The Interactions among Air Freight, GDP, Energy Usage and Ecological Footprint: An Empirical Investigation from Turkey

Seda Bahadır*

School of Civil Aviation, Malatya Turgut Özal University, Malatya, Turkey. *Email: seda.dursun@ozal.edu.tr

ABSTRACT

The major aim of this manuscript is to examine the long-run relationship between air freight, economic growth, energy usage and ecological footprint by employing Multivariate Regression (MR), FMOLS (Fully Modified Ordinary Least Squares), DOLS (Dynamic Ordinary Least Square), CCR (Canonical Co-integrating Regression), and Generalized Method of Moments (GMM) analysis for Turkey from 1970 to 2018 within the sense of EKC hypothesis. According to Multivariate Regression (MR) result of Turkey, air freight, economic growth, and energy usage influence the ecological footprint from 1970 to 2018. Besides, the long-term linkage of variables including air freight, economic growth, energy usage and ecological footprint is indicated through FMOLS, DOLS, CCR and GMM analysis which is verified the EKC hypothesis for Turkey. Thus, all-time series analysis of this paper confirms that air freight, economic growth, and energy usage cause environmental pollution between 1970 and 2018 for Turkey. When the empirical results are considered the Environmental Management System has not yet been established at airports open to international traffic. However, in order to meet the standards expected by international aviation authorities, it is necessary to develop practices in this regard at airports in Turkey. Today, when environmental pollution has reached serious dimensions, airport operators, local people and every unit of the aviation industry will go to produce solutions and take precautions together. With the Environmental Management System to be established within the airport, which is accepted as indispensable businesses in terms of social and economic aspects for the environment; it will be able to achieve sustainable development by increasing their performance in the new period. The use of renewable energy sources at airports will contribute to the process. Financial incentives should be provided to airline companies that are willing to invest in line with these targets, and tax exemptions should be introduced for such investments. Although it does not seem possible in the near future, it is important for the future sustainability of the sector to carry out studies on electric air transportation.

Keywords: Air Freight, GDP, Energy Usage, Ecological Footprint, Multivariate Regression, Generalized Method of Moments
JEL Classifications: L93, O4, E2, Q57, C20, B23

1. INTRODUCTION

Human history is built on sustainable development. Especially the technological inventions confirm this thesis. This development process, which started with the creation of an agricultural society through transition of humanity to a settled life, gained a much different dimension by industrialization. It is the renaissance and enlightenment periods that prepare the infrastructure of this process. The scientific atmosphere that emerged with the interpretation of Eastern sciences in the West got rid of the dogmatic and stereotypical thoughts of the church and created an environment of free thought and science. In addition, laying the foundations of the information society, which is defined as the reach of computers and communication to inconceivable levels, has carried humanity to a very different era. Therefore, people who are identified with the telephone, internet and computer have laid the foundations of individual and social integration without even realizing it in today's societies. This trend, which is described as globalization, has undoubtedly made the world a "small and global village." Civil aviation is an increasingly attractive industry today (Egilmez, 2020).

Airline companies are growing rapidly, and all components of the industry are gaining importance. For example, the demand for flight personnel, the demand for aircraft, and the demand for capacity at the airport are increasing day by day. Civil aviation not only contributes to the country's economy in the production of goods and services to the real economy, also provides a complementary service by undertaking important intermediary duties in areas such as tourism and foreign trade. While the commercial dimension of aviation is developing and growing day by day, the non-commercial dimension of aviation seeks to find its own new application areas in this change. Sports aviation activities are also developing as a result of the increasing interest in aviation through development of commercial air transport. The aviation industry has a significant impact on the development of the country, the welfare of the society, and the mobilization of economic dynamics (Kalayci, 2021).

France, one of the countries where the most flight tests were made, called on 21 countries to discuss the developments in the field of civil aviation in Paris in 1910 and to make international regulations. This conference later took its place as the first conference in the history of world civil aviation. The success achieved in the flight trials of heavier-than-air vehicles and balloons has increased the interest in aviation. The test flights made did not stay within the borders of one country; landings began to be made in the other country. The absence of legal regulations regarding aviation and the increase in border violations forced countries to take action. In such a period, countries where border violations are common have announced that they will punish those who commit such violations and warned the countries. The start of the First World War, 4 years after the Paris Conference, did not allow civil aviation to find a ground for development. However, the developments in the military field during the war also affected the aircraft, and the war caused a significant development of aircraft technology from a technical point of view (Gerede, 2015).

Although the first civil aviation activities in Turkey date back to the First World War, aviation-related initiatives started only after the proclamation of the republic. Afterwards, the infrastructure of civil aviation was created with the laws made in this context. Firstly, in 1933, the State Airways Administration was established under the Ministry of National Defense and postal services were started. In 1955, as a result of the conditions of the time, the institution had to be divided into different departments. In this process, Turkish Airlines (THY) and State Airports Authority (DHMI) were established and started to serve. Although the first civil aviation activities in Turkey date back to the First World War, aviation-related initiatives started only after the proclamation of the republic. Afterwards, the infrastructure of civil aviation was created with the laws made in this context. Firstly, in 1933, the State Airways Administration was established under the Ministry of National Defense and postal services were started. In 1955, as a result of the conditions of the time, the institution had to be divided into different departments. In this process, Turkish Airlines (THY) and State Airports Authority (DHMI) were established and started to serve (Gerede, 2015).

