

A STAR-based Cointegration Analysis of Globalization and Air Transport in Türkiye

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Abstract

This study employs the smooth transition autoregressive (STAR) model-based cointegration tests developed by Kapetanios et al. (2006) and Maki (2010) to investigate the long-term relationship between air transport and globalization, including its economic, social, and political dimensions in Türkiye. STAR models reflect the smooth nature of real-world processes and can capture the complex and nonlinear relationships between variables that linear models struggle to represent effectively. We offer a novel methodological approach to examine the relationship between air transport and globalization in Türkiye, providing valuable insights for policymakers and researchers. Our empirical results reveal a long-term equilibrium relationship between air transport and overall globalization and the economic and political dimensions of the globalization index. These results imply that both variables move together in the long run. However, no cointegration was found between air transport and the social dimension of globalization.

Keywords: air transport, STAR model, cointegration, Türkiye, globalization

JEL Classification: L93; F60; C32

1. Introduction

The concept of globalization is multidirectional, and its interpretation varies among individuals and societies. The most common definition emphasizes the increasing interconnectedness and interdependence between people, societies, and countries. Globalization encompasses a multidimensional interaction network, including exchanging ideas, information, and collaboration on global challenges among people and governments worldwide. To assess the multifaceted impacts of globalization and its relationship with other indicators, globalization needs to be measurable. This enables us to investigate the causes and consequences of globalization with other indicators. The KOF Globalization Index, developed by Dreher (2006) and published by the KOF Swiss Economic Institute, offers a comprehensive measure of a country's level of globalization, combining various indicators along economic, social, and political dimensions for a large number of countries (Gygli et al., 2019).

Building upon the existing literature that explores the multidirectional effects of globalization, this study investigates the long-run relationship between globalization and air transport in Türkiye by employing cointegration analysis. Air transport has emerged as a critical industry for global economic development, experiencing tremendous growth fuelled by technological advancements. It directly and indirectly fosters a country's development by creating job opportunities, facilitating trade and tourism, and promoting economic integration (Küçükönel & Sedefoğlu, 2017). The air transport sector contributes significantly to the Turkish economy, facilitating international connections and integration. Projections based on the current trends scenario suggest a 109% growth in the Turkish air transport market by 2037 (IATA, 2019). Thus, air transport can be seen as one of the major contributors to the economy, and, like any other contributor, its lack can prevent efficient growth (Ion, 2011). Analyzing the long-term link via cointegration tests will seek an answer to the question "Do air transport and globalization in Türkiye move together in the long term?". The development of air transport is influenced by economic factors, international relations, and cultural and social structures since it is more than just moving cargo and passengers. From this point of view, it is obvious that globalization has a significant effect on the development of the aviation industry in the World and Türkiye (Özür, 2019). Finding a long-term relationship between globalization and air transport in Türkiye by applying cointegration tests will prove this argument. Thus, policymakers, businesses, and researchers can benefit from a thorough analysis of

the long-term relationship between air transport and globalization, gaining valuable insights into its economic, social, and political implications.

In this study, we employ smooth transition autoregressive (STAR)-based, Kapetanios et al. (2006) and Maki (2010), cointegration tests to reveal the long-term equilibrium relationship between variables. These tests address a critical gap in the existing literature on cointegration analysis in terms of the nonlinear aspects of the variables. STAR models are capable of capturing the intricate, nonlinear relationships between variables, making them suitable for modelling complex phenomena that linear models cannot adequately represent. This advantage makes them popular as an alternative to linear models. On the other hand, STAR models are specifically designed to capture gradual transitions between different regimes or states in time series data. This feature makes them particularly useful for modelling economic phenomena that exhibit gradual shifts rather than abrupt changes, reflecting the smooth nature of real-world processes. The nonlinear nature of economic variables has gained significant attention in recent years within the field of time series analysis, as ignoring these nonlinearities can result in power issues in statistical tests (Güriş & Sedefoğlu, 2022).

