Impact of Liner Shipping Connectivity on Container Traffic in Turkish Ports

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Demand for the transport sector is a derived demand; however, the transport sector is not only affected by the demand for the goods transported, but can also influence demand for itself by providing more transport facilities, which can affect trade by generating more options for foreign trade stakeholders. Accordingly, we have examined the effect of the Liner Shipping Connectivity Index (LSCI) variable, which is an indicator of countries' liner transportation connectivity, on Turkey's export and import container traffic, by using regression analysis. We have enriched our model by adding the real exchange rate variable, which is the most important factor affecting foreign trade. Our results show that a 1% increase in the country's LSCI increases export and import container traffic by approximately 1%. This result shows that not only exchange rate and production policies, but also transportation policies, are critical in improving foreign trade of the country. The development of transportation facilities can both reduce transport costs and shorten the delivery time, thereby supporting Turkey's policies to become a production centre.

KEY WORDS

~ Liner shipping
~ Container port
~ Exchange rate
~ Export
~ Import
~ Port connectivity

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1. INTRODUCTION

Ports have an important place in international trade, as world trade is largely carried out by maritime transport and it forms the most important infrastructure of maritime trade. The effect of the ports on the development of industry and trade is clear, and they have contributed significantly towards the regional and national economies (Funke and Yu, 2011; Yu et al., 2017, Cong et al., 2020). In addition to intensely increasing industrial activities, ports perform various value-added services, as well as cargo handling and storage services due to ever increasing technological and logistics innovations (Bayraktutan and Özbilgin, 2013, Tatar et al., 2019). With the advancement of technology and the expansion of international trade, new markets and new trade corridors are emerging, with cargo movements also being increased. To ensure a faster and more efficient flow of goods, old ships are being replaced with modern and large-capacity ships, whereas ports are being transformed into larger areas, equipped with more advanced facilities. As a vital element for international trade and GDP calculation, ports are increasingly coming to the fore as one of the important indicators in determining the economic development level of countries (Zaucha and Matczak, 2018). The number and capacity of ports is an important criterion that shows the national power and the competitive capacity of countries.

The port sector has experienced significant development with its employment and added value features, thereby effecting an increase in the number of ships in the world fleet, while also increasing cargo volumes and the emergence of large container ships. After the emergence of containers in the middle of the 20th century, a significant growth was achieved in the port sector, product transportation becoming cheaper and growth in world trade accelerating (Cullinane et al., 2006, Liu, 2010). Container transportation, which is a method in maritime transportation, is very popular because it is a fast and reliable transportation system compared to other systems (Ateş et al., 2013, Yüksekyıldız, 2021). Close to 70% of maritime transport is done by containers (Notteboom, 2008).

However, the effects of ports on the region and the country they are located in are naturally closely related to their degree of connection. Ports, which are rarely or not at all preferred by ship owners, cannot offer attractive transportation opportunities for foreign trade stakeholders in the country. For this reason, it is important not only that a port exists or that its equipment is at a sufficient level, but also how well connected it is with other ports and countries. Ports with poor connectivity cannot conduct efficient operational activities, and this is reflected as a cost increase to both port and cargo owners. In this respect, the connectivity of ports is critical. In the literature, there are studies examining the traffic of ports and examining the effects of some main factors on port traffic. However, studies examining the effect of connectivity have not sufficiently attracted the attention of academics. When the relevant literature is examined, we can group their studies as those which examine the ports and those who examine the Turkish ports. In studies examining the Turkish ports, port outputs have been modelled using various micro and macro variables. These variables can be counted as exchange rates, economic growth, industrial production, population, and transportation costs. These variables examine the container traffic at the ports on the demand side. The change in these variables will affect the demand for products, which in turn will determine the demand for maritime transport.On the other hand, supply is one of the most important factors affecting port traffic. If variables such as route diversity, frequency of liner ships, and available capacity, increase in a region, entrepreneurs within a country may want to increase trade activities. This will be a result of supply-side interaction. However, variables representing the supply side are rarely encountered in the models in the literature. LSCI can be used to measure supply-side opportunities in container shipping. This variable is a functional indicator showing the connectivity of regular line transport in a country. We have made a more comprehensive modeling by adding LSCI, which is a supply-side indicator, to our research modelling port output. In our study, in which we have modelled container traffic in Turkish ports, using the LSCI variable and the real exchange rate, which is another important macroeconomic variable, we have found that connectivity has a significant and positive effect on port traffic in terms of both export and import containers. We have also found that the effect of real exchange rate is negative, or slightly higher on export container traffic. These results have revealed that not only the policies that support the demand for ports by

increasing production activities, but also the supply-side policies that increase the transportation opportunity for producers, will have a positive effect on international trade.

In the second part of the study, our research model has been established, and the theoretical framework of this model has been drawn. Our dataset modelling port traffic and an analysis method have been introduced in part three. In part four, the findings obtained as a result of the regression analysis are presented and discussed.

