Ali Tehci, PhD
Associate Professor
Ordu University, Fatsa Faculty of Marine Sciences
Department of Maritime Business Administration, Ordu, Türkiye
E-mail: a.tehci@odu.edu.tr
Orcid: https://orcid.org/0000-0001-9949-2794

Fuad Selamzade, PhD
Associate Professor
Muş Alparslan University, Faculty of Health Sciences, Muş, Türkiye
E-mail: f.salamov@alparslan.edu.tr
Orcid: https://orcid.org/0000-0002-2436-8948

Sam Demirkol, PhD
Associate Professor
University of Sussex, Strategy & Marketing Department
Sussex Business School, United Kingdom
E-mail: s.demirkol@sussex.ac.uk
Orcid: https://orcid.org/0000-0002-8923-9821

Aycan Kama, PhD
Nevşehir Hacı Bektaş Veli University, Nevşehir, Türkiye
E-mail: kamaaycan@hotmail.com
Orcid: https://orcid.org/0000-0001-5008-9072

Yusuf Ersoy, PhD
Associate Professor
Muş Alparslan University, Malazgirt Vocational School, Muş, Türkiye
E-mail: y.ersoy@alparslan.edu.tr
Orcid: https://orcid.org/0000-0002-0106-1695

THE IMPACT OF SEAPORT CARGO ON ECONOMIC DEVELOPMENT: PANEL DATA EVIDENCE FROM TÜRKIYE

UDC / UDK: 656.61:627.093]:338.1(560)
JEL classification / JEL klasifikacija: L91, R41, F14, O18
DOI: 10.17818/EMIP/2025/18
Preliminary communication / Prethodno priopćenje
Received / Primljeno: September 2, 2024 / 2. rujna 2024.
Accepted / Prihvaćeno: March 6, 2025 / 6. ožujka 2025.

Abstract

The strategic importance of ports increases the share of maritime transport in international trade. Most of the cargo handled in ports is related to foreign trade. The current study focuses on the impact of the outputs of 18 container and cargo ports involved in international trade in Türkiye on macroeconomic indicators. The effects of the cargo outputs of the ports for the years 2004-2022 on GDP were estimated using *panel data regression models. The results show that the amount of cargo handled in ports influences the exports and industrial production of the provinces. It was also concluded that the amount of cargo exports has an essential impact on increasing GDP. It is imperative to enhance ports and fully utilize their potential.*

Keywords: Maritime Transportation, Port, Economic Development, GDP, Panel Data Regression

1. INTRODUCTION

Countries' port capacities and numbers are directly related to their competitiveness and development level. Maritime transport plays a significant role in international trade. Ports hold strategic importance as they also function as connection points for other logistics operations (Ferrari et al., 2010). Ports, which offer social and economic benefits to the countries and cities (Yu et al., 2017; Marušić, 2021), are transportation and distribution centers equipped with various facilities for the safe entry and exit of ships (Cong et al., 2020). They are crucial to the global economy by linking to other logistics operations like roads and railways. Supply chains have evolved with globalization, elevating ports to key players in national economies. Ports, serving as hubs for cargo, ships, and passengers, play a vital role in connecting national and international trade (Perez et al., 2020). They are logistical hubs facilitating market operations in their regions (Shan et al., 2014). Ports collaborate with various entities such as agencies, shipping companies, and governments, making them highly dynamic (Esmer et al., 2016). Ports are central to economic activities as they contribute to all sectors in terms of both transfer and storage.

The significance of maritime logistics is progressively increasing. However, high freight rates, increasing traffic, epidemics, and wars also have an impact on demand. Considering that 90% (WEF, 2024) or more than 80% of global trade is conducted by sea, the absence of sea connections and high transportation costs lead to inflation (UNCTAD, 2022). Simultaneously, it can be argued that ports also incur local costs on host cities. Ports can increase the attractiveness of cities by increasing their population. Nevertheless, it is indicated that local costs associated with port development diminish total welfare gains, and container transportation in ports elevates global welfare by 3.4% (Ducruet et al., 2024b). Ports, crucial for advancing countries' economies, expedite development, particularly concerning transshipment and logistics operations. While they handle supply and marketing activities, they contribute to various sectors, such as manufacturing, international trade, and logistics (Moschovou & Kapetanakis, 2023; Baştuğ et al., 2023). Most countries benefit from this scenario due to economic growth, which positively impacts the progress and demand for ports.

It can be said that container trade, which has an important place in international trade, is growing rapidly in terms of being safer and easier to handle than other modes of transport. Maritime container transportation positively affects economic growth (Özer et al., 2021). Compared to the previous year, container loads handled in Turkish ports increased by 1.2%, and the total load increased by 3.1% in tonnage in 2022. The increased rate of total load handled in Turkish ports, which was 5.9% in 2021 compared to the previous year, decreased to 3.1% in 2022. Approximately 72.6% of the handled loads are subject to foreign trade. As of 2022, the rate of cabotage loads was 12.4%, and the rate of transit loads was 14.9% (TURKLIM, 2023). Türkiye has potential in terms of logistics operations due to its important straits. This potential needs to be well evaluated. Therefore, when considering the gains and costs of ports, it is vital to know the relationships between macroeconomic indicators and port outputs and their economic effects.