The main objectives of the study can be summarized as follows:

- To see the long-term relationship between air transport and globalization in Türkiye by considering the multidimensional aspect of globalization with its economic, social, and political dimensions.
- To contribute to the literature in terms of the originality of the methodology.
- To help the policymakers and researchers better understand the integration of air transport into globalization in Türkiye, as discussed in the following section, there is a massive gap in the literature regarding econometric analysis.

The rest of the paper is organized as follows: The second section provides a discussion of the lack of literature. The third section examines the dataset. Method and results are presented in the fourth and fifth sections, respectively. Final remarks are given in the conclusion section.

2. Literature

In the literature on air transport and globalization, some remarkable research, reports, and papers are found, which are mainly created based on a discussion or descriptive statistics, such as Bugayko et al. (2013), Cidell (2013), Goetz and Graham (2004), and Fayed et al. (2002). A few studies have focused explicitly on globalization rather than the impact of aviation. For instance, Rafindadi and Usman (2019) utilized the globalization index to highlight the different aspects of globalization through the Maki (2012) cointegration test. Hasan (2019), Samimi and Jenatabadi (2014), Ying et al. (2014), Gurgul and Lach (2014), and Chang and Lee (2010) primarily focused on the link between globalization and economic growth. Dreher and Gaston (2008), Giri et al. (2021), and Jaumotte et al. (2013) assessed the link between globalization and inequality for different groups of countries. On the other hand, some other studies specific to Turkish air transport literature written in Turkish address globalization. For instance, Esin and Düzgün (2021) focused on examining the changes that occur due to globalization and emphasized the effects and consequences of the globalization process on airline companies. Özü (2019) examined the development process of air transport in Türkiye and the World. Ataman and Tolga (2003) discussed the chaotic nature of the globalization process and the effects of air transportation on it. Nevertheless, previous research has not utilized econometric techniques to explore the link between globalization and air transport in Türkiye. Analyzing the two-way relationship between air transport and globalization is important to develop strategies for maximizing both benefits. This is especially true for developing countries like Türkiye, which must identify strategies to leverage air transport to integrate into the global market, attract foreign investment, and promote tourism.

To the best of our knowledge, this study is the first to highlight the importance of using techniques in econometrics to support the discussion on the connection between air transport and dimensions of globalization and the advantages of STAR models and their application to aviation literature.

3. Data and Methodology

3.1 Data

The data on air transport is collected from the World Bank database, which lists the number of domestic and international aircraft passengers. The KOF Globalization Index is used for the globalization variable between 1990 and 2021. The time period was selected based on the availability of data for Türkiye. Moreover, the most dramatic growth was observed in the aviation sector in Türkiye in the late 20th century as a result of technological advancements, tourism, and economic liberalization.

The KOF Globalization Index measures globalisation's economic, social, and political dimensions. Equal weights are used for each dimension, and the overall globalization index is calculated by averaging the *de facto* and *de jure* Globalization Index.

Economic globalization encompasses trade (goods, services, partner diversity in *de facto* and regulations, taxes, tariffs, and trade agreements in *de jure*) and financial globalization (foreign direct investment, portfolio investment, international debt, reserves, and income payments in *de facto* and investment restrictions, capital account openness, international investment agreements in *de jure*). Factual indicators of social globalization include interpersonal (International voice traffic, transfers, international tourism, international students, migration in *de facto* and telephone subscriptions, freedom to visit, international airports in *de jure*), informational (used internet bandwidth, international patents, high technology exports in *de facto* and television access, internet access, press freedom in *de jure*), and cultural globalization (trade in cultural goods, trade in personal services, international trademarks, McDonald's restaurant, IKEA stores in *de facto* and gender parity, human capital, civil liberties in *de jure*). Political Globalisation is measured through embassies, UN peacekeeping missions, and international NGOs in *de facto* and international organizations, international treaties, and treaty partner diversity in *de jure* (Gygli et al., 2019).