2. RESEARCH MODEL AND RELATED LITERATURE

This can be attributed to many factors that affect cargo traffic in ports. Since maritime transport has a derived demand structure, these factors consist of the factors that affect international trade. In general literature, the factors affecting port and maritime traffic have been determined as the exchange rate (Kim, 2017; Chi and Cheng, 2016; Açık et al. (2019a), industrial production (Chou et al., 2008; Korkmaz, 2012; Tunalı and Akarçay, 2018; Açık et al., 2019b), transportation costs (Kim, 2016; Açık, 2019), GDP (Michail, et al., 2020), etc.

In this study, we have decided to include the real effective exchange rate and LSCI variables in our model. We have not taken industrial production into account because, according to our theoretical framework and many empirical studies, exchange rates are the main determining factor for production activities within a country (e.g. Bradley and Moles, 2002; Frenkel and Ros, 2006; Gala, 2008; Marconi, 2012; Kohli and Natal, 2014; Bruno and Shin, 2019). Therefore, using industrial production and the exchange rate in the same model is likely to cause a multicollinearity problem. We have preferred to use the real exchange rate, which is thought to be the main factor that effects production activities in a country.

Additionally, transportation costs are also an important determining factor for port traffic (Açık, 2019). However, due to data constraints, we could not reach the container freight rates for the period under consideration. This is why we could not include this important variable in our models. In some studies, the BDI variable was also used as a cost indicator for maritime transportation (Kim, 2016). However, the dry bulk market and the container market are very different in structure, the former having the characteristics of a perfectly competitive market, while the latter has more oligopoly market characteristics. Therefore, we have not used the BDI variable, considering that it would make a representation issue.

We have included the LSCI variable, considering its supply-led contribution towards the international trade. In the literature, its effect on export performance of countries has been examined, but its direct effect on container traffic in the country's ports has not yet attracted enough attention. Examining the impact on container ports will provide more specific findings to both country policy makers and port managers. For this reason, we have examined the effects of developments in countries' connectivity on port traffic, using the exchange rate as a control variable because its influence is undeniable.

It is for this reason that in this section the effect of exchange rate on international trade and maritime transport will first be examined. Then, by evaluating the effect of the LSCI variable on the trade and maritime transport of the countries, the framework of our study will be formed.

2.1. Exchange Rate and Trade

One of the most important factors affecting foreign trade is exchange rates. Depending on the increase and decrease in the exchange rates, the relative prices of goods within the country change. This change, in turn, determines the demand of foreign people for goods produced in the country and the demand of people in the country for foreign goods. The interventions to the exchange rate and the policies followed to balance foreign trade basically arise from these reasons.

There are studies that directly or indirectly examine the theoretical effect of the exchange rate on foreign trade. While studies that directly examine the issue over the export and import values of the countries, studies that examine it indirectly deal with the issue through the amount of cargo transported by sea. Since the demand for maritime transport is a derived demand, it would be appropriate to first refer to studies examining the country's foreign trade.

Studies examining the effect of exchange rate on the export and import performance of countries generally focus on the developing countries. The main reason for this focus is their economic structure, which depends on export performances. In terms of the developing countries, significant effects of the exchange rate on the exports of the countries have been revealed by many studies (e.g. Brada and Mendez 1988; Choi, 2007; Haddad and Pancaro, 2010; Freund and Pierola, 2012; Demirtas and Demirhan, 2013; Chaudhary et al., 2013; Cheung and Sengupta, 2013). With their research that includes fourteen developing countries, Brada and Mendez, (1988) have revealed that the exchange rate uncertainty hinders bilateral exports. Choi, (2007) shows that the increase in exchange rate volatility has a significant negative impact on the Container Trade Volume in the long run. There are also studies explaining the relationship between exchange rate and economic growth and their mutual impacts. In this mutual impact, a volatile real exchange rate diminishes company profitability and stifles economic growth (Haddad & Pancaro, 2010). Bosworth, Collins, and Yuchin (1995) offered evidence that real exchange rate volatility stifles economic growth and reduces productivity growth in a large sample of industrial and emerging countries. Aghion et al. (2009) found a similar result; however, they discovered that the negative impact of real exchange rate volatility on economic growth was reduced in nations with higher levels of financial development. Servén, (2003) demonstrates that real exchange rate volatility has a negative impact on investment in a wide panel of developing nations. Also, Arize, et al., (2000) determined a significant negative link between increased exchange rate volatility and developing-country exports. Kim, (2016) also reached similar conclusions as other researchers and found that exchange rate volatility had a statistically significant negative effect on import cargo volume. In studies examining the effect of exchange rate on exports in Turkey, the effect of real exchange rate on exports has been found to be negative (e.g. Ayhan, 2019; Tatliyer and Yigit, 2016). The increase in the value of the country's local currency reflects negatively upon the export amount. Additionally, in studies conducted with large datasets on a firm basis, it has been determined that the depreciation of Turkey's local currency has a positive impact on the competitive power and market shares of exporting companies (e.g. Karamollaoğlu and Yalçin, 2020).