Physical capital, which is closely related to the neoclassical growth theory, is the factor that constitutes the basic element of growth. Physical capital refers to a concept consisting of fixtures such as machinery and equipment that can be used for many years in the production phase. Physical capital at the macro level; It refers to infrastructure investments, public expenditures on transportation systems such as highways, railways and airlines. The reason for using capital goods in the production process is based on efficiency. The efficient use of physical capital will positively affect economic growth and pave the way for an increase in production. Two important factors that determine the output in the production function; labor and physical capital. Investments and savings have a large share in physical capital (Songur, 2017).

With the increase in technological investments in transportation networks such as highways, bridges, tunnels, airlines, and railways, it is seen that the country follows an economic growth-oriented course. Good transport infrastructure; the expansion of markets means that materials can be moved easily and labor migration is prevented. With the innovation process of infrastructure and services in transportation, transportation costs will decrease, accessibility will be provided easily, input costs will decrease, foreign investments will increase, and thus both trade and employment will be created (Kara and Ciğerlioğlu, 2018).

Road transport constitutes a large proportion of the carbon dioxide originating from the transport sector. Fuel consumption increases depending on the weight of the vehicle and the intensive use of air conditioners. This situation negatively affects climate change. In addition to the pollution caused by the fuel consumed in air transportation, the white lines produced by jet planes cause global warming by increasing the cirrus clouds (Karakaya, 2008).

Considering the contribution of the results of this research to the academic literature, the effects of independent variables including air freight, economic growth, energy usage on ecological footprint is elaborated empirically from 1970 to 2018 which is confirmed the EKC hypothesis for Turkey. Besides, the long-term linkage of variables including air freight, economic growth, energy usage and ecological footprint is indicated through FMOLS, DOLS, CCR and GMM analysis which is verified the EKC hypothesis for Turkey. Thus, all-time series analysis of this paper confirms that air freight, economic growth, and energy usage cause environmental pollution between 1970 and 2018 for Turkey.

When the figure in Figure 1 is examined, air cargo transportation has increased significantly between 1970 and 2018 in Turkey. Especially since 1995, air cargo transportation has increased from "214.6999" to "5949.2122" with a record increase. The relationship between this sharp increase in air cargo transportation and environmental pollution has been the main research topic of this article.

There is no other research paper in the literature for Turkey that correlates relevant variables via air freight-induced EKC hypothesis by econometric models. The remainder of the research is structured as follows. Part 2 presents a brief literature review. Part 3 involves the data analysis and the research methodology of
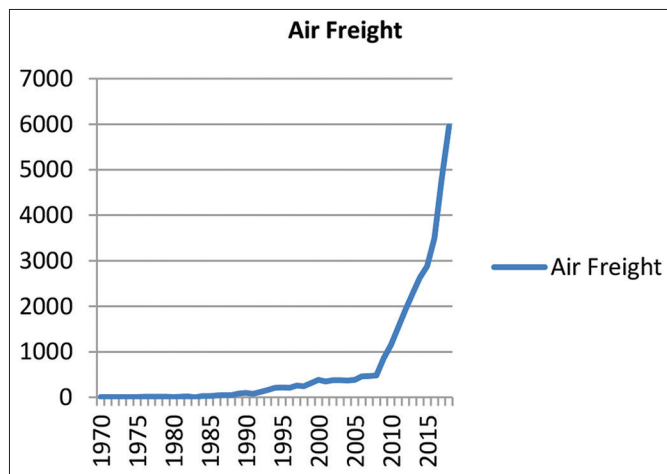
this manuscript. Part 4 discusses the empirical results by ensuring some suggestions to the policy makers of Turkey in terms of how to reduce the environmental degradation.

2. LITERATURE REVIEW

There are lots of topics in the EKC literature which investigates the relationship between environmental pollution, economic growth and air freight. Some of these researches examine the nexus among ecological footprint and economic growth within the context of EKC hypothesis (Beşe and Kalayci, 2021a; Beşe and Kalayci, 2021b; Dursun, 2022a; Dursun, 2022b; Kalayci and Özden, 2021; Köksal and Cetin, 2021; Köksal, 2021; Kayabas, 2022; Liu et al., 2022; Öztürk et al., 2016; Öztürk et al., 2021; Siddique, 2022; Tarazkar et al., 2021; Yazici, 2022). The main aim of this research is to demonstrate the long-term relationship between air freight, economic growth, energy usage and ecological footprint by implementing FMOLS (Fully Modified Ordinary Least Squares), DOLS (Dynamic Ordinary Least Square), CCR (Canonical Cointegrating Regression), and GMM (Generalized Method of Moments) tests for Turkey from 1970 to 2018. There are limited researches within the context of the air transport-induced EKC hypothesis in the academic literature. In this sense, EKC hypothesis is examined for the Turkey in detail as well.