2. LITERATURE

Various studies in the literature investigate the effects of ports on economies. It is seen that there are topics such as increasing private investments (Bottasso et al., 2014), reducing transportation and production costs (Cohen, 2008), and the effects of ports on employment and regional economies (Mudronja et al., 2020; Osadume, 2020; Cong et al., 2020). There are also results on whether ports, which are important connection and transfer locations of trade in the globalizing world and are seen as the driving force of economic development, contribute to the national and regional economies. Ports contribute to the growth of country and city economies (Bottasso et al., 2013; Chang et al., 2014; Park & Seo, 2016; Munim & Schramm, 2018; Ma et al., 2021). However, some studies have also stated that they do not play a significant role (Jung, 2011; Deng et al., 2013). It has been emphasized that local benefits provided by ports are decreasing, especially due to developing technology, increasing logistics opportunities, and structural changes in economies (Jung, 2011). While the quality of a country's logistics performance is affected by its port infrastructure (Hausman et al., 2013), it has also been found to have a positive impact on maritime trade (Munim & Schramm, 2018). Ports also have environmental costs. They can cause negative impacts such as noise and pollution, especially in the cities where they are located (Ducruet et al., 2024a). Policymakers should focus on the transportation infrastructure of ports to reduce economic inequalities and support development. Although environmental policies and policy options negatively affect ports in the short term, they contribute to increasing the competitiveness of ports in the long term because of the revitalization of port activities (Woo et al., 2018). They significantly affect GDP (Cong et al., 2020). However, it is stated that the performance of ports affects economic growth in the short term, which is why policymakers should encourage greater utilization by foreign shipping companies (Osadume, 2020).

There are studies in the literature that use Panel Data Analysis. Cong et al. (2020) created 10 different models. They found that GDP and secondary industry had a positive significant effect on port efficiency. In contrast, primary and tertiary industries negatively affected port efficiency in their study of China's major ports. Mudronja et al. (2020) analyzed the impact of ports on the growth of regional economies within the scope of the endogenous growth theory based on research and development. As a result of the research, they found that ports significantly impact the economic growth of EU port regions. However, they said that other factors affecting the growth of regional economies, such as investments in R&D and human capital, should also be considered. Özer et al. (2021) investigated the impact of railway and container transportation on economic growth in their study for Türkiye. They found that container transportation significantly and positively impacts economic growth in both the short and long term. In the study conducted by Tunalı and Akarçay (2022), it was concluded that container and port infrastructure investments positively affect economic growth for Türkiye. Daniş and Acar (2024) examined the efficiency and competitiveness of container ports in the Black Sea Basin with Data Envelopment Analysis (DEA) using the input-oriented CCR model. They noted that it was not enough for a port to have the longest quay or the most modern equipment. Many factors had to be in harmony. Nayak et al. (2024) evaluated 12 major Indian ports regarding operations, physical infrastructure, technical infrastructure, finance, and socio-economic dimensions using panel data regression and efficiency analysis. As a result of the analysis, they found that operations, physical infrastructure, and socio-economic dimensions have a positive and significant impact on the port's financial performance. Bartosiewicz et al. (2024) evaluated the efficiency of 46 Baltic maritime container terminals using a DEA slack-based model with quay length, terminal equipment, and depth at the quay as input variables and throughput and short sea shipping links as output variables. As a result, they found that Baltic terminals are more efficient than their smaller counterparts. Türkiye has potential in terms of maritime logistics because it has important straits. Therefore, the current study focuses on the economic effects of port outputs by considering the macroeconomic indicators of Turkish container ports.

3. METHODOLOGY

Parametric methods and nonparametric methods are commonly favored in economic literature for measuring the efficiency changes of service-producing businesses over time and for making future predictions (Učkar & Petrović, 2022; Ersoy & Tehci, 2023). Various data types, such as time series and panel data, are typically employed in parametric analyses with data collected across different periods. Consequently, panel data analysis was selected for the current study. Fixed and random effect models are used in panel data analysis, including time series observations, as they can handle data in horizontal and vertical dimensions (Greene, 1993). However, it is stated that panel data has limitations such as data collection and design, short time series, and distortions in measurement errors (Hsiao, 2003). Panel data, a time series of cross-section numbers or cross-data with a time dimension (Greene, 2003), allows different observation numbers about the same sampling unit (Özer & Çiftçi, 2009). Baltagi (2005) expressed the panel data regression equation, which is different from cross-section data or time series regression equation, as follows:

$$y_{it} = \alpha + \beta X'_{it} + u_{it} \qquad i=1,2,\ldots,N;\ t=1, 2,\ldots,T \tag{1}$$

In this formula, y_{it} is the dependent variable for the ith unit (ports) at time t, α is the constant term that is common to all units and times or can vary according to unit and time, β is the coefficient vector to be estimated, X_{it} is the matrix of independent variables determined according to each model, u_{it} is the error term that includes the effects specific to units and time. The error term u_{it} in the model (1) is based on the decomposition of its components in terms of unit and time effects. The following equation is obtained when the error term is decomposed (Baltagi, 2005; Kutlar, 2012).

$$u_{it} = \mu_i + \lambda_t + \theta_{it} \tag{2}$$

This last equation obtained is called the error component model. Here, μ_i shows individual effects, λ_t shows time effects. μ_i, λ_t ve θ_{it}~IID $(0, \sigma^2)$ (Independent Identically Distributed), i.e., the error terms are assumed to have a mean of zero, a constant variance, and a normal distribution. Panel Data Analysis has followed the basic features (Kutlar, 2012). The case where cross-section and time dimensions are examined: With panel data analysis, differences between units and changes over time are observed simultaneously. The case where variability increases: By modeling both changes between units (cross-section) and over time (time series), more variability is provided, and the estimates are considered more reliable. Data structure: The number of observations in panel data is found by multiplying the number of units (N) by the time dimension (T) (N×T).

