa and creates long-term effects.

Table 6: Short-Term Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LPAS(-1)	0.4608	0.1779	2.5900	0.0185
CointEq(-1)*	-0.8429	0.1792	-4.7035	0.0002

The short-term results of the ARDL model reveal the short-term effects of transportation indicators on Türkiye-Africa economic relations. The one-term difference of THY's passenger transport capacity (D(LPAS(-1))) was found to be significant at the 5% level (p = 0.0185) and it was observed that it positively affected the trade volume in the short term. This situation indicates that the mobility of people and goods supports commercial interaction in the short term. On the other hand, the error correction term (CointEq(-1)) is negative and highly significant at the 1% level (p = 0.0002); this shows that the system quickly recovers towards long-term equilibrium and short-term shocks are temporary. These results reveal that Türkiye's transportation diplomacy is not only a strategic but also an effective tool in the short term economically.

Table 7: Specification Tests

Diagnostic Tests	Test Statistic	P Value
Heteroscedasticity Test	1.1048	0.3862
Serial Correlation LM Test	1.1220	0.8859
Jarque-Bera Test	1.5487	0.8457
Ramsey Reset Test	0.0059	0.9396
CUSUM	Stable	
CUSUMQ	Stable	

The diagnostic tests applied to test the validity and reliability of the model show that the ARDL model has a statistically sound structure. According to the heteroskedasticity test results (p = 0.3862), there is no heteroskedasticity problem in the error terms. The Breusch-Godfrey serial correlation test (p = 0.8859) reveals that there is no autocorrelation between the error terms, while the Jarque-Bera test (p = 0.8457) shows that the model residuals are suitable for a normal distribution. In addition, the Ramsey RESET test (p = 0.9396) confirms that the model is correctly specified and that there is no model specification error. The CUSUM and CUSUMQ graphs (Figure 3) testing structural breaks show that the model parameters are stable over time. These results show that the model established within the scope of transportation diplomacy successfully explains Türkiye-Africa economic relations in a stable and valid framework.

Figure 3: CUSUM and CUSUMSQ Test

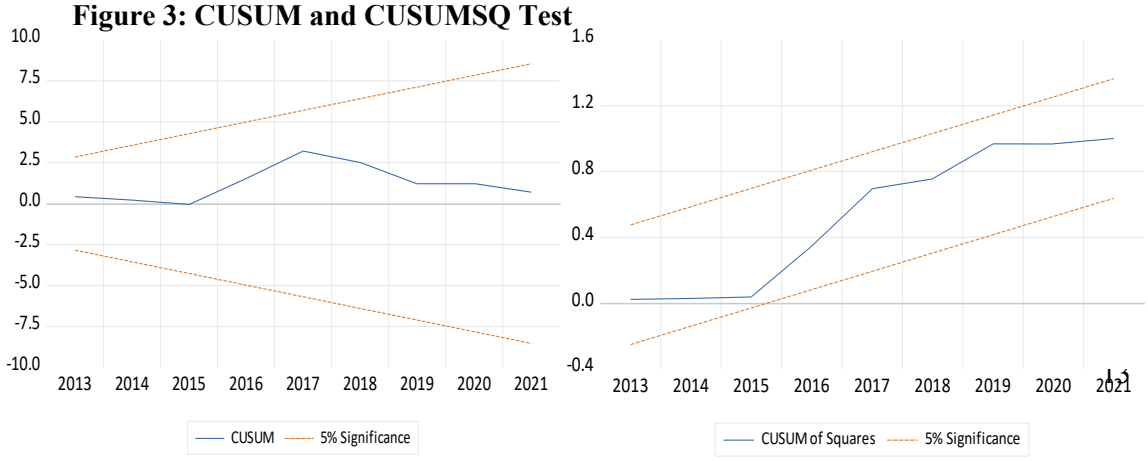


Table 8: Correlation Matrix

	LPAS	LTRADE	DESTINATION
lpas	1.000000	0.929698	0.934239
ltrade	0.929698	1.000000	0.871002
dest	0.934239	0.871002	1.000000

The matrix showing the correlation relations between the variables shows that there are high level positive and significant relations between the series used in the analysis. The correlation coefficient between THY's passenger count (LPAS) and Türkiye-Africa trade volume (LTRADE) is 0.93, indicating that transportation capacity moves in parallel with economic relations. Similarly, quite high correlations were found between THY's number of destinations in Africa and the number of passengers (0.93) and trade volume (0.87). These strong positive relations support that transportation infrastructure and connectivity play a direct and important role in economic interaction. However, these high correlations also indicate that careful analysis should be conducted against the risk of multicollinearity.