There are also studies examining the effect of exchange rate on international trade through maritime transport. Since the increase in the real exchange rate indicates an increase in value, it can theoretically be expected to negatively affect maritime transport. In support of this argument, it has been determined that Turkey's real exchange rate significantly affects exports by sea and this effect is negative (Emeç, 2021). This outcome is an indirect result of the exchange rate's reflection on exports and imports. Additionally, since there are other factors affecting foreign trade, it may be misleading to talk about the continuity of the effect of the exchange rate. In this direction, also studies examine the effect of the exchange rate on the container traffic in Turkish ports with a time-varying method and reveal that the relationship is not continuous (Açık et al., 2019).

2.2. Liner Shipping Connectivity and Trade

Developments in a country's transportation infrastructure contribute towards development as they have trade-facilitating and cost-reducing results. This situation can be explained by supply-led growth. Entrepreneurs with limited trade opportunities in the current situation will increase their activities if the appropriate infrastructure is provided, thereby contributing towards the increase in the country's commercial volume. Thus, new trade formation activities, intra-trade volumes, and international trade volumes will increase (Lun and Hoffmann, 2016).

In the study examining the effect of the LSCI index on the exports of European countries and Turkey, it has been revealed that the LSCI index has a positive effect on exports together with GDP. It was determined that 1% increase in LSCI caused an increase of 0.21% in exports (Şeker, 2020). Similarly, positive impact of LSCI on export volumes of different country groups has been verified using panel dataset (Ünver, 2016). These results reveal the contribution of the developments in the infrastructure and transportation networks to the national economies. Additionally, since the index consists of many factors, what needs to be improved from these factors may differ for each country (Reza et al., 2015). The advantage or disadvantage of the factors that each country has may vary.

Apart from these evaluations, considering the components used in the calculation of the index value, it can be thought that a lower index value means higher transportation costs (Wilmsmeier and Hoffmann, 2008). Of course, the increase in transportation costs has a negative impact on international trade since this situation increases the final price of the products.

Using the Port Liner Shipping Connectivity Index (PLSCI), which is a port-based version of the LSCI, in the study examining the effect of providing infrastructure on regional development in Turkey, it has been determined that the increase in the index value of the port with trade volume has a positive effect on regional development (Kesiktaş and Başer, 2021). The national income *per capita* in the province where the port is connected increases with the increase in variables, such as the number of ships calling at the port, the number of lines at the port, and the average ship size.

3. DATA AND METHODOLOGY

The dataset used in our modelling consists of quarterly observations. The main reason for this structure is that the LSCI variable is published quarterly. The dataset consists of 63 observations covering the periods 2006 Q1 and 2021 Q3. Export and import container data were obtained from the Ministry of Transport and Infrastructure (MTI) (2022) website. The quarterly values were collected by summing up three months to convert the monthly information into quarterly data. The information in the source divides the containers into import, export, transit, and cabotage. We have only included the number of exported and imported containers in our research, because we have thought that these are variables that better represent the country's foreign trade. The real exchange rate variable has been was obtained from the Central Bank of the Republic of Turkey (CBRT) (2022) website on a quarterly basis. It is calculated to be equal to the value of 100 for the year 2003. The increase in this value, which was generated on the basis of 2003 exchange rates, indicates that the country's currency was appreciated, while its decrease indicates that it was depreciated. The LSCI variable was obtained from the United Nations Conference on Trade and Development (UNCTAD) (2022) website. A higher value in the index indicates that the country's container trade connectivity has improved. This index value is published quarterly for most countries. Since this variable is published quarterly, we have converted our other three variables to quarterly observations.

In time series analysis, the structures of the variables and the motion characteristics of the period in which they are handled can be examined through descriptive statistics. We have hereby presented the information about the data we used in our research in Table 1. When the average values are examined, it may be seen that the number of imported containers is slightly higher than the number of exported containers. This situation shows that imported container-based handling is carried out in Turkish ports. However, when the maximum values are examined, it can be seen that the export container has a higher value. This information and the high standard deviation of the export container indicate higher fluctuations in this operation type. This situation is also seen in the coefficients of variation, $(mean_i/std\_dev_i)$ and the value, which is 29.3% for exports is 28% for imports. The coefficient of variation is calculated as 12.8% for the real exchange rate and 20.8% for LSCI.