Fixed effects and random effects approaches are generally preferred in panel data analyses. When all variables are fixed by the data used in the study, analyses are conducted using the Ordinary Least Squares (OLS) method. This model assumes that changes over time are constrained by shifts in the regression function (Mohan & Mirmirani, 2007). The Random Effects Model, which treats individual effects as a random component of the error term, was developed to address the issues encountered with the variables in analyses conducted using the Fixed Effects Model. Analyses within this model are performed using the Generalized Least Squares (GLS) method (Mohan & Mirmirani, 2007). The Random Effects Model is employed when there is no correlation between the unobserved individual effects and the observed effects resulting from the analysis. Conversely, the Fixed Effects Model is utilized when a correlation problem exists. In the estimation analyses conducted using the Fixed Effects Model, assumptions regarding the constant, slope variables, and error terms can lead to various issues. The literature presents several methods to address these problems (Kutlar, 2012; Yesilyurt & Selamzade, 2020). All variables were assumed to be constant to resolve the issues in our study, and the analysis was performed using the Ordinary Least Squares method. This regression analysis yielded a consistent constant and variable coefficient for all countries. The formulas used in the analyses for Model 6 and Model 11 are presented below (Selamzade, 2020):

$$y_{it} = \alpha + \beta_1 X_{1it} + \ldots + \beta_n X_{nit} + u_{it} \text{ here } n=1\ldots M;\ i=1\ldots N;\ t=1..T \tag{3}$$

Since the Fixed Effects Model includes numerous parameters, the Random Effects Model was developed to address the issue of artificial variables. The calculation for this model is presented in the formula below (Kutlar, 2012; Selamzade & Yeşilyurt, 2021).

$$y_{it} = \alpha + \beta_1 X_{1it} + ... + \beta_{n-1} X_{n-1it} + \beta_n X_{nit} + e_i + u_{it} \quad n=1...M;\ i=1...N;\ t=1..T \quad (4)$$

Here, the (e_i+u_{it}) variable contains multiple error terms. The classical assumptions, including the absence of correlation between individual error terms and the absence of autocorrelation among time series and cross-sectional terms, also remain valid in this context.

3.1. Hausman Test

Panel data analysis is employed to assess the activities of decision-making units over a specific period; the Hausman test is utilized to determine whether the Fixed Effects Model or the Random Effects Model is more appropriate. This test offers a statistical foundation for selecting the suitable model in panel data analysis, thereby enhancing the validity of the results. It is calculated using the formula below (Baltagi, 2005; Selamzade, 2020).

$$H = (\beta_{FE} - \beta_{RE})'[V_{FE} - V_{RE})]^{-1} (\beta_{FE} - \beta_{RE}) \quad (5)$$

β_{FE} - Fixed Effects, β_{RE} is the Random Effects estimator. V_{FE} and V_{RE} are the covariance matrices derived from the fixed and random effects model estimation, respectively. In this context, the H statistic follows a distribution with degrees of freedom equal to the number of regressors (Winkelmann, 2008). Compare the H statistic value obtained from the calculations with the critical value in the χ^2 table. If the H statistic exceeds the critical value, the null hypothesis is rejected, and the fixed effects model is preferred. Conversely, the random effects model is favored if the H statistic does not exceed the critical value (Bell et al., 2019).

3.2. Unit Root Test

To accept the results as valid in panel data analysis, testing the stability of the data utilized is essential. The extent to which the value of the data series from the previous period influences the value in the current period must be assessed, along with whether the data is stationary. Unit root tests are employed to evaluate this relationship. Among the various unit root test methodologies used to ascertain the stationarity of the data, the Fisher-type test is classified as a first-generation test (Levin et al., 2002; Androniceanu & Georgescu, 2023). The panel unit root test results are derived using the following formula (Quah, 1994).

$$\Delta y_{it} = \rho_i y_{i,t-1} + \sum_{L=1}^{p_i} \theta_{iL} \Delta y_{i,t-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \quad (6)$$

After adding $y_{i,t-1}$, Δy_{it}, $\Delta y_{i,t-L}$ and d_{mt} to the regression to obtain $\tilde{e}_{it}$ and $\nu_{i,t-1}$ residuals, the performance of these residuals is standardized, as illustrated below.

$$\tilde{e}_{it} = \hat{e}_{it}/\hat{\sigma}_{\varepsilon i};\ \tilde{v}_{i,t-1} = \hat{v}_{it}/\hat{\sigma}_{\varepsilon i} \quad (7)$$

Where $\sigma_{\varepsilon i}$ denotes the standard error from ADF (Levin, Lin & Chu, 2002).

Levin Lin Chu panel unit root test (LLC) and Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan Quinn Information Criterion (HQIC) were used to conduct unit root analyses with constant and trend fixed terms. Table 1 shows they are significant at the 1% level in all tests and fixed-term unit root analyses.

Table 1 Levin Lin Chu Panel Unit Root Test Results

Variables	AIC		SIC		HQIC	
	Fixed	Fixed and Trended	Fixed	Fixed and Trended	Fixed	Fixed and Trended
KX	-5,91***	-16.71***	-5,91***	-16.71***	-5,91***	-16.71***
KM	-7,33***	-16,58***	-7,33***	-16,58***	-7,33***	-16,58***
KNX	-7,10***	-16,79***	-7,10***	-16,79***	-7,10***	-16,79***
KE	-8,05***	-16.71**	-8,05***	-16.71**	-8,05***	-16.71**
YX	-17,80***	-20,87***	-17,80***	-20,87***	-17,80***	-20,87***
YM	-16,87***	-14,74***	-16,87***	-14,74***	-16,87***	-14,74***
YNX	-20,58***	-25,76***	-20,58***	-25,76***	-20,58***	-25,76***
YE	-49,04***	-43,34***	-49,04***	-43,34***	-49,04***	-43,34***
GDP	-10,67***	-12,56***	-10,67***	-12,56***	-10,67***	-12,56***
GDPpc	-39,66***	-60,12***	-39,66***	-60,12***	-39,66***	-60,12***
X	-6,61***	-4,51***	-6,61***	-4,51***	-6,61***	-4,51***
Industry	-9,04***	-11,58***	-9,04***	-11,58***	-9,04***	-11,58***

Note: ***$p \leq 0.01$, Probabilities were calculated assuming asymptotic normality.