Figure 1 illustrates the overall globalization index and its economic, social, and political components from 1990 to 2021. While economic and social globalization have contributed significantly, political globalization has played an even more dominant role. Notably, social globalization lagged behind until 2004 but surpassed economic globalization after this year.

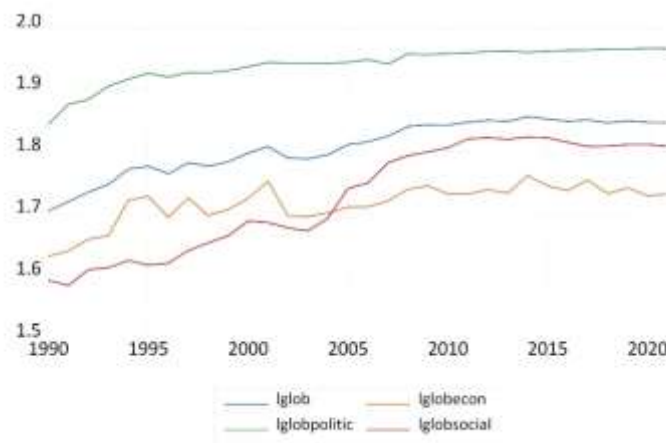


Figure 1. Globalization Index

Source: Data of the Globalization Index is obtained from the KOF Swiss Economic Institute.

The air transport variable demonstrates a nonlinear image with its ups and downs, as seen in Figure 2.

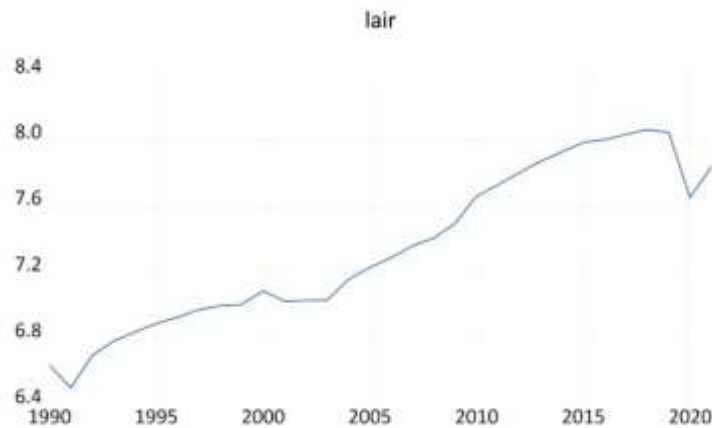


Figure 2. Air transport

Source: Data on air transport is obtained from the World Bank database.

3.2 Method

Maki (2010) offers an alternative approach to existing tests to assess cointegration within the STAR model framework. This test specifically examines the null hypothesis of no cointegration for exponential STAR (ESTAR) and double-logistic STAR models, contrasting it with the alternative hypothesis of cointegration with STAR adjustment. The most critical feature of this test is the use of the grid search method when calculating *t*-test statistics, unlike the Kapetanios et al. (2006) test where Taylor expansion is used for eliminating the nuisance parameter problem (see Davies (1987) and Luukkonen et al. (1988)).

The model considered in the cointegration analysis is expressed as follows:

$$y_t = \beta' x_t + u_t, \quad t = 1, 2, \dots, T \tag{1}$$

where y_t and x_t are the variables stationary at the first differences. $\beta' = (\beta_1, \beta_2, \dots, \beta_m)$ are the estimated parameters. $x_t = (x_{1t}, x_{2t}, \dots, x_{mt})'$ is a $(m \times 1)$ vector, and u_t is the equilibrium error expressed in the following equation,

$$u_t = \phi_1 u_{t-1} + \phi_2 u_{t-1} G(\cdot) + e_t, \tag{2}$$

where e_t zero mean error and $G(\cdot)$ is the smooth transition function. The exponential form of the transition function is defined as follows:

$$G(u_{t-1}; \gamma) = 1 - \exp\{-\gamma u_{t-1}^2\}, \tag{3}$$

where the smoothness of the functions is examined by the parameter γ , assuming $\gamma > 0$. The model, null hypothesis of no cointegration $H_0: \rho = 0$ tested against the alternative hypothesis of cointegration with a STAR adjustment $H_a: \rho < 0$, is created as follows:

$$\Delta \hat{u}_t = \rho \hat{u}_{t-1} (1 - \exp\{-\gamma \hat{u}_{t-1}^2\}) + \sum_{j=1}^p \psi_j \Delta \hat{u}_{t-j} + \epsilon_t, \tag{4}$$

where ϵ_t is a stationary error term with zero mean.

Since the nuisance parameter γ in the transition function has not been defined under the null hypothesis, the smoothness parameter γ is the nuisance parameter in the ESTAR model.

We utilize the grid search approach involving the calculation of infimum-*t* statistics for the parameter ρ for each possible value of γ in the equation above.

The test statistic is defined as follows:

$$inf_{\gamma \in \Gamma_n} t_n(\gamma) \equiv inf_{\gamma \in \Gamma_n} \frac{\hat{\rho}}{s.e.(\hat{\rho})}, \tag{5}$$

where $\hat{\rho}$ is the OLS estimator of the ρ , $s.e.(\hat{\rho})$ is the standard error of the $\hat{\rho}$ and Γ_n random sequences of the parameter space.

In the Kapetanios et al. (2006) test, residuals obtained from the OLS estimation of equation (1) are used to create the model for cointegration analysis. The exponential STAR-based model for the analysis is as follows:

$$\Delta \hat{u}_t = \delta \hat{u}_{t-1}^3 + \sum_{i=1}^p \Psi_i' \Delta \hat{u}_{t-i} + e_t, \tag{6}$$

where we test the null hypothesis of no cointegration, $H_0: \delta = 0$, against the alternative hypothesis of ESTAR cointegration, $H_a: \delta < 0$, for the t statistics of the parameter δ .

4. Results

In this section, we present the unit root test results as a basic assumption of the cointegration analysis and the findings of the Kapetanios et al. (2006) and Maki (2010) cointegration tests to evaluate the long-term relationship between air transport and globalization. The logarithmic transformation has been made for the variables before the analysis. In Table 1, the results of the linear unit root tests, ADF and Lee-Strazicich LM (2003), and the nonlinear tests, Kapetanios et al. (2003) and Kruse (2011), provide that overall, the *lair*, *lglob*, *lglobecon*, *lglobpolitic*, and *lglobsocial* variables are not stationary at level. Thus, we test the stationary level of the variables at the first difference, as presented in Table 2. These tests prove that the considered variables in the analysis are statistically significant at the first difference by rejecting the null of the unit root.

Table 1. Unit root test results for the levels of the series

	ADF	Lee-Strazicich LM (2003)	Kapetanios et al. (2003)	Kruse (2011)
<i>lair</i>	-1.069 (0)	-2.389 (4)	-1.987 (2)	3.429 (0)
<i>lglob</i>	-2.1501 (0)	-2.101 (3)	-1.878 (0)	5.580 (0)
<i>lglobecon</i>	-3.167 (0)	-3.124 (3)	-1.733 (0)	4.365 (0)
<i>lglobpolitic</i>	-2.125 (0)	-2.379 (0)	-1.468 (0)	4.605 (0)
<i>lglobsocial</i>	-1.777 (1)	-2.508 (5)	-1.927 (1)	4.790 (1)
Critical Values (5%)	-2.960	-3.563	-2.93	10.17

Note: Numbers in parentheses are the lags chosen by the minimum value of the Akaike Information Criteria.