	EXP	IMP	REALEXC	LSCI
Mean	804411.7	812332.9	96.52841	47.78903
Median	814726.5	829401.5	98.65000	51.04055
Maximum	1259126.	1234817.	115.4100	61.52975
Minimum	383679.0	398803.2	69.82000	29.81667
Std. Dev.	235319.1	227433.7	12.37432	9.919991
Skewness	0.184922	0.037579	-0.443107	-0.405841
Kurtosis	1.946895	1.859553	2.224005	1.696246
Jarque-Bera	3.270262	3.428956	3.642305	6.191331
Probability	0.194927	0.180058	0.161839	0.045245
Observations	63	63	63	63

Table 1. Descriptive Statistics of The Dataset (Source: UNCTAD, 2022; MTI, 2022; CBTR, 2022)

The course of the variables we have used in the study within the period under consideration is presented in Figure 1. The real effective exchange rate follows a downward trend. In some periods, this decline was sharp, while in others it was slight. This movement indicates the depreciation of the Turkish currency. The depreciation of the currency can cause labour and goods to become relatively cheaper within the country and an increase in demand for goods that are produced in that country. The LSCI variable, on the other hand, follows an increasing course over time. This structure shows that the country's liner shipping transport connections have developed over time and container shipping opportunities have increased. However, this increase is not as sharp as the increase in container traffic. The trend of export and import container amounts shows also a generally increasing trend. Although there are contractions in volumes due to economic factors in some periods, the general trend is towards an increase. In some periods, while the imported container is more than the exported container, in some periods, the opposite has happened.

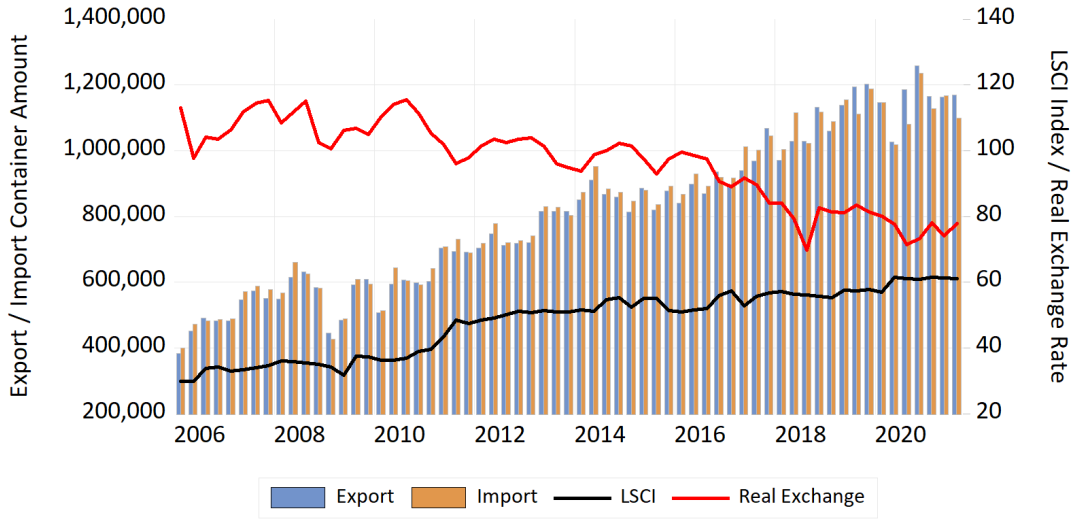

Figure 1. Graphical Display of the Variables (Source: UNCTAD, 2022; MTI, 2022; CBTR, 2022).

The variation of the ratio between exported and imported containers is largely related to real exchange rates. To see the situation better, we can generate “net export” variable by subtracting the number of imported containers from the number of exported containers. In Figure 2, the net exported container quantity and the real effective exchange rate value are presented. As can be seen, in some periods when the exchange rate is depreciated, net exports containers have gained positive values. In the periods when the exchange rate is appreciated, the same variable has taken negative values. This situation can be explained by the increase in the

demand for the goods of the country and the increase in exports during the periods when the local currency loses its value. In periods when local currency gains value, the demand for country goods decreases and simultaneously, the demand for foreign goods within the country increases. This may cause the number of imported containers to be higher. In the last part of the period under consideration, a sharp decrease in the value of the real exchange rate and a large increase in the net export container amount is striking. This supports our statements, also explaining the relationship between variables.