Source: Authors' calculations.

3.3. Data of the Research

The data were obtained from the websites of the Ministry of Transport and Infrastructure of the Republic of Türkiye, the General Directorate of Maritime Trade, the Turkish Statistical Institute (TURKSTAT), and the Turkish Exporters Assembly. The analysis was planned to use data from all ports in Türkiye. However, only the relevant data for the years 2004-2022 could be accessed. These data reflect the total data of ports that contribute to Türkiye's foreign trade. The analysis included all data from 17 provinces related to container handling and cargo operations. Ports not involved in international trade were excluded from the study. The variables presented in Table 2 were selected for the stochastic model based on national and international studies (Cong et al., 2020; Mudronja et al., 2020; Coto-Millan et al., 2000; Cullinane et al., 2006; Cullinane & Wang, 2010; Güner, 2015).

Table 2 Variables of the Research

KX	Container export (TEU)	YNX	Cargo foreign trade (export + import) (tonne)
KM	Container import (TEU)	YE	Cargo handling (loading + unloading) (tonne)
KNX	Container foreign trade (export + import) (TEU)	GDP	Gross Domestic Product (2009 prices, thousand TL)
KE	Container handling (loading + unloading) (TEU)	GDPpc	Gross Domestic Product per capita (US$)
YX	Cargo export (tonne)	X	Export (thousand US$)
YM	Cargo import (tonne)	Industry	Industrial production (thousand TL)

Source: Authors

Table 3 shows that the province with the least amount of container export, import, foreign trade, and handling data in twenty-foot equivalent units (TEU) carried out in 8 ports in Türkiye between 2004-2022 was Tekirdağ in 2010, and the province with the most was Istanbul in 2014. The provinces with the least amount of cargo export in tonne units carried out in 18 ports in Türkiye between 2004-2022 were Trabzon in 2021, Muğla in 2005, Rize in 2018 in foreign trade, and Rize in 2022 in handling. The province with the most amount of cargo data was İzmir in 2022. According to the macroeconomic indicators in Türkiye between 2004 and 2022 in Table 3, the highest GDP was realized in 2022. GDP per capita was highest in 2013, exports peaked in 2008, and industrial production reached its highest in 2022 in Istanbul. The lowest GDP was recorded in 2004, exports hit a low in 2014, and industrial production was at its lowest in 2009 in Bartin.

Table 3 Statistical Data of Variables

Provinces	**KX**	**KM**	**KNX**	**KE**
Max	1249612	1348098	2597710	3576387
Min	7	10	17	17
Average	340583	349212	689795	854994
Std Deviation	350606	369598	719398	929274
Provinces	**YX**	**YM**	**YNX**	**YE**
Max	28593717	48546134	77139851	91776752
Min	29184	0	206474	503504
Average	5241805	10166898	15408703	20956949
Std Deviation	6056577	11857405	17191513	22547838
Provinces	**GDP**	**GDP pc**	**X**	**Industry**
Max	682064230,9	20882,71	66112446847	106737732,5
Min	1514432,75	2967,841	11176,056	207769,3751
Average	47413123	9668	1853712486	9462545
Std Deviation	101114351	3692	7821619516	17457181

Source: Authors' calculations.

GDP per capita was at its lowest in Ordu in 2004. Panel data analysis determined the relationship between macroeconomic indicators and port outputs. Models 1 to 6 were utilized for the analysis using the Container data of 8 ports, while Models 7 to 11 were employed for the analysis using the Cargo data of 18 ports. All analysis results from the study were obtained from the Eviews 7.0 software. For the models, attention was paid to using dependent and independent variables used in domestic and foreign studies in the literature. The purpose of using 1 or 2 independent variables in the models is to estimate the effects of these variables on macroeconomic indicators together or separately.

Table 4 Equations related to the research models

Model 1	$Industry_{it} = \alpha + \beta_1 LnKE_{it} + \beta_2\ LnYE_{it} + e_i + u_{it}$
Model 2	$Industry_{it} = \alpha + \beta_1 LnKNX_{it} + \beta_2 LnYNX_{it} + e_i + u_{it}$
Model 3	$X_{it} = \alpha + \beta_1 LnKNX_{it} + \beta_2 LnYNX_{it} + e_i + u_{it}$
Model 4	$GDP_{it} = \alpha + \beta_1 LnKNX_{it} + e_i + u_{it}$
Model 5	$GDPpc_{it} = \alpha + \beta_1 LnKNX_{it} + e_i + u_{it}$
Model 6	$GDPpc_{it} = \alpha + \beta_1 LnKX_{it} + \beta_2 LnKM_{it} + u_{it}$
Model 7	$Industry_{it} = \alpha + \beta_1 LnYE_{it} + e_i + u_{it}$
Model 8	$Industry_{it} = \alpha + \beta_1 LnYNX_{it} + ei + u_{it}$
Model 9	$GDP_{it} = \alpha + \beta_1 LnYNX_{it} + e_i + u_{it}$
Model 10	$GDP_{it} = \alpha + \beta_1 LnYX_{it} + \beta_2 LnYM_{it} + e_i + u_{it}$
Model 11	$GDPpc_{it} = \alpha + \beta_1 LnYX_{it} + u_{it}$

Source: Authors

4. RESULTS

The effects of container and cargo outputs from the ports of 8 provinces in Türkiye (Antalya, Bursa, Istanbul, Izmir, Kocaeli, Mersin, Tekirdag, and Trabzon) on macroeconomic indicators such as GDP, GDP per capita, exports, and industrial production were examined through regression analysis. The Hausman test was applied to the regression analyses conducted with Model 1 to Model 5, leading to the utilization of the random effects calculation method. In Model 6, the fixed effects calculation method was employed. In the regression analysis using Model 1, it was estimated that a 1% increase in the amount of container handling and cargo handling in the 8 provinces involved in container import and export activities in Türkiye would result in a 0.105% and 0.670% increase in the industrial production of the provinces, respectively. The results from Model 2 and Model 3 showed that a 1% increase in container and cargo foreign trade positively impacted exports and industrial production. It was noted that the volume of container foreign trade significantly contributed to boosting the province's GDP and GDP per capita, with effects of 0.296% on GDP and 0.044% on GDP per capita. The regression analysis in Model 6 demonstrated that a 1% increase in container exports raised GDP per capita by 0.136%, while a 1% increase in container imports decreased GDP per capita by 0.109%.