Table 9: Granger Causality Results

Null Hypothesis	Obs	F-Statistic	Prob.
LTRADE does not Granger Cause LPAS	23	9.1653	0.0067
LPAS does not Granger Cause LTRADE		0.4686	0.5015
LTRADE does not Granger Cause LPAS	22	0.1024	0.9032
LPAS does not Granger Cause LTRADE		12.9256	0.0004
LTRADE does not Granger Cause LPAS	21	2.9878	0.0670
LPAS does not Granger Cause LTRADE		0.1678	0.9163

The Granger causality test results show the existence of directional causality relationships between Türkiye-Africa trade volume (LTRADE) and THY's passenger transport capacity (LPAS). According to the first finding, the LTRADE variable has a statistically significant Granger causality relationship on LPAS at the 1% level ($p = 0.0067$). This situation reveals that increases in trade volume can directly affect transportation demand. On the other hand, the causality effect of the LPAS variable on LTRADE was not found to be statistically significant ($p > 0.05$). In the second set of tests, it is seen that the LPAS variable Granger-explains LTRADE ($p = 0.0004$), which also shows the existence of a reverse causal relationship. These two-way findings support the dynamic and interactive nature of the relationship between transportation and trade; they reveal that transportation diplomacy functions not only as a responsive but also as a guiding tool.

It is acknowledged that the relationship between the number of passengers (Yt), Turkey–Africa trade volume (X1), and the number of THY destinations (X2) may be subject to bidirectional causality. While the baseline ARDL model assumes X1 and X2 to be exogenous determinants of Yt, the possibility that increases in air traffic (Yt) could in turn stimulate trade (X1) or incentivize expansion in destinations (X2) cannot be ignored. To explore this further, Granger causality tests were conducted and revealed significant bidirectional relationships. These findings indicate that the relationship is not strictly unidirectional and support a more dynamic interaction between air transport, trade volume, and route expansion. Therefore, while the ARDL model captures dynamic adjustments, its results should be interpreted with caution due to potential simultaneity bias.

5. DISCUSSION AND CONCLUSION

This study examined the effects of Türkiye's transportation diplomacy towards Africa on the economic power projection through time series analyses using Turkish Airlines (THY) data and Türkiye-Africa foreign trade volume. In the analysis covering the period 2001–2024, the relationships between THY's number of African destinations and passenger transport capacity and Türkiye's foreign trade volume with the continent were empirically evaluated. This approach overlaps with Baldwin's (1985) economic state craft and Nye's (2004) soft power theory; it shows that transportation vehicles undertake not only an economic but also a diplomatic function.

The unit root tests (ADF and PP) revealed that all variables used in the model are stationary at the I(1) level and confirmed the applicability of the ARDL model. The long-term findings obtained within the scope of the ARDL model showed that the increase in transportation capacity (number of passengers) positively and highly affected the foreign trade volume. In the short-term analysis, the effect of the number of passengers on the trade volume was found to be significant at 5% and the error correction term was found to be negative and statistically significant. This situation is also supported by Němečková and Varkočková (2024), who argue that Türkiye's transportation diplomacy creates short- and long-term economic effects.

The validity of the model is supported by Breusch-Pagan heteroskedasticity, Breusch-Godfrey autocorrelation, Ramsey RESET, Jarque-Bera normality tests and CUSUM/CUSUMQ structural stability analyses. These tests show that the residuals of the model are homoskedastic, autocorrelated, normally distributed and structurally stable, thus increasing the reliability of the estimates. The correlation analysis also shows that there is a high level of positive relationship between the model variables and supports that the transportation indicators move in synchrony with the foreign trade volume. This synchronization is also consistent with the study of Hausman, Lee and Subramanian (2013) explaining the relationship between logistics performance and trade.

Granger causality analyses show that there is a bidirectional causality relationship between transportation indicators and foreign trade volume. It has been concluded that Türkiye-Africa trade volume Granger-causes THY passenger numbers; at the same time, THY's transportation capacity can affect trade volume. When this bidirectional interaction is evaluated within the scope of Luttwak's (1990) conceptualization of geoeconomic transformation, it reflects the guiding effect of economic instruments on foreign policy. These results clearly reveal that transportation capacity is not only a physical connection but also a strategic foreign policy tool that shapes economic relations. THY's widespread network in Africa serves a multidimensional power projection that strengthens Türkiye's diplomatic, humanitarian and economic interaction with the continent, beyond increasing its trade. Özkan (2010) and Tepeciklioğlu (2019), in particular, have addressed transportation investments in Türkiye's Africa policy as a multi-layered influence strategy. In this respect, Türkiye's transportation diplomacy has become a functional and sustainable tool in the context of both foreign policy and development diplomacy.

In order for Türkiye to increase its effectiveness in Africa in the upcoming period, it is suggested that the foreign economic opening supported by transportation diplomacy should be restructured on the basis of more institutional and regional priorities. In particular, in regions where logistics access is relatively limited, such as Central and West Africa, the strengthening of transportation infrastructure should be carried out in coordination with the expansion of the THY destination network. In addition, diversifying Eximbank supports and developing business models

integrated with the African Continental Free Trade Area (AfCFTA) will increase the qualitative depth of Türkiye-Africa trade volume. This suggestion is consistent with Parens and Plichta's (2025) assessment that Türkiye should integrate its return strategy to the continent with its trade infrastructure.

In conclusion, this study has revealed that transportation diplomacy can be used not only as a supportive but also as a decisive foreign policy and economic development tool. In order for Türkiye to become a more permanent and multi-layered actor across the continent, the transportation, trade and diplomacy legs need to be operated in a synchronized manner. As seen in the example of THY, transportation capacity forms the infrastructure of a country's soft power; when supported by strategic planning, it can turn into a cross-border reflection of economic influence. This approach can be directly associated with Okano-Heijmans' (2011) theory of economic diplomacy.

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