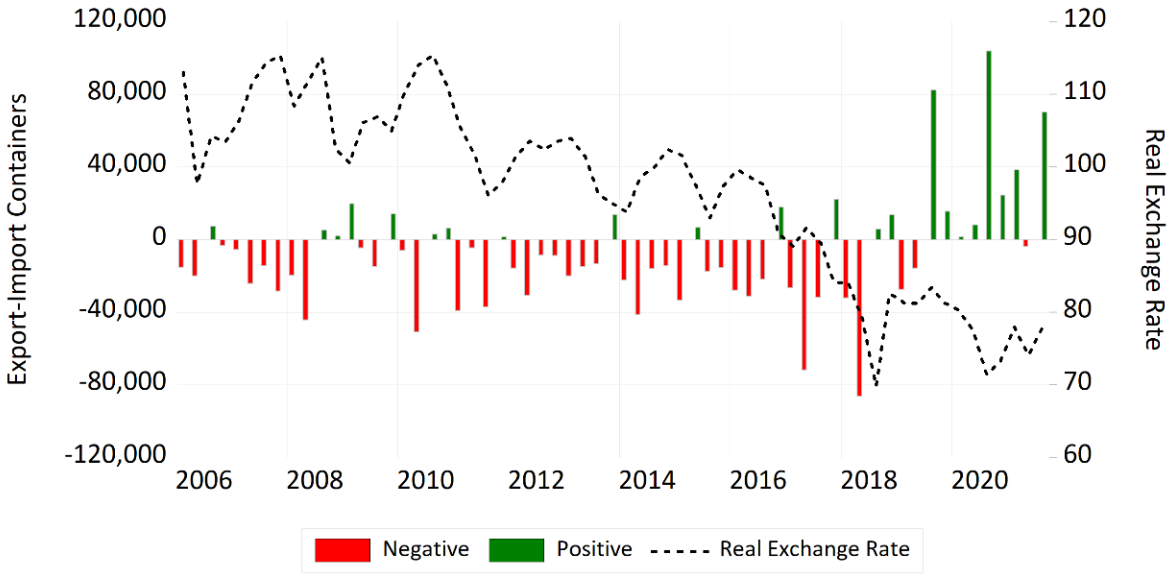

Figure 2. Net Exports and Real Exchange Rate (Source: MTI, 2022; CBTR, 2022).

We have chosen to use linear regression analysis to model Turkey's export and import container traffic. This type of analysis consists of dependent and independent variables, and it can be determined how much of an effect a 1-unit change in the independent variable has on the independent variable (Archdeacon, 1994:148). In our study, we have applied log-log regression analysis by taking the logarithms of the series to see the elasticity of the variables (Gujarati, 2004). Taking the logarithms of the series contributes towards a better distribution of the properties (Shahbaz et al., 2017). A normal distribution makes the results of linear analysis more valid, and according to JB statistics, all data are normally distributed at 1% confidence level.

The linear simple regression model can be expressed as in equation (1). Y represents the dependent variable, X the independent variable, and ε the error terms. β's show how much the independent variable affects the dependent variable.

$$Y = c + \beta_1 X_1 + \varepsilon \quad (1)$$

The model we have estimated in the study is presented in equation (2). This model has been estimated in two different ways, both for the number of exported containers and for the number of imported containers. Thanks to the log-log regression, it has been determined how much the 1% change in the real exchange rate and LSCI affects the container traffic. Thus, the effect of independent variables has been tested, and it has been determined whether there is a difference between export and import container models.

$$lnContainer_t = ln\beta_0 + \beta_1 lnLSCI_t + \beta_2 lnRealExchangeRate_t + \varepsilon_t \quad (2)$$

Since our dataset used in regression analysis is a time series type of data, some tests should be applied before the analysis. The most important situation is to determine whether there is a unit root in the series. Regression analysis with unit root or non-stationary series may present biased results since the regression becomes spurious. For this reason, the unit root test should be applied to the series and if it is determined that it contains a unit root, the difference taking process should be applied. In this respect, we have applied the Augmented Dickey-Fuller (ADF) test recommended by Dickey and Fuller (1969) and the KPSS stationarity test proposed by Kwiatkowski et al. (1992) to the series. The null hypothesis of the ADF test indicates the unit root, while the null hypothesis of the KPSS test indicates stationarity.

The structures of the series can affect the results of unit root and stationarity tests. In the global world, since data are exposed to too many unexpected events and shocks, their structures can be deteriorated, and breaks can occur. These breaks can also cause a result as if there is a unit root in the series. Therefore, in addition to conventional tests, we have applied one break ADF test (Zivot and Andrews, 1992), one break LM test (Lee and Strazicich, 2013), two break ADF test (Narayan and Popp, 2010), two break LM test (Lee and Strazicich, 2003), two break KPSS test (CiS and Sanso, 2007) to the series. In this way, we have obtained more valid results by considering the breaks. The fact that the series are not stationary can be interpreted as they carry the shocks they are exposed to and do not tend to return to their mean in the long run. In the next section, the regression analysis is performed together with the pretests and the results are presented.

4. RESULTS

Before applying the analysis, the logarithms of the series have been taken. Logarithmic data makes the discrete series continuous and shows better distribution properties. Additionally, because of the log-log regression analysis, the effect of the independent variables on the dependent variable can be examined as a percentage and comparisons can be made more easily between two or more models.