Hu et al. (2015) analyze the relationship between air traffic and economic growth for 29 provinces in China by using the data of 2006Q1-2012Q3 through panel data analysis method. GDP, domestic air passenger traffic variables are used in the study. As a result of the analysis, a bidirectional relationship is obtained between the variables in the long run. In the short run, a one-way causality relationship is found from airline traffic to Gross Domestic Product (GDP).

Kalayci and Yanginlar (2016) discuss the relationship between air transportation, foreign direct investment and GDP in Turkey within the context of co-integration and multivariate linear regression analyzes by using the 1974-2014 period of data. The variables of economic growth and number of passengers are used, in order to investigate the long-term relationship. In addition, according to

the multivariate regression result, no relationship is found between airline demand and economic growth. Kalayci and Yazici (2016) investigate the exports of USA from 1980 to 2012 by analyzing the effect of trade volume and GDP on civil aviation through linear regression and Johansen co-integration tests and it is revealed that there is a long-term relationship between the relevant variables.

Hassan et al. (2021) analyze the validity of the EKC hypothesis in terms of aviation sector of 21 OECD countries by using the 1980-2018 period data and the GMM method. In the study, while an inverted U-shaped relationship is determined in the field of economic growth and passenger transportation by air, it was seen that there was a U-shaped EKC in the field of air freight transportation.

Gyamfi et al. (2022) analyze the validity of EKC in air and rail transport of E7 countries using second generation panel data analysis methods using data from the period 1995-2016. In this study; It has been determined that the EKC is valid in the air and rail transportation of the countries in question, and that rail transportation and urbanization reduce environmental pollution. For this reason, it was emphasized that railway transport should be especially supported in terms of sustainable environment.

When the transportation processes is examined between countries, it is possible to see that the different used transportation systems cause pollution in different sizes. With the increasing trade and liberalization of trade, the transportation of goods and services is also important. For example, it is stated that the transportation of goods and services by air will cause more pollution. Because millions of tons of fuel are used, especially in air transport and it causes quite negative effects on the atmosphere. At the same time, since energy is used in transportation as well as the energy used in production, its negative impact on environmental pollution increases even more (Batra et al., 1998).

McKinnon (2007) analyze carbon dioxide emissions from freight transport in the UK. In particular, the difficulties in calculating air and sea cargo emissions are emphasized. As a result of the study, it is determined that 33.7 million tons of carbon dioxide emissions were generated from freight transport in 2004, and freight transport carbon dioxide emissions constituted 6% of the total emissions of the United Kingdom.

Akdemir (2020) conclude in his empirical study that the taxes to be applied on aircraft fuel for European Union countries will reduce greenhouse gas emissions by saving energy. On the other hand, he stated that the aviation tax applied in Germany, Sweden and France is 1.5-9 Euros per passenger, and that it is another ecological tax type used in the fight against climate change, and that preparations for legal regulations are ongoing in many EU member countries.

Yıldız et al. (2020) investigate the possibilities of using renewable energy sources in order to reduce energy costs and emissions at airports. It has been concluded that airports have significant opportunities in the use of renewable energy sources and that studies in this direction should be increased.

Table 1: Multivariate regression analysis for Turkey

Dependent Variable: Ecological_footprint Sample: 1970-2018, Included observations: 49 Method: LS				
Variable	Coefficient	SE	Prob.	t-statistic
Air freight	0.062808	0.018358	0.0390	2.697703
Energy cons	0.310685	0.073211	0.0001	4.243695
Econ growth	0.086861	0.027113	0.0025	3.203702
C	−4.069872	0.454781	0.0000	−8.949080
Mean dependent var	0.230321	R-squared	0.985410	
SD dependent var	0.349338	Adj R-squared	0.984438	
Akaike info criterion	−3.350346	SE of regr	0.043580	
Schwarz criterion	−3.195912	Sum sqr resid	0.085463	
Hannan-Quinn criter	−3.291754	Log likelihood	86.08347	
Durbin-Watson stat	1.990669	F-statistic	1013.120	
AR (1) 0.03	@trend: 0.85	Prob (F- statistic)	0.000	

Table 2: ADF unit root test results of Turkey

Results	Country	Series	ADF test at I (0)	ADF test at I (1)
I (1)	Turkey	Air_freight	**−1.5817**	**−5.9683***
			−2.9266	−2.9389
I (1)		Energy_cons	**2.5435**	**−6.2557***
			−2.9237	−2.9251
I (1)		Econ_growth	**0.0639**	**−5.9298***
			−2.9237	−2.9251
I (1)		Ecological_footprint	**0.2595**	**−11.4612***
			−2.9251	−2.9251

Bold values demonstrate ADF test results. "*" and "**" symbols indicate the unit root test of the variables which is employed in the estimation process, 1 and 5% significance levels, respectively

