Analyzing the Convergence of Transport Network Connectivity: Case for Türkiye and its Neighbors

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ABSTRACT

Intense trade between China and Europe increases the competition between Mediterranean, Aegean and Black Sea countries on alternative routes. To obtain a significant share from this sector, connectivity to the transportation network must be sufficient. The most important indicator developed for the measurement of connectivity is Liner Shipping Connectivity Index (LSCI). By using this index, inferences can be made about possible competitors by determining which countries' differences diverge or converge in the long run. In the research, a sample of Türkiye's neighbors and competitors in maritime transportation was formed, which includes Bulgaria, Egypt, Georgia, Greece, Israel, Lebanon, Romania, Russia and Ukraine. To test the convergence, we tested unit root by using the log differences of the LSCI values of Türkiye and other countries. The countries converging with Türkiye are Bulgaria, Lebanon, Romania, and Ukraine. Since the average LSCI values of the converging countries are lower than Türkiye, they will become possible competitors in the region. Egypt and Greece are diverging and their dominant role in the region will continue. It would be beneficial for Türkiye to strengthen its infrastructure in alternative transportation routes as well as maritime transportation.

Key words: Connectivity; convergence; liner shipping; unit root.

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Recibido: 27 de junio de 2023 / Modificado: 28 de agosto de 2023 / Aceptado: 30 de agostos de 2023

Para citar este artículo:

Açık, A., & Atacan, C. (2023). Analyzing the Convergence of Transport Network Connectivity: Case for Türkiye and its Neighbors. *Oasis*, 39, 189-212.

DOI: https://doi.org/10.18601/16577558.n39.11

ANÁLISIS DE LA CONVERGENCIA DE LA CONECTIVIDAD DE LAS REDES DE TRANSPORTE: EL CASO DE TURQUÍA Y SUS VECINOS

RESUMEN

El intenso comercio entre China y Europa aumenta la competencia entre los países del Mediterráneo, el Egeo y el Mar Negro en rutas alternativas. Para obtener una participación significativa de este sector, la conectividad a las redes de transporte debe ser adecuada. El indicador más importante desarrollado para medir la conectividad es el Liner Shipping Connectivity Index (LSCI). Al utilizar este índice, se pueden hacer inferencias sobre posibles competidores al determinar qué diferencias de países divergen o convergen en el largo plazo. En la investigación se creó una muestra de los vecinos y competidores de Türkiye en el transporte marítimo, que incluye a Bulgaria, Egipto, Georgia, Grecia, Israel, Líbano, Rumania, Rusia y Ucrania. Para comprobar la convergencia probamos la raíz unitaria utilizando las diferencias logarítmicas de los valores LSCI de Türkiye y otros países. Los países que convergen con Türkiye son Bulgaria, Líbano, Rumania y Ucrania. Dado que los valores medios del LSCI de los países convergentes son inferiores a los de Türkiye, se convertirán en posibles competidores en la región. Egipto y Grecia están divergiendo y su papel dominante en la región continuará. Sería beneficioso para Türkiye fortalecer su infraestructura en rutas de transporte alternativas, así como en transporte marítimo.

Palabras clave: conectividad; convergencia; transporte marítimo; raíz unitaria.

INTRODUCTION

Since the development of the container in a standard size in 1956, container shipping has been positioned as an accelerating factor for the world economy. Standard sized containers have increased transportation efficiency because they can easily be loaded onto trains, ships, and trucks (Garrett, 2014 p. 1088). Thus, loading, unloading and transfer operations have been simplified and costs have been reduced. In addition, it has become easier to transfer cargoes between transportation modes (Button, 2010, p. 329). One of the most important benefits is that it reduces the time the ships stay in the port. Ships, which used to have to stay in the port for about two months, now complete their loading and unloading activities in one day. Thanks to their metal-constructed design, containers ensure both the safety of the cargoes and the safety of the workers. Of these benefits, the ones that most affect the world economy are standardization and the reduction of costs (Wang & Liu, 2015, p. 362).

Cargoes transported by container transportation can generally be defined as valuable cargoes. Although all types of cargo can be technically transported, generally final products such as consumer goods, electronics, clothing, furniture; intermediates such as raw materials, semi-finished products, machine parts, and product components; perishable products such as vegetables, fruits, meat, and food are transported (Neise, 2018, p. 35). For this reason, container traffic volumes between countries vary according to the geographical locations, climates, specializations and industrial policies.