In time series analysis, unit root testing is performed before applying the analysis to the series. In some time series methods, stationarity is not a necessity, while in others it is. For this reason, we have applied the unit root and stationarity tests to the export container, import container, real effective exchange rate, and LSCI variables, including them in our model. The unit root test we have chosen for our research is the Augmented Dickey-Fuller (ADF) test recommended by Dickey and Fuller (1969). The results of the test we have performed are presented in Table 2. According to the results, the unit root null hypothesis has been rejected at the level for the variables of export and import container amount, which indicates that these series are trend stationary. On the other hand, for our real effective exchange rate and LSCI variables, the unit root null hypothesis has been rejected at first difference. The results show that export and import container amounts are I (0), exchange rate and LSCI variables are I (1). We have also applied the KPSS stationarity test proposed by Kwiatkowski et al. (1992) as a confirmatory test and presented the results in Table 2. According to the results of this test, the stationarity null hypothesis could not be rejected for all variables, and they have been determined as trend stationary. This test indicates that all series are I (0).

A situation that is likely to affect the result when performing unit root and stationarity tests is the structural break in the series. Since time series are exposed to too many unexpected news and shocks in the globalizing world, their linearity may be distorted and structural breaks may occur. These breaks can also affect the results of unit root and stationarity tests. In this respect, it is useful to apply tests that take the possible structural breaks into account in the series.

	Level		First Difference		
	Intercept	Intercept & Trend	Intercept	Intercept & Trend	Decision
	Augmented Dickey-Fuller (1969)				
Export	-0.861	-3.350*	-4.048**	-4.028**	I (0)
Import	-1.424*	-5.125***	-7.748***	-7.805***	I (0)
LSCI	-1.660	-2.287	-8.664***	-8.755***	I (1)
Real Exchange	-1.362	-3.358	-9.285***	-9.308***	I (1)
	Kwiatkowski et al. (1992)				
Export	1.001	0.083*	0.355**	0.136**	I (0)
Import	0.994	0.117*	0.436**	0.189*	I (0)
LSCI	0.937	0.194*	0.186*	0.051*	I (0)
Real Exchange	0.889	0.209***	0.041*	0.032*	I (0)

*Note: ADF CVs -3.548*** for 1%, -2.912** for 5%, -2.594* for 10% at Intercept, -4.124*** for 1%, -3.489** for 5%, -3.173* for 10% at Intercept & Trend, Schwarz Information Criterion is used. KPSS CVs 0.739*** for 1%, 0.463** for 5%, 0.347* for 10% at Intercept, 0.216*** for 1%, 0.146** for 5%, 0.119* for 10% at Intercept & Trend, Bartlett Kernel and Newey West are used.*

Table 2. Unit Root and Stationarity Test Results

Considering the possible structural breaks in the series, we have applied one break ADF test (Zivot & Andrews, 1992), one break LM test (Lee and Strazicich, 2013), two break ADF test (Narayan and Popp, 2010), two break LM test (Lee and Strazicich, 2003), two break KPSS test (CiS and Sanso, 2007) to all the variables and presented the results in Table 3. These tests have been performed using the GAUSS statistical software. Additionally, the structural break data are presented in the table. According to the results obtained, at least 1 test for all variables has rejected the unit root null hypothesis or accepted the stationarity null hypothesis. In one break (Zivot and Andrews, 1992) and two break (Narayan and Popp, 2010) ADF tests, the unit root null hypothesis is rejected for all variables. Additionally, the null hypothesis of stationarity has been accepted for all variables in the two-break stationarity test (CiS and Sanso, 2007). Here, it is decided that all variables are I (0). This shows that the effects of shocks to which the series are exposed are temporary and the series tend to return to their average values in the long run.

Test Items	Mod A Export	Mod C Export	Mod A Import	Mod C Import	Mod A Exchange	Mod C Exchange	Mod A LSCI	Mod C LSCI
	One break ADF test (Zivot and Andrews, 1992)							
ADF Stat	-3.71	-4.47**	-5.06**	-5.20***	-6.33***	-6.21***	-6.90***	-6.18***
Break Date	22	19	16	10	46	46	20	20
Fraction	0.34	0.30	0.25	0.15	0.73	0.73	0.31	0.31
Lag	4	4	4	4	0	0	1	1
	One break LM test (Lee and Strazicich, 2013)							
LM Stat	-3.02	-3.63	-5.10***	-3.78	-5.08***	-6.53***	-2.73	-2.96
Break Date	14	18	21	18	50	46	14	23
Fraction	0.22	0.28	0.33	0.28	0.79	0.73	0.22	0.36
Lag	6	6	4	4	1	3	2	2
	Two break ADF test (Narayan and Popp, 2010)							
ADF Stat	-5.71***	-7.44***	-5.82***	-7.26***	-6.71***	-6.66***	-7.31***	-7.25***
Break Dates	11, 19	11, 35	11, 19	11, 35	15, 46	20, 46	18, 20	11, 20
Fraction	0.17, 0.30	0.17, 0.55	0.17, 0.30	0.17, 0.55	0.23, 0.73	0.31, 0.73	0.28, 0.31	0.17, 0.31
Lag	4	4	4	4	0	0	1	1