Table 3: PP unit root test results of Turkey

Results	Country	Series	PP test at I (0)	PP test at I (1)
I (1)	Turkey	Air_freight	**1.5588**	**5.7321***
			−2.9237	−2.9251
I (1)		Energy_cons	**1.8996**	**−6.2530***
			−2.9237	−2.9251
I (1)		Econ_growth	**−0.1229**	**−6.0760***
			−2.9237	−2.9251
I (1)		Ecological_footprint	**0.0826**	**−17.1858***
			−2.9237	−2.9251

Bold values demonstrate PP test results. "*" and "**" symbols indicate the unit root test of the variables which is employed in the estimation process, 1 and 5% significance levels, respectively

Kumaş et al. (2019) conclude in their study that the measures to be taken at airports will reduce greenhouse gas emissions. Some of these measures are; It has been expressed as reducing passenger loading and unloading times, increasing aircraft occupancy rates, developing methods to access reliable data, and developing new techniques that can be used in calculating the carbon footprint of the aviation industry.

Akyüz et al. (2017) elaborate the effects of structural changes to be made in the terminal building on the heating energy in their study

Figure 2: Autocorrelation diagram of multivariate regression
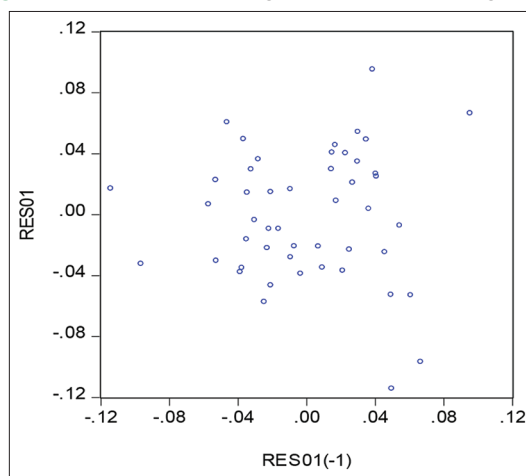
for the Hasan Polatkan Airport terminal building. They calculated the energy savings and economic payback periods used for heating as a result of thermal insulation in the building envelope and replacing the existing windows with windows through a lower heat transmission coefficient. In the study, the importance of the building envelope in energy saving was emphasized.

Bal et al. (2017) examine the Turkey in terms of relationship between the aviation sector and economic growth in their studies. In the period of 1967-2015, the effect of air passenger demand and cargo transportation, which are symbols of air transportation in the Turkish economy, on economic growth has been tried to be found by VECM Granger Causality analysis. According to the results of the study; It has been determined that the aviation sector has a positive and unidirectional effect on economic growth in the long run.

Kundak and Aktop (2018) investigate the effect of air transport, which has an important place in the service sector in the Turkish economy, on the economic growth. The impact of positive developments in air transport, which has a key importance in the service sector, on economic growth has been examined. By using the input-output analysis method of 2002-2012 data, it was concluded that air transport is a sector that can affect other sectors and creates added value for the country's economy. It has been stated that this sector has made a dynamic development in Turkey.

3. DATA AND METHODOLOGY

The long-run relationship among variables and impact of air freight, economic growth, energy usage on ecological footprint are considered from 1970 to 2018 by employing multivariate regression, FMOLS (Fully Modified Ordinary Least Squares), DOLS (Dynamic Ordinary Least Square), CCR (Canonical Co-integrating Regression), and GMM (Generalized Method of Moments) tests for Turkey. The data are obtained from World Bank's (2022a), (2022b) official website for air freight and GDP respectively. The rest of variable's data are collected from Our World in Data (2022) for energy usage and Global Footprint Network (2022) for ecological footprint.

Table 4: FMOLS, DOLS, and CCR results of Turkey

Country	Dependent variable Ecol_foot	FMOLS			EKC hypothesis
	Independent variables	T-stats.	Coeff.	P-val.	Verified
	Air_freight	−1.026463	−3.33E-05	**0.0104**	
	Energy_cons	6.527023	0.001484	**0.0000**	✓
	Econ_growth	1.729834	3.13E-13	**0.0408**	
	C	−1.786042	−0.019866	**0.0811**	
	DOLS				
	Air_freight	−2.840597	−0.000147	**0.0078**	
Turkey	Energy_cons	1.922397	0.000802	**0.0635**	✓
	Econ_growth	1.322219	2.90E-13	**0.0455**	
	C	0.456188	0.004321	**0.6513**	
	CCR				
	Air_freight	−0.473774	−2.06E-05	**0.0381**	
	Energy_cons	2.918473	0.001175	**0.0056**	✓
	Econ_growth	1.139703	2.78E-13	**0.0607**	
	C	−0.758395	−0.010427	**0.4524**	

Table 5: Generalized method of moments root mean square error results of Turkey

GMM methods errors comparison	Root mean square error
GMM/TSLS	5.02
GMM/White	6.63
GMM/HAC	5.21

According to Multivariate Regression (MR) result of Turkey, air freight, economic growth, energy usage influence the ecological footprint from 1970 to 2018 (Table 1). The logarithm of the series are taken in order to hinder the variance booming. Besides, the residuals are distributed randomly at Figure 2 which demonstrates that there is no autocorrelation problem in the model. The other proof in terms of nonentity autocorrelation is the results of Durbin-Watson statistics which is around 2. The code of @trend is added to the model to apprehend that there is a pseudo regression or not. The findings of the @trend is more than 0.05 which indicates that there is no pseudo linkage between air freight, economic growth, energy usage and the ecological footprint from 1970 to 2018 (Table 1).