Table 5 Regression Results Obtained with Container Data

Variables	**Model 1 RE**	**Model 2 RE**	**Model 3 RE**	**Model 4 RE**	**Model 5 RE**	**Model 6 FE**
Constant	3,567***	5,329***	8,656***	14,053***	8,819***	9,066***
KE	0,105**					
YE	0,670***					
KNX		0,133***	0,280***	0,296***	0,044***	
YNX		0,553***	0,371***			
KX						0,136***
KM						-0,109***
σ_u	0	0	3,338	0	0,125	0,176
σ_e	0,927	0,968	1,099	0,821	0,280	0,269
ρ	0	0	0,902	0	0,166	0,300
R^2	0,518	0,474	0,496	0,454	0,133	0,207
Wald X^2 F	176,7***	144,19***	64,47***	131,12***	22,24***	17,08****
Hausman X^2	0,28	0,57	-0,34	0,59	2,68	6,83**
Obs	152	152	152	152	152	152

Note: ****$p \leq 0.01$, **$p \leq 0.05$*

Source: Authors' calculations.

The highest R^2 value was 51.8% in the first regression. It was 47.4%, 49.6%, and 45.4% in the second, third, and fourth regressions. It was notably low at 13.3% and 20.7% in the fifth and sixth regressions. These percentages indicate the degree to which the independent variables explain the dependent variable, macroeconomic indicators. Wald X^2 and F-statistical probability values also indicate that all variables are statistically significant at the 1% level. The rates derived from the intraclass correlation coefficients, referred to as Rho (ρ) correlation coefficients, in the third, fifth, and sixth regressions (90.2%, 16.6%, and 30%) demonstrate the proportion of variance originating from differences between the panels (see, Table 5). It presents the results of the regression analysis conducted to examine the effects of cargo outputs (tonne) from the ports of 18 provinces, including Adana, Antalya, Balıkesir, Bartın, Bursa, Çanakkale, Hatay, İstanbul, İzmir, Kocaeli, Mersin, Muğla, Ordu, Rize, Samsun, Tekirdağ, Trabzon, and Zonguldak, on macroeconomic indicators. The Hausman test applied to the regression analyses from Model 7 to Model 10 revealed the random effects calculation method, while the fixed effects calculation method was determined in Model 11.

Table 6 Regression Results Obtained with Cargo Data

Variables	Model 7 RE	Model 8 RE	Model 9 RE	Model 10 RE	Model 11 FE
Constant	2,933***	4,329***	7,9890***	7,959***	7,186***
YE	0,751***				
YNX		0,679***	0,557***		
YX				0,518***	0,131***
YM				0,082***	
σ_u	0	0	0	0	0,167
σ_e	0,94	0,978	0,891	0,845	0,282
ρ	0	0	0	0	0,260
R^2	0,537	0,499	0,448	0,507	0,313
Wald X^2 F	418,20***	354,18***	288,87***	357,52***	146,37***
Hausman X^2	1,73	3,71	2,22	2,22	121,53***
Obs.	342	342	342	342	342

Note: ****p ≤ 0.01, **p ≤ 0.05*

Source: Authors' calculations.

In Model 7 and Model 8, a 1% increase in the amount of cargo handled and subject to foreign trade in 18 provinces that import and export cargo in Türkiye caused an increase of 0.751% and 0.679% in the industrial production of the provinces, respectively. In Model 9 and Model 10, a 1% increase in cargo involved in foreign trade and import and export-led to an increase in GDP. It was found that the amount of cargo exports effectively increased the province's GDP and GDP per capita. In Model 11, a 1% increase in cargo exports increased GDP per capita by 0.131%.

The highest R^2 value representing the explanatory power of the regression was 53.7% and 50.7% in the seventh and tenth regressions. In the eighth and ninth regressions, the R^2 value was 49.9% and 44.8%, respectively. The lowest R^2 value was 31.3% in the eleventh regression. These rates demonstrate the extent to which the macroeconomic indicators, which are dependent variables, are explained by the independent variables. Wald X^2 and F-statistical probability values also indicate that all variables are statistically significant at the 1% level (see Table 6).

5. CONCLUSION

Maritime trade encompasses ship movements between the departure port where the goods are received and the destination port where they are delivered. In ports where the share of maritime transport in international trade is increasing, most cargo pertains to foreign trade. Consequently, the primary demand in maritime transport consists of importing raw materials or trading products. The dominance of sea transport in international logistics has elevated container transportation. It is recognized as a safe and convenient mode of transportation. Maritime trade, often deemed pivotal to international trade, delivers direct and indirect economic benefits to both countries and cities. Therefore, the current study examines the effects of the outputs of 18 container and cargo ports involved in international trade on macroeconomic indicators in Türkiye. Panel data regression models were used to estimate the effects of the ports' cargo outputs on GDP between 2004 and 2022. The study contributes both theoretically and practically to the literature. In study: Container export (TEU), Container import (TEU), Container foreign trade (export + import) (TEU), Container handling (loading + unloading) (TEU), Cargo export (tonne), Cargo import (tonne), Cargo foreign trade (export + import) (tonne), Cargo handling (loading + unloading) (tonne), Gross Domestic Product (2009 prices, thousand TL), Gross Domestic Product per capita (US$) Export (thousand US$), Industrial production (thousand TL) were used as variables. The total number of observations was 152 for Models 1 to 6 and 342 for Models 7 to 11.