	Two break LM test (Lee and Strazicich, 2003)							
LM Stat	-3.66*	-6.26***	-5.38***	-6.78***	-5.88***	-7.04***	-3.48	-4.93
Break Dates	9, 14	12, 20	10, 21	12, 20	43, 50	15, 46	14, 45	13, 29
Fraction	0.14, 0.22	0.19, 0.31	0.15, 0.33	0.19, 0.31	0.68, 0.79	0.23, 0.73	0.22, 0.71	0.20, 0.46
Lag	6	5	4	4	1	3	2	2
	Two break KPSS test (CiS and Sanso, 2007)							
KPSS Stat	0.10***	0.03*	0.12***	0.03*	0.02*	0.02*	0.09***	0.03*
Break Dates	12, 14	12, 35	12, 14	12, 21	5, 47	20, 47	21, 39	12, 22
Fraction	0.19, 0.22	0.19, 0.55	0.19, 0.22	0.19, 0.33	0.07, 0.74	0.31, 0.74	0.33, 0.61	0.19, 0.34

*Note: For ADF and LM tests: Null of unit root is rejected at *10%, **5%, ***1%. For KPSS test: Null of stationarity is accepted at *90%, **95%, ***99%. Mod A refers to Break in Level, Mod C refers to Break in Level and Trend.*

Table 3. Unit Root and Stationarity Test Results with Possible Structural Breaks

Considering the results obtained from the unit root and stationarity tests, the raw forms of the series have been used in the regression model. The regression equations for which we have modelled the export container and imported container amounts are presented in equation (3) and equation (4) below. In the models, container amounts are considered as dependent variables, LSCI and real effective exchange rate are considered as independent variables. Apart from these variables, factors such as freight rates and port costs can also significantly affect the container traffic in ports, but we could not include these variables in our models because we could not access these variables due to data constraints. Models have been estimated with EViews econometric software.

$$lnExportContainer_t = ln\beta_0 + \beta_1 lnLSCI_t + \beta_2 lnRealExchangeRate_t + \varepsilon_t \quad (3)$$

$$lnImportContainer_t = ln\beta_0 + \beta_1 lnLSCI_t + \beta_2 lnRealExchangeRate_t + \varepsilon_t \quad (4)$$

The results of the estimated regression equations for the export and import models are presented in Table 4. Equations have been estimated using the ordinary least squares method. In the model estimated for the export container amount, the constant and all independent variables are significant at the 1% level. As a result of the autocorrelation (Ljung and Box, 1978), heteroscedasticity (White, 1980) and normality (Jarque-Bera) tests applied to the residuals of the model, autocorrelation was determined. Therefore, the model was re-estimated by applying HAC (Newey and West, 1987) covariance correction to the model. Standard errors were recalculated; however there was no change in probabilities after correction. According to the model, independent variables explain the dependent variable by 92%. 1% change in LSCI variable causes 1.02% change and a 1% change in the real exchange rate causes a -0.57% change in the exported container amount.

In the imported container model, constant and all independent variables are significant at the 1% level. In this model, the autocorrelation problem has been identified in the residuals. Therefore, the model has been re-estimated by applying the HAC covariance correction. In the new model, the probability of the real exchange rate variable has changed to be significant at 5% level. According to the coefficients, a 1% change in the LSCI variable causes a 1.06% change, and a 1% change in the exchange rate causes a -0.42% change in the in the number of import containers.

Model	Export	Import
LSCI	1.029 [0.000]	1.059 [0.000]
Real Exchange	-0.567 [0.000]	-0.422 [0.003] *[0.010]
C	12.183 [0.000]	11.421 [0.000]
F Stat.	363.14 [0.000]	302.97 [0.000]
R-Squared	0.923	0.909
Adj. R-Squared	0.921	0.906
Durbin-Watson	1.200	1.298
Autocorrelation	Yes	Yes
Heterosc.	No	No
Normality (JB)	0.775 [0.678]	0.545 [0.761]
Wald F Stat.	206.12 [0.000]	302.97 [0.000]

*Note: *Indicates probability change after covariance corrections.*

Table 4. Regression Estimation Results

We have visualized the coefficients obtained from the regression equations in Figure 3. Thus, it has become easier to compare the effects of exchange rate and LSCI among themselves, as well as comparing them for the number of exported and imported containers.