Both ADF and PP tests are essential to analyze the stationarity of the variables. According to Tables 2 and 3, all series are not stationary at I(0) including air freight, economic growth, energy usage, and ecological footprint. Besides, performing the first differences of series for Turkey, all variables become stationary at I(1). In order to employ FMOLS, DOLS, and CCR tests, all variables must be stationary. Phillips and Perron (1988) recommend a non-parametric methodology for serial correlation in terms of unit root test. In addition, PP test forecasts the Dickey-Fuller equation and changes the t-value of the α coefficient. Consequently, the serial correlation does not influence the asymptotic distribution of the test statistics.

The ADF test (which is considered according to the AIC Akaike Information Criterion) is employed to the series containing air freight, economic growth, energy usage, and ecological footprint to analyze for stability. The maximum lag length is determined to be 2 as per Serena and Perron's (2001) recommendation. The ADF unit root test involves a parametric equation for higher-order correlation, supposing that the series follow an AR (k) process and add the lagged difference terms of the dependent variable to the right side of the series.

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \tag{1}$$

$$\Delta y_t = c + \alpha y_{t-1} + \beta t \sum_{j=1}^{k} d_j \Delta y_{t-j} + \varepsilon_t \tag{2}$$

Considering the above equation (1) investigates the null hypothesis towards a mean stationary alternative unit root in y_t of the examined time series of y. Equation (2) demonstrates the unit root of the null hypothesis towards the trend-stationary alternative as well. The expression Δy_{t-j} indicates the first difference in the error term that ensures the serial correlation. Finally, a constant and linear time trend can be involved in the Augmented Dickey Fuller test, as demonstrated in the above equations.

The econometric equation is forecasted through the group mean FMOLS, DOLS, and CCR analysis, while the lag length is selected in compliance with the Schwarz information criterion in Table 4. When findings of the DOLS, CCR and FMOLS analysis are investigated through all panels, the main results of P-values mostly coincide between each other. Considering the findings of FMOLS, DOLS, and CCR analysis of Turkey from 1970 to 2018 the EKC hypothesis is verified. In addition, there is a long-term nexus between air freight, economic growth, energy usage, and ecological footprint which confirms the EKC hypothesis from 1970 to 2018. According to Table 4, the P-values of all independent variables of Turkey are <0.05 which demonstrates that these values are within the 5 percent confidence interval. On the other hand, according to Multivariate Regression (MR) result of Turkey, air freight, economic growth, energy usage influence the ecological footprint from 1970 to 2018 which is consistent with the findings of FMOLS, DOLS, and CCR. These 3 econometric analyzes (FMOLS, DOLS, and CCR) included in the study also measure the effect of independent variables on dependent variables, apart from measuring the long-term relationship between variables, unlike classical co-integration tests.

Table 6: Generalized method of moments) test results of Turkey

Dependent variable: Ecol_foot				
Applied analysis: Generalized method of moments				
Sample size (Adjusted): 1971-2018				
Observations: 48 (after adjustments), Estimation weighting matrix: TSLS two stage least squares				
Variables	**Coefficient**	**SE**	**t-statistic**	**Prob.**
Air_freight1	−1.85E-05	3.98E-05	−0.464463	0.0446
Energy_cons1	0.001629	0.000280	5.829276	0.0000
GDP1	4.35E-13	2.22E-13	1.954850	0.0570
C	−0.029423	0.013492	−2.180725	0.0346
Mean dependent var	0.030208	AR (1): 0.002	R-squared:	0.545876
SD dependent var	0.098790	AR (1): 0.345	Adjusted R-squared:	0.514913
Sum squared resid	0.208306		S.E. of regression:	0.068806
J-statistic	44.00000		Durbin-Watson stat:	2.522213
Prob (J-statistic)	0.000000		Instrument rank:	5

The GMM (Generalized Method of Moments) is employed to ascertain the linear linkage among the variables. The Generalized Method of Moments (GMM) is a general performed test to forecast the parameters from the point of a statistical method if it is taken into account as an econometric model. In this sense, the GMM is a way of statistical approach which bands together the annual macroeconomic data through the information of moment terms to forecast the uncertain elements of the economic analysis. After attaining these elements, it should be examined at the probability values to make inferences about the basic questions. Time series analysis may have self-relationships, and it can be expressed that this can lead to endogeneity problems and unreliable results.

GMM method is employed to minimize the internal problem. Different TSLS (Two-Stage Least Squares), White and HAC, are used by performing several GMM method by selecting TSLS test. The findings of GMM are demonstrated above (Table 5). The lowest root mean square error is obtained in the GMM-TSLS tests. Thus, GMM–TSLS test is specified for the econometric analysis. According to GMM–TSLS analysis (Table 6), there is no validation issue since the value of t-statistic is more than 0.05. AR 1 is significant, and AR 2 is meaningless.