Within the scope of the research, the regression analysis conducted with Model 1 estimated that a 1% increase in the amount of container handling and cargo handling in 8 provinces in Türkiye would result in an increase of 0.105% and 0.670% in the industrial production of the provinces, respectively. Models 2 and 3 indicated that container and cargo foreign trade significantly boosted exports and industrial production. It was observed that the volume of container foreign trade positively impacted the province's GDP and per capita GDP. Model 6 revealed that a 1% increase in container exports led to a decrease in GDP per capita by 0.136%, while an increase in imports decreased it by 0.109%. Models 7 and 8 suggested that a 1% increase in cargo handled and involved in foreign trade in 18 provinces in Türkiye, engaged in importing and exporting cargo, would increase the industrial production of the provinces by 0.751% and 0.679%, respectively. Models 9 and 10 demonstrated that a 1% increase in the volume of freight foreign trade and import and export activities effectively boosted GDP. Model 11 estimated that a 1% increase in cargo exports raised GDP per capita by 0.131%.

The findings from this study indicate that an increase in the volume of cargo handled at ports positively impacts industrial production and GDP. Consequently, it can be concluded that foreign trade in containers and cargo enhances the economic performance of the provinces. Furthermore, consistent with similar studies in the literature, it is evident that investments in port infrastructure contribute to economic growth. In this context, the results provide valuable insights for policymakers regarding the optimization of port investments and the formulation of regional development policies. These findings can stimulate critical thinking and motivation among all stakeholders. Additionally, they have the potential to improve the welfare of residents in the cities where these ports are situated. Understanding the relationship between port cargo efficiency and GDP is essential for enhancing operations and maximizing potential.

Author Contributions: Conceptualization, A.T., and F.S.; Methodology, A.T., and F.S.; Software, F.S.; Validation, A.T., F.S., S.D., Y.E., and A.K; Formal Analysis, F.S.; Investigation, A.T., and F.S.; Resources, A.T. and F.S.; Data

Curation, F.S.; Writing – Original Draft Preparation, A.T.; Writing – Review & Editing, A.T. and F.S.; Visualization, Y.E., A.K. and S.D.; Supervision, A.T., F.S., S.D., A.K. and Y.E.

Funding: This research received no specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interests: The authors declare they have no competing interests.

REFERENCES

Androniceanu, A., & Georgescu, I. (2023). The impact of CO2 emissions and energy consumption on economic growth: a panel data analysis. *Energies*, *16* (3), 1342. https://doi.org/10.3390/en16031342

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data*. 3rd Edition. John Wiley, New York.

Bartosiewicz, A., Kucharski, A., & Miszczyński, P. (2024). Efficiency of maritime container terminals in the Baltic Sea region using data envelopment analysis slack-based model. *Research in Transportation Business & Management*, 56, 101166. https://doi.org/10.1016/j.rtbm.2024.101166

Baştuğ, S., Haralambides, H., Akan, E., & Kiraci, K. (2023). Risk mitigation in service industries: A research agenda on container shipping. *Transport Policy*. https://doi.org /10.1016/j.tranpol.2023.07.011

Bell, A., Fairbrother, M., & Jones, K. (2019). Fixed and random effects models: making an informed choice. *Quality & quantity*, 53, 1051-1074. https://doi.org/10.1007/s11135-018-0802-x

Bottasso, A., Conti, M., Ferrari, C., & Tei, A. (2014). Ports and regional development: A spatial analysis on a panel of European regions. *Transportation Research Part A: Policy and Practice*, 65, 44-55. https://doi.org/10.1016/j.tra.2014.04.006

Chang, Y. T., Shin, S. H., & Lee, P. T. W. (2014). The economic impact of port sectors on South African economy: An input-output analysis. *Transport Policy*, 35, 333-340. https://doi.org/10.1016/j.tranpol.2014.04.006

Cohen-Blankshtain, G. (2008). Framing transport–environmental policy: The case of company car taxation in Israel. *Transportation Research Part D: Transport and Environment*, *13* (2), 65-74. https://doi.org/10.1016/j.trd.2007.11.002

Cong, L. Z., Zhang, D., Wang, M. L., Xu, H. F., & Li, L. (2020). The role of ports in the economic development of port cities: Panel evidence from China. *Transport Policy*, 90, 13-21. https://doi.org/10.1016/j.tranpol.2020.02.003

Coto-Millan, P., Banos-Pino, J., & Rodriguez-Alvarez, A. (2000). Economic efficiency in Spanish ports: some empirical evidence. *Maritime Policy & Management*, *27* (2), 169-174. https://doi.org/10.1080/030888300286581

Cullinane, K., & Wang, T. (2010). The efficiency analysis of container port production using DEA panel data approaches. OR spectrum, *32* (3), 717-738. https://doi.org/10.1007/s00291-010-0202-7

Cullinane, K., Wang, T. F., Song, D. W., & Ji, P. (2006). Cullinane, K., Wang, T. F., Song, D. W., & Ji, P. (2006). The technical efficiency of container ports: Comparing data envelopment analysis and stochastic frontier analysis. *Transportation research part A: Policy and practice*, *40* (4), 354-374. https://doi.org/10.1016/j.tra.2005.07.003

Daniş, M., & Acar, A. Z. (2024). Evaluation of Containerized Trade and Competitiveness among Container Ports in Black Sea Basin. *Pomorstvo*, *38* (1), 126-140. https://doi.org/10.31217/p.38.1.10