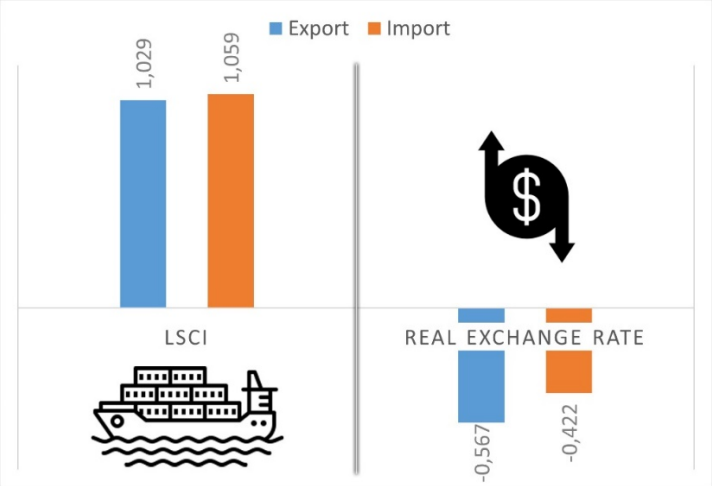

Figure 3. Coefficients for Two Models

5. DISCUSSION AND CONCLUSION

As expected, the effect of LSCI variable is positive and the effect of real effective exchange rate is negative. Two type increases can be mentioned for the LSCI variable. First, due to the demand within the country, regulations such as the number of voyages, average ship sizes, and the number of direct lines can be implemented. This is the effect of increasing demand on maritime transport, which has a derived demand structure. Second, because of an increase in the factors that make up the LSCI variable in the relevant country, demand may arise because of increased transportation opportunities. This situation contributes towards the economic development in the region where the port is located (Kesiktaş and Başer, 2021). We can define the first increase in LSCI as demand-side and the second increase as supply-side. In this study, we have aimed at modelling the supply-side effect. Whether due to increased demand or not, the increase in LSCI has a positive impact on Turkey's import and export container volume. An increase in LSCI also means an increase in the supply of transportation, which can result in a relative reduction in transportation costs. This may lead to an increase in demand. In fact, the development in the LSCI has contributed towards Turkey's transition to a positive situation by reducing the freight deficit (Açık, 2021), which indicates the difference between freight export and freight import in the balance sheet of CBTR. The effect of the changes in the index on the number of exported

and imported containers is almost the same. The 1% change in the index causes a 1% change in the number of imported and exported containers.

However, we have strengthened our model by adding a demand-side variable, which includes a supply-side variable. This variable is the real effective exchange rate, which is thought to affect both maritime transport and international trade in the national and international literature. In parallel with the literature, we have determined that the values increasing in the exchange rate have a negative impact on container traffic. Additionally, we have determined that the changes in the exchange rate affect export and import container quantities differently. While the 1% increase in the exchange rate decreases the export container traffic by 0.57%, it decreases the imported container traffic by 0.42%. This may be the result of export-based growth strategies in the country. Export container traffic is much more sensitive to changes in exchange rates. This situation can also be explained by the fact that the country's economy is mostly dependent on imported intermediate goods in production, whether for domestic consumption or for export. This dependency causes the average number of imported containers to be higher than exported ones (804411.7 TEU < 812332.9 TEU). Although the share of Turkish manufacturing industry in total exports amounts to 94.4% (TÜİK, 2022a), intermediate goods imports have a share of 77.4% in total imports (TÜİK, 2022b), which supports our arguments. The coefficient of variation is therefore lower for the number of imported containers (28%<29.3%). However, on the export side, since the changes in the exchange rate affect the competitive position of the products in the country by determining the relative price, exchange rate affect the export container quantity more. Recently, both the excessive depreciation of the country's currency and the policies encouraging domestic production, export containers have been handled more in Turkish ports.

During the COVID-19 period, significant changes have occurred in the supply chain structure in the world. While low cost was once prioritized over fast delivery, disruptions in the supply chain during the COVID-19 period has caused the advantages of low costs to lose their importance. For this reason, companies and countries have started to prefer the way of shortening their supply chains. This situation offers important opportunities for Turkey, which becomes a production base and is, due to its geographic location, relatively close to the markets. Road and rail connections are strong. However, in order not to keep the target market too narrow, maritime transport, which is preferred over travelling long distances, should also be functional. Our findings show how the increase in connectivity greatly affects foreign trade of the country. In this respect, investments should be made in ports and their connections with inland regions. Supportive policies should be developed to increase the number of lines arriving at the ports. It may not be possible to increase the number of large ships arriving at the ports due to the constraints of the ports such as draft, cranes, and docks. However, by improving the organization between large ports and relatively small ports, the roles of ports as transit or hub ports can be made more specific and disadvantages can be eliminated. These developments will not only increase competitiveness by reducing transportation costs in export activities, but also reduce the input costs of imported intermediate goods.

The important limitation of this study is that it has been implemented only in a single country. The dataset can be developed to include other countries as well. Additionally, countries with similar profiles can be determined by applying methods such as cluster analysis before the analysis and benchmark countries can be included in a more reliable way. Of course, another important factor affecting port traffic is costs. However, we could not include costs in our model because we could not reach them due to data constraints. Like some other studies, we have not found it advisable to use structurally different freight indices, such as BDI. In this respect, models that include container transportation costs can offer more comprehensive results.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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