The correlation between the variables of time series behind by a constant amount of time in the way of these parameters has been verified statistically. Besides, when taking into account the Generalized Method of Moments-TSLS (Two Stage Least Squares) model, there is no autocorrelation problem since the Durbin Watson value (2.52—Table 6.) is close to 2. Instrumental series are attached to the test as well. The results of GMM analysis reveal that air freight, economic growth, energy usage affect the ecological footprint from 1970 to 2018 for Turkey which is consistent with Multivariate Regression (MR), FMOLS (Fully Modified Ordinary Least Squares), DOLS (Dynamic Ordinary Least Square), CCR (Canonical Cointegrating Regression) and confirms the EKC hypothesis as well.

4. DISCUSSION AND CONCLUSION

In today's world, it is of great importance to ensure that people can reach a different region or from a city to a different city in a short time due to reasons such as the diversification of work and the time becoming a very valuable element. Transportation is a very large sector that covers including road, sea, air and rail transport sectors. In the air transport sector, which is among the sub-sectors of the transport mode, passenger and freight transport operations are carried out much faster than in other sectors. In this respect, the aviation industry has an important role for both passengers and national economies. After 1980, with the globalization policies, international trade gained importance for all countries of the world. Since exports are both a source of growth and a financing tool for imports, countries focus on policies to increase exports. Simultaneously with the growth of international trade, the importance of the logistics sector has increased and international supply chains have become more complex. Although the share of air cargo transportation in all transportation modes is low in terms of weight, it is high in terms of value.

In other words, expensive products are transported by air cargo. The air cargo transportation sector is important in terms of not disrupting the flow of goods in the supply chains and the continuation of international trade.

With the globalization process, an export-based growth model has been adopted, and both imports and exports have entered an increasing trend in this process in Turkey. In this context, the air cargo sector has grown, especially in import shipments, and its share in value basis among all transportation modes has increased from 9% to 22% in the last ten years. The increase in the share of the air cargo sector in transportation modes and the prediction that the sector will enter into an even faster growth trend in the future have brought along some problems and discussions.

There are concerns that the growth of the air cargo sector will lead to an increase in greenhouse gas emissions and contribute more to the global warming problem. While it is aimed to reduce greenhouse gas emissions through global initiatives such as the Kyoto Protocol and the Paris Agreement within the scope of combating climate change, the structuring of the air cargo sector in line with this target is important for the sustainability of the sector. In this study, the relationship between air cargo freight and ecological footprint in Turkey was investigated by time series co-integration methods.

The long-term relationship between air cargo freight and ecological footprint has been determined in the study, where data

has been used since 1970. Air freight, economic growth, energy usage affect the ecological footprint from 1970 to 2018 for Turkey according to multivariate regression and GMM tests. In addition, according to the FMOLS, DOLS, and CCR analysis there is a long-term relationship between variables.

An increasing number of businesses in the world are realizing their responsibilities in protecting the environment and are changing their perspectives towards the natural environment. In this context, it is seen that environmental awareness is established in enterprises with the efficient use of resources, reduction of waste and recycling, and reduction in costs. Demands from consumers about the environment also lead businesses to be more sensitive to the environment. In order not to fall behind the change, business managers develop an environmentally sensitive management approach by taking into account the demands in this direction. The social responsibilities of businesses that promote responsible attitudes and practices that contribute socially, economically and environmentally sustainable development in the business world serve success in business life. ISO 14001 Standard contributes businesses to fulfill their social responsibility towards the natural environment, society and consumers.

This standard guides businesses in environmental management, helps them to improve their environmental performance, facilitates compliance with legal regulations, improves their image in society and accelerates business culture to be more sensitive to environmental problems. Airports, which are the building blocks of the air transport sector, play an important role in the social and economic development. For instance, Istanbul Airport is planned to be one of the most important attraction centers of the world. As a result of the activation of Istanbul Airport, all passenger movements from Atatürk Airport were shifted to the new airport as of April 2019. It has been decided to continue air cargo transportation in coordination with Atatürk Airport for a while. The sudden relocation of an airport with a lot of passenger traffic to the new airport has caused many discussions. In this transition period, the lack of infrastructure and the fact that the established area is far from the city center brought along some transportation problems. However, as a result of the development of industrialization around the airport, the rapid consumption of energy resources, the growth of residential areas and the increase in population, the effects of environmental pollution are also increasing.

The fact that it causes not only regional, but also long-term, global environmental effects necessitates the control of airport activities by establishing an environmental management system within the airport. Despite the rapid spread of the environmental management system with the increasing consumer awareness in developed countries, the importance of this issue has not yet been grasped in Turkey. It has been determined that the ISO 14001 Environmental Management System has not yet been established at airports open to international traffic. However, in order to meet the standards expected by international aviation authorities, it is necessary to develop practices in this regard at airports in Turkey. Today, when environmental pollution has reached serious dimensions, airport operators, local people and every unit of the aviation industry will go to produce solutions and take precautions together. With the

Environmental Management System to be established within the airport, which is accepted as indispensable businesses in terms of social and economic aspects for the environment; it will be able to achieve sustainable development by increasing their performance in the new period.