Today, a very large proportion of container traffic originates from China, and, in 2021, approximately 31% of the total container traffic at ports around the world took place in Chinese ports (UNCTAD, 2023a). The main reason for this is China's policy positioning itself as the world's manufacturing plant. It imports the raw materials and energies from around the world, to a large extent, and exports the products it produces with these inputs to the world. China alone imported 73% of the iron ore and 23% of the coal transported by sea all over the world in 2021 (RMT, 2022). In addition, 50.5% of coal production and 19.5% of coal imports worldwide is performed by China. On the crude oil side, 19% of the world's oil imports were made by China (BP, 2023). All these statistics support China's positioning as the world's factory. One of the main customer regions of China is European countries. In addition, countries on the transportation routes to European countries are also important customers of China. Approximately 30% of the total trade volume of European countries is carried out with China (Eurostat, 2023). This situation sheds light on the significant dimension of trade between China and Europe.

China attaches great importance to European countries, which are its most important customers, and therefore invests in alternative transportation projects (Yu *et al.*, 2021, p. 16). In this direction, China has invested in European ports in countries such as Greece, Italy, Malta, Spain, France, Germany, and the Netherlands, and Middle Eastern ports in countries such as Egypt and Israel. In Türkiye, China aimed to expand its transportation network and security by acquiring Kumport. Great efforts were made to sell the Çandarlı port to China, but ultimately the Chinese company preferred the Greek port of Piraeus. This has also affected the difference in cargo traffic and connectivity to the transport network between Türkiye and Greece.

In addition to the direct sea transport to Europe via the Suez Canal, there are alternative ways such as the direct railway route from China to Europe, the sea route over the Arctic Sea, the trans-Caspian route consisting of rail, sea and later rail transport, and the Middle East route transporting goods to the Middle East by sea and then by land or rail. As can be seen from these alternative routes, the transportation method may consist of one mode of transportation or a combination of several modes of transportation, depending on factors such as cost, time, political relations, and infrastructure. Transitions between more than one mode require transshipment points. Transshipment points, on the other hand, provide serious benefits to the country where they are located, both in terms of income (Santos & Soares, 2015, p. 91) and transportation accessibility (OECD, 2017, p. 88).

For this reason, there may be great competition between geographically advantageous regions. Thanks to the advantage of its geographical location and increasing infrastructure investments, Türkiye is a candidate country to become one of these main transit points (Taneja, 2010, p. 210). The main requirements of being a transshipment point in container transportation are to have a strong transportation infrastructure and facilities. One of the most common and accepted indicators used to measure

facilities on the seaside side is the Liner Shipping Connectivity Index (LSCI). A high index will indicate a high connectivity since it is calculated according to the size of the ship arriving in the country, the frequency of voyages, the number of countries with direct voyages, and the number of liner shipping companies. Therefore, a country with a higher index is considered to be in a more competitive position (Notteboom *et al.*, 2022, p. 420). While it is sufficient to evaluate the countries with a high index to analyze the current situation of the countries, the course of the difference between the countries should be examined to analyze their possible future situations. Since transportation infrastructures are costly and provide time-consuming processes, it is of great importance to have a foresight in advance before new investments. One of the most accepted approaches examining whether the course between connectivity values of the countries is closed in the long run is the convergence approach.

The concept of convergence is basically defined as an analogy and developing similar features. This analogy can be in the form of ideas, values, culture, economy, politics, religion, among other things (Ratavaara, 2008, p. 3). From the perspective of countries, there may be a convergence in beliefs, principles, social norms, and economic levels. The main factors triggering this convergence can be shown as increased intercultural interaction and communication due to globalization and technological progress (Bellet & Massard, 2002, p. 133). The location of production factors in different countries, the cheapening of transportation facilities, and the development of a common financial system accelerated this convergence. In addition, increasing economic cooperation between countries, cultural interaction and diplomatic relations are other factors that accelerate convergence between countries.