Deng, P., Lu, S., & Xiao, H. (2013). Evaluation of the relevance of measures between ports and regional economies using structural equation modeling. *Transport Policy*, 27, 123-133. https://doi.org/10.1016/j.tranpol.2013.01.008

Ducruet, C., Juhász, R., Nagy, D. K., & Steinwender, C. (2024b). All aboard: The effects of port development. *Journal of International Economics*, 151, 103963. https://doi.org/10.1016/j.jinteco.2024.103963

Ducruet, C., Martin, B. P., Sene, M. A., Prete, M. L., Sun, L., Itoh, H., & Pigné, Y. (2024a). Ports and their influence on local air pollution and public health: A global analysis. *Science of the Total Environment*, 915, 170099. https://doi.org/10.1016/j.scitotenv.2024.170099

Ersoy, Y., & Tehci, A. (2023). Efficiency Evaluation of Energy Companies with Data Envelopment Analysis. *The Journal of International Scientific Researches*, *8* (3), 360-366. https://doi.org/10.23834/isrjournal.1331147

Esmer, S., Nguyen, H. O., Bandara, Y. M., & Yeni, K. (2016). Non-price competition in the port sector: A case study of ports in Turkey. *The Asian Journal of Shipping and Logistics*, *32* (1), 3-11. https://doi.org/10.1016/j.ajsl.2016.03.001

Ferrari, C., Percoco, M., & Tedeschi, A. (2010). Ports and local development: Evidence from Italy. *Int. J. Transp. Econ*., 37, 9-30. http://www.jstor.org/stable/42747893 accessed 25 july 2024

Greene, W. H. (1993). *Econometric Analysis*. McMillan, New York.

Güner, S. (2015). Proposal of a two-stage model for measuring the port efficiency and an implication on Turkish ports. *Alphanumeric Journal*, *3* (2), 99-106. https://doi.org/10.17093/aj.2015.3.2.5000142149

Hausman, W. H., Lee, H. L., & Subramanian, U. (2013). The impact of logistics performance on trade. *Production and Operations Management*, *22* (2), 236-252. https://doi.org/10.1111/j.1937-5956.2011.01312.x

Hsiao, C. (2003). *Analysis of Panel Data*. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9780511754203

Jung, B. M. (2011). Economic contribution of ports to the local economies in Korea. *The Asian Journal of Shipping and Logistics*, *27* (1), 1-30. https://doi.org/10.1016/S2092-5212(11)80001-5

Kutlar, A. (2012). *Introduction to Econometrics*. 3rd Edition. Nobel, Ankara.

Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: asymptotic and finite-sample properties. *Journal of econometrics*, *108* (1), 1-24. https://doi.org/10.10 16/S0304-4076(01)00098-7

Ma, Q., Jia, P., She, X., Haralambides, H., & Kuang, H. (2021). Port integration and regional economic development: Lessons from China. *Transport Policy*, 110, 430-439. https://doi.org/10.1016/j.tranpol.2021.06.019

Marušić, E. (2021). The Model of expressing Revenues through Sustainable Development Variables on the example of Nautical Ports in Croatia. *Ekonomska misao i praksa*, *30* (2), 367-392. https://doi.org/10.17818/EMIP/2021/2.3

Ministry of Transport and Infrastructure, Republic of Türkiye (2024). Cargo statistics. https://denizcilikistatistikleri.uab.gov.tr/yuk-istatistikleri

Ministry of Transport and Infrastructure, Republic of Türkiye (2024). Container statistics. https://denizcilikistatistikleri.uab.gov.tr/konteyner-istatistikleri

Mohan, R., & Mirmirani, S. (2007). An Assessment of OECD Health Care System Using Panel Data Analysis. *Southwest Business and Economics Journal*, 16, 21-35. https://mpra.ub.uni-muenchen.de/6122/1/MPRA_paper_6122.pdf Accessed 25 Jun 2024

Moschovou, T. P., & Kapetanakis, D. (2023). A Study of the Efficiency of Mediterranean Container Ports: A Data Envelopment Analysis Approach. *CivilEng*, *4* (3), 726-739. https://doi.org/10.3390/civileng4030041

Mudronja, G., Jugović, A., & Škalamera-Alilović, D. (2020). Seaports and economic growth: Panel data analysis of EU port regions. *Journal of marine science and engineering*, *8* (12), 1017. https://doi.org/10.3390/jmse8121017

Munim, Z. H., & Schramm, H. J. (2018). The impacts of port infrastructure and logistics performance on economic growth: the mediating role of seaborne trade. *Journal of Shipping and Trade*, *3* (1), 1-19. https://doi.org/10.1186/s41072-018-0027-0

Osadume, R. C. (2020). Port revenue performance and economic growth: The Nigerian ports authority experience, 2010-2019. *LOGI–Scientific Journal on Transport and Logistics*, *11* (2), 1-11. https://doi.org/10.2478/logi-2020-001

Özer, M., Canbay, Ş., & Kırca, M. (2021). The impact of container transport on economic growth in Turkey: An ARDL bounds testing approach. *Research in Transportation Economics*, 88, 101002. https://doi.org/10.1016/j.retrec.2020.101002

Özer, M., & Çiftçi, N. (2009). Relationship Between R&D Expenditures and Exports: A Panel Data Analysis for OECD Countries, Dumlupınar University. *Journal of Social Sciences*, 23, 39-50.