There are not many studies in the literature examining the relationship between the air cargo sector and environmental degradation through quantitative methods. Generally, studies report statistics from aviation authorities. The most important output of this study is to clearly reveal the relationship between air cargo freight traffic and greenhouse gas emissions using econometric methods. Turkey contributes to the international fight against climate change.

It is aimed to make energy-saving low-carbon investments in order to reduce ecological footprint. Controlling greenhouse gas emissions is of great importance in ensuring the sustainability of the air cargo industry. Investments should be made urgently for the use of alternative fuels in aircraft. The carbon tax applied in some countries with successful results will also be effective in reducing the greenhouse gas emissions of the sector. Another advantage of the carbon tax is that it will direct the sector to technological investments that will reduce emissions. Directing some of the road transport, where fossil fuel consumption is most intense, to seaway and rail transport, and transferring light but expensive cargoes to air cargo, will also be effective in reducing greenhouse gas emissions. Greenhouse gas emissions in the aviation sector do not increase only because of airplanes. Greenhouse gas emissions from airports should also be reduced. The use of renewable energy sources at airports will contribute to the process. Financial incentives should be provided to airline companies that are willing to invest in line with these targets, and tax exemptions should be introduced for such investments. Although it does not seem possible in the near future, it is important for the future sustainability of the sector to carry out studies on electric air transportation.

REFERENCES

Akdemir, T. (2020), Avrupa birliği'nde iklim değişikliği ile mücadelede havacilik vergileri. Ankara Avrupa Çalışmaları Dergisi, 19(1), 1-24.

Akyüz, M.K., Altuntaş, Ö., Söğüt, M.Z. (2017), Economic and environmental optimization of an airport terminal building's wall and roof insulation. Sustainability, 9(10), 1-18.

Bal, H., Manga, M., Gümüş Akar, P. (2017), Havacılık sektörü ve ekonomik büyüme: Türkiye örneği. Akademik ve Sosyal Araştırmalar Dergisi, 5(45), 353-366.

Batra, R., Beladi, H., Frasca, R. (1998), Environmental pollution and world trade. Ecological Economics, 27(2), 171-182.

Beşe, E., Kalayci, S. (2021a), Environmental Kuznets curve (EKC): Empirical relationship between economic growth, energy consumption, and CO_2 emissions: Evidence from 3 developed countries. Panoeconomicus, 68(4), 483-506.

Beşe, E., Kalayci, S. (2021b), Relationship between life expectancy, foreign direct investment and trade openness: Evidence from Turkey. Montenegrin Journal of Economics, 17(1), 31-43.

Dursun, E. (2022a), Investigating the air transport-induced EKC hypothesis: Evidence from NAFTA countries. International Journal of Energy Economics and Policy, 12(4), 494-500.

Dursun, E. (2022b), The Nexus among civil aviation, energy performance efficiency and GDP in terms of ecological footprint: Evidence from France and Finland. International Journal of Energy Economics and Policy, 12(5), 243-251.

Egilmez, F. (2020), The long-run relationship between airline transport, export volume and economic growth: Evidence from USA. Academic Review of Humanities and Social Sciences, 3(2), 466-482.

Gerede, E. (2015), Havayolu taşımacılığındaki ekonomik düzenlemeler. In: Gerede, I.E., editors. Havayolu Taşımacılığı ve Ekonomik Düzenlemeler: Teori ve Türkiye Uygulaması. Ankara: Sivil Havacılık Genel Müdürlüğü Yayınları. p47-80.

Global Footprint Network. (2022), Ecological Footprint, Total Biocapacity in Global Hectares. Califorina: Global Footprint Network's Official Website Database. Available from: https://www.data.footprintnetwork.org/?_ga=2.184715049.1847198878.1657106657-1497168924.1657106657

Gyamfi, B.A., Bekun, F.V., Balsalobre-Lorente, D., Onifade, S.T., Ampomah, A.B. (2022), Beyond the environmental Kuznets curve: Do combined impacts of air transport and rail transport matter for environmental sustainability amidst energy use in E7 economies? Environment, Development and Sustainability, 24(10), 1-19.

Hassan, S.A., Nosheen, M., Rafaz, N., Haq, I. (2021), Exploring the existence of aviation Kuznets curve in the context of environmental pollution for OECD nations. Environment, Development and Sustainability, 23(10), 15266-15289.

Hu, Y., Xiao, J., Deng, Y., Xiao, Y., Wang, S. (2015), Domestic air passenger traffic and economic growth in China: Evidence from heterogeneous panel models. Journal of Air Transport Management, 42, 95-100.