Source: own calculations

Table 2. Unit root test results at the first difference of the variables

	<i>lair</i>	<i>lglob</i>	<i>lglobecon</i>	<i>lglobpolitic</i>	<i>lglobsocial</i>	Critical Values (5%)
ADF	-6.241 (0)	-4.901(0)	-7.026 (0)	-6.371(0)	-4.291 (0)	-2.96
Lee-Strazicich LM (2003)	-5.074 (0)	-5.610 (4)	-6.299 (1)	-8.970 (0)	-4.093 (0)	-3.56

Note: Numbers in parentheses are the lags chosen by the minimum value of the Akaike Information Criteria.

Source: own calculations.

Table 3 shows the findings of the cointegration analysis for the long-term relationship between air transport, globalization, economic globalization, political globalization, and social globalization. The Kapetanios et al. (2006)

and Maki (2010) test results imply that there is a long-term equilibrium relationship between air transport and economic and political globalization since the null of no cointegration is rejected at the 0.05 significance level. On the other hand, both test results found no long-term relationship between air transport and social globalization.

Table 3. Kapetanios et al. (2006) and Maki (2010) cointegration test results (Note 1)

	lglob	lglobecon	lglobpolitic	lglobsocial
Kapetanios et al. (2006)	-3.662 (0)**	-3.723 (0)**	-3.8944 (2)***	-1.9499 (0)
Maki (2010)	-3.658 (0)**	-3.707 (0)**	-3.6406 (0)**	-2.0137 (0)

Note: Numbers in parentheses are the number of lags chosen by the minimum value of the Akaike Information Criteria. Critical values are given at the 1%, 5%, and 10% significance levels as -3.84, -3.28, and -2.98 for the Kapetanios et al. (2006) test, -4.048, -3.492, and -3.217 for the Maki (2010) test. The signs of *, **, *** denote rejection of the null hypothesis of no cointegration relation at 10%, 5% and 1% significance levels.

Source: own calculations.

5. Conclusion

Through the ESTAR-based cointegration tests, this study investigates the long-term equilibrium relationship between air transport and globalization and its multidimensional aspect in Türkiye. To our knowledge, this study is the first to examine the air transport-globalization long-term link in Türkiye by considering the nonlinear feature of the variables through the ESTAR model, which is important to avoid Type II statistical error in the testing process.

Our results prove the long-term equilibrium relationship between air transport and overall globalization, economic and political globalization, which means air transport and globalization move together in Türkiye in the long run, different from the existing literature mainly focused on the different aspects of globalization and air transport without an econometric analysis. This finding provides evidence of the relationship that is lacking in the applied literature. In contrast, there is no long-term relationship between air transport and social globalization, which covers interpersonal, informational, and cultural globalization. However, that does not mean that the variables do not have short-term interactions with each other and no correlation between variables. As presented in the Data section, the contribution of the social globalization index to the overall globalization index was lower than the other indexes until 2005. After the year 2004, the index surpassed the economic index by having the second most effective contribution to the overall index, although the impact of political globalization is always higher than others. Thus, re-examining the relationship between social globalization and air transportation when the data for the coming years are published can be essential to make meaningful inferences. Furthermore, the selected indicators for social globalization may be inadequate and require reconsideration of the variables used. This could be considered by the researchers who play the main role in developing the index.

The findings reveal opportunities for future research on different developing countries to compare the results. Since globalization also presents challenges for air transport in terms of environmental effects and security, it is crucial to discuss the link between air transport and globalization by including different variables and using alternative methods.

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Authors' contributions

The author confirms sole responsibility for the following: study design and revising, data collection, analysis and interpretation of results, and drafting the manuscript. The author read and approved the final manuscript.

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Data sharing statement

No additional data are available.

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Note

Note 1. Before running the STAR-based cointegration tests, we applied the Harvey and Leybourne (2007) and Harvey et al. (2008) tests to display if the variables are nonlinear or linear. We found that one of the main indicators of aviation, air transport, and social globalization variables show a nonlinear aspect. These results indicate that in addition to the other advantages of using STAR-based models, the usage of nonlinear models is necessary for this research.