Park, J. S., & Seo, Y. J. (2016). The impact of seaports on the regional economies in South Korea: Panel evidence from the augmented Solow model. *Transportation Research Part E: Logistics and Transportation Review*, 85, 107-119. https://doi.org/10.1016/j.tre.2015.11.009

Pérez, I., González, M. M., & Trujillo, L. (2020). Do specialisation and port size affect port efficiency? Evidence from cargo handling service in Spanish ports. *Transportation Research Part A: Policy and Practice*, 138, 234-249. https://doi.org/10.1016/j.tra.2020.05.022

Quah, D. (1994). Exploiting cross-section variation for unit root inference in dynamic data. *Economics letters*, *44* (1-2), 9-19. https://doi.org/10.1016/0165-1765(93)00302-5

Selamzade, F. (2020). An empirical analysis of the relationship between health expenditures and health status ındicators in the countries of the African Union. In Özmen M. (ed.), *Economics Studies*. Ankara.

Selamzade, F., & Yeşilyurt, Ö. (2021). Evaluation of health indicators of OECD countries by stochastic frontier analysis. *Journal of Productivity*, 4, 35-49. https://doi.org/10.51551/verimlilik.734328

Shan, J., Yu, M., & Lee, C. Y. (2014). An empirical investigation of the seaport's economic impact: Evidence from major ports in China. *Transportation Research Part E: Logistics and Transportation Review*, 69, 41-53. https://doi.org/10.1016/j.tre.2014.05.010

Tunalı, H. & Akarçay, N. (2022). Analysis of The Relationship Between Container Freight Transportation, Port Infrastructure and Economic Growth: The Example of OECD Countries. *Journal of Economics and Financial Researches*, *4* (1), 102-118.

Türkiye Exporters Assembly (2024). Export Figures. https://tim.org.tr//tr/ihracat-rakamlari

Türkiye Statistical Institute (TURKSTAT) (2024). Statistical Data Portal. https://data.tuik.gov.tr/

TÜRKLİM (2023). https://www.turklim.org/wp-content/uploads/2023/07/TURKLIM-Sektor-Raporu-2023.pdf

Učkar, D., & Petrović, D. (2022). Efficiency of insurance companies in Croatia. *Ekonomska misao i praksa*, *31* (1), 49-79. https://doi.org/10.17818/EMIP/2022/1.3

UNCTAD (2022). https://unctad.org/system/files/official-document/rmt2022_en.pdf

Yesilyurt O., & Selamzade F. (2020). Measuring CIS health systems using the stochastic Frontier Analysis (SFA). *Economy of Region*, *16* (1), 59-68. https://doi.org/10.17059/2020-1-5

WEF (2024). https://www.weforum.org/agenda/2024/02/worlds-busiest-ocean-shipping-routes-trade/

Winkelmann, R. (2008). *Econometric Analysis of Count Data*. Springer Verlag, Berlin.

Woo, J. K., Moon, D. S., & Lam, J. S. L. (2018). The impact of environmental policy on ports and the associated economic opportunities. *Transportation Research Part A: Policy and Practice*, 110, 234-242. https://doi.org/10.1016/j.tra.2017.09.001

Yu, S., Hong, B., Ma, J., Chen, Y., Xi, X., Gao, J., … & Sun, Y. (2017). Surface sediment quality relative to port activities: A contaminant-spectrum assessment. *Science of the total environment*, 596, 342-350. https://doi.org/10.1016/j.scitotenv.2017.04.076

Dr. sc. Ali Tehci
Izvanredni profesor
Sveučilište Ordu, Fatsa Fakultet pomorskih znanosti
Odjel za pomorsku poslovnu administraciju, Ordu, Turska
E-mail: a.tehci@odu.edu.tr
Orcid: https://orcid.org/0000-0001-9949-2794

Dr. sc. Fuad Selamzade
Izvanredni profesor
Sveučilište Muş Alparslan, Fakultet zdravstvenih znanosti, Muş, Turska
E-mail: f.salamov@alparslan.edu.tr
Orcid: https://orcid.org/0000-0002-2436-8948

Dr. sc. Sam Demirkol
Izvanredni profesor
Sveučilište u Sussexu, Odjel za strategiju i marketing
Sussex Business School, Ujedinjeno Kraljevstvo
E-mail: s.demirkol@sussex.ac.uk
Orcid: https://orcid.org/0000-0002-8923-9821

Dr. sc. Aycan Kama
Sveučilište Nevşehir Hacı Bektaş Veli, Nevşehir, Turska
E-mail: kamaaycan@hotmail.com
Orcid: https://orcid.org/0000-0001-5008-9072

Dr. sc. Yusuf Ersoy
Izvanredni profesor
Sveučilište Muş Alparslan, Malazgirt Strukovna škola, Muş, Turska
E-mail: y.ersoy@alparslan.edu.tr
Orcid: https://orcid.org/0000-0002-0106-1695

UTJECAJ TERETNOG PROMETA U POMORSKIM LUKAMA NA GOSPODARSKI RAZVOJ: PANEL PODACI IZ TURSKE

Sažetak

Strateško značenje luka povećava udio pomorskog prometa u međunarodnoj trgovini. Većina tereta koji se pretovari u lukama odnosi se na vanjsku trgovinu. Fokus je ovog istraživanja utjecaj kapaciteta 18 kontejnerskih i teretnih luka uključenih u međunarodnu trgovinu u Turskoj na makroekonomske pokazatelje. Učinci prekrcajnog kapaciteta u lukama za razdoblje 2004. – 2022. na BDP procijenjeni su korištenjem regresijskim modelima panel podataka. Rezultati pokazuju da količina pretovarenog tereta u lukama utječe na izvoz i industrijsku proizvodnju regija. Također je zaključeno da količina izvoza tereta bitno utječe na povećanje BDP-a. Imperativ je unaprijediti luke i u potpunosti iskoristiti njihov potencijal.

Ključne riječi: pomorski promet, luka, gospodarski razvoj, BDP, regresijska analiza panel podataka.

JEL klasifikacija: L91, R41, F14, O18.