Kalayci, S. (2021), Analysing Transportation-Induced Economic Growth, Energy Use, and CO_2 Emissions: An Empirical Investigation from EU Countries. Research Anthology on Clean Energy Management and Solutions. United States: IGI Global. p1277-1293.

Kalayci, S., Özden, C. (2021), The linkage among sea transport, trade liberalization and industrial development in the context of CO_2: An empirical investigation from China. Frontiers in Environmental Science, 9, 633875.

Kalayci, S., Yanginlar, G. (2016), The effects of economic growth and foreign direct investment on air transportation: Evidence from Turkey. International Business Research, 9(3), 154-162.

Kalayci, S., Yazici, S. (2016), The impact of export volume and GDP on USA's civil aviation in between 1980-2012. International Journal of Economics and Finance, 8(1), 229-235.

Kara, M.A., Ciğerlioğlu, O. (2018), Türkiye ekonomisinde ulaşım altyapısının ekonomik büyümeye etkisi. Gaziantep University Journal of Social Sciences, 17(2), 577-591.

Karakaya, E. (2008), Küresel Isınma ve Kyoto Protokolü: İklim Değişikliğinin Bilimsel, Ekonomik ve Politik Analizi. Turkey: Bağlam Yayıncılık.

Kayabas, Y.E. (2022), Testing the EKC Hypothesis in terms of trade openness, industrial and construction development: Evidences from Northern European and Latin American countries. International Journal of Energy Economics and Policy, 12(5), 319-331.

Köksal, C., Cetin, G. (2021), Türkiye'de kirlilik yaratan sektörlerin dış ticaretinin analizi. Journal of Economic Policy Researches, 8(2), 257-275.

Köksal, C. (2021), The impact of international trade and tourism development on quality of life: Evidence from Turkey. JOEEP: Journal of Emerging Economies and Policy, 6(2), 406-413.

Kumaş, K., İnan, O., Akyüz, A. ve Güngör, A. (2019), Muğla dalaman havalimanı uçaklardan kaynaklanan karbon ayak izinin belirlenmesi. Academic Platform Journal of Engineering and Science, 7(2), 291-297.

Kundak, S., Aktop, V.S. (2018), Türkiye ekonomisinde havayolu taşımaciliğinin girdi-çikti analizi ile değerlendirilmesi. Uluslararası Yönetim ve Sosyal Araştırmalar Dergisi, 5(10), 82-93.

Liu, J., Nathaniel, S.P., Chupradit, S., Hussain, A., Köksal, C., Aziz, N. (2022), Environmental performance and international trade in China: The role of renewable energy and eco-innovation. Integrated Environmental Assessment and Management, 18(3), 813-823.

McKinnon, A. (2007), CO_2 emissions from freight transport: An analysis of UK data. In Logistics Research Network-2007 Conference Global Supply Chains: Developing Skills, Capabilities and Networks.

Our World in Data. (2022), Energy Consumption. The Data is Collected. Avalable from: https://www.ourworldindata.org/energy-production-consumption

Öztürk, I., Al-Mulali, U., Saboori, B. (2016), Investigating the environmental Kuznets curve hypothesis: The role of tourism and ecological footprint. Environmental Science and Pollution Research, 23(2), 1916-1928.

Öztürk, I., Majeed, M.T., Khan, S. (2021), Decoupling and decomposition analysis of environmental impact from economic growth: A comparative analysis of Pakistan, India, and China. Environmental and Ecological Statistics, 28(4), 793-820.

Phillips, P.C., Perron, P. (1988), Testing for a unit root in time series regression. Biometrika, 75(2), 335-346.

Serena, N., Perron, P. (2001), Lag length selection and the construction of unit root tests with good size and power. Econometrica, 69(6), 1519-1554.

Siddique, H.M.A. (2022), Industrialization, energy consumption, and environmental pollution: Evidence from South Asia. Environmental Science and Pollution Research, 182, 1-9.

Songur, M. (2017), Türkiye'de beşeri sermaye ve fiziksel sermaye arasındaki ikame olanakları: Translog Üretim Fonksiyonu yaklaşımı. Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 7(2), 201-224.

Tarazkar, M.H., Kargar Dehbidi, N., Ansari, R.A., Pourghasemi, H.R. (2021), Factors affecting methane emissions in OPEC member countries: Does the agricultural production matter? Environment, Development and Sustainability, 23(5), 6734-6748.

World Bank. (2022a), Air Transport, Freight (Million Ton-km), the Data is Retrieved from United States: World Bank. Available from: https://www.data.worldbank.org/indicator/IS.AIR.GOOD.MT.K1

World Bank. (2022b), GDP (Current US$), the Data. United States. World Bank. Available from: https://www.data.worldbank.org/indicator/NY.GDP.MKTP.CD

Yıldız, Ö.F., Yılmaz, M., Çelik, A., Edip, İ.M. (2020), Havalimanlarında yenilenebilir enerji kaynaklarının kullanılması. Journal of Aviation, 4(1), 162-174.

Yazici, S. (2022), Investigating the maritime freight-induced EKC hypothesis: The case of Scandinavian countries. Frontiers in Environmental Science, 289, 1-18.