In the literature, the subject of convergence has been researched and examined in many areas over digitized values for the countries all over the world. These research areas covered different topics such as GDP values (e.g. Siljak, 2015; Cabral & Castellanos-Sosa, 2019; Matsuki, 2019; Lau *et al.*, 2022), unemployment rates (e.g. Cuestas *et al.*, 2015; Monfort *et al.*, 2018), inflation rates (e.g. Valera & Valera, 2014; Liu & Lee, 2021), interest rates (e.g. Arghyrou *et al.*, 2009; Liu *et al.*, 2013), trade volumes (e.g. Jena & Barua, 2020), stock prices (e.g. Chien *et al.*, 2015), energy consumptions (e.g. Kasman & Kasman, 2020; Simionescu, 2022), carbon emissions (e.g. Herrerias, 2012; Yilanci & Pata, 2020; Marrero *et al.*, 2021; N'Drin *et al.*, 2022), transportation networks (e.g. Atacan *et al.*, 2022), product prices (e.g. Zavaleta *et al.*, 2015; Romero *et al.*, 2020; Gil *et al.*, 2022), military expenditures (e.g. Sawhney *et al.*, 2016; Clements *et al.*, 2021), citizens' life satisfactions (e.g. Welsch & Bonn, 2008) of countries. Considering the application areas of convergence, we used this approach to analyze the long-term course of the gap between the transport connectivity of Türkiye and the rival countries in the region in terms of becoming a major transshipment node. Thus, it will be possible to develop more effective policies for the future by using the effects of the investments made and the policies implemented so far and considering the situation of the competitors. Port investments in

particular are very costly and time-consuming investments, and the economic and environmental costs of possible faulty policies high. As a result of the analysis applied to nine (9) countries in the region, the countries converging with Türkiye were Bulgaria, Lebanon, Romania and Ukraine, and the countries diverging with Türkiye were Egypt, Georgia, Greece, Israel, and Russia. Since the ports of Egypt, Greece and Israel are important points on the trade route with Europe, North Africa, and the Middle East, they have received significant investments from Chinese companies. For this reason, especially Egypt and Greece's connectivity on international container transportation network diverges from Türkiye. In this direction, Türkiye should design its policies that propose faster and more cost-effective alternatives by using rail and road networks.

In the second section of the study, the theoretical framework of the research was drawn based on maritime transportation. The data set and method used in the research were introduced in the third section. In addition, the situation of Türkiye and the countries in the region at the time were evaluated using LSCI and container traffic data. The findings obtained by analyzing the difference between Türkiye's LSCI value and those of other countries with unit root tests were presented in the fourth section. Potential structural breaks and nonlinearities in the variables were also considered during the analyses.

THEORETICAL FRAMEWORK

The LSCI variable is an indicator developed by the United Nations Conference on Trade and Development (UNCTAD) that aims to measure the integration of countries into global liner transportation (OECD/EUIPO, 2021 p. 59). For this measurement, the composite main index value is calculated based on the values in the six components, which are the weekly scheduled ship call, the total annual capacity deployed, the number of liner services, the size of the largest ship deployed, and the number of countries connected to the country by direct service UNCTAD (2023a).

Generally speaking, LSCI can be considered supply side of container transportation. Therefore, LSCI also demonstrates accessibility to international trade. A higher index value makes it easier to participate in higher-capacity regular transport opportunities (Mangan *et al.*, 2020, p. 70). The demand side is determined by the container traffic at the ports. Accordingly, positive and bidirectional causality can be expected between LSCI and container traffic of the countries. In addition, container traffic in ports is directly related to the economic activities and trade volumes of the countries (Yap, 2021, p. 68). Therefore, it can be said that there is a positive relationship between all of them. To confirm this positive relationship, we examined the correlation coefficients between LSCI, container throughput (twenty-foot equivalent unit), total GDP (current US$) and trade volume (Exports + Imports of goods and services in current US$) values of our sample countries, which are Bulgaria, Egypt, Georgia, Greece, Israel, Lebanon, Romania, Russia, Türkiye, and Ukraine, for 2020 and presented the results in Table 1.

As can be seen, there is a strong positive correlation between LSCI and container

throughput, indicating that countries with high port traffic also have high LSCI values. On the other hand, the relationship of LSCI variable with GDP and trade volume variables is positive, but it is a moderate relationship. The reason for this may be that the service and finance sector, which does not have physical product output, is included in these variables. There is also a very strong correlation between the two variables, as the GDP account also includes trade data. In general, there are strong positive relationships between container traffic and economic activities, and between LSCI and the container traffic of the countries. In other words, the main determinant of the LSCI variable is the economic activities in the country.

Table 1
Correlation of Selected Variables

	LSCI	CONTAINER THROUGHPUT	GDP	TRADE VOLUME
LSCI	1	0.83 (0.00)	0.67 (0.03)	0.53 (0.11)
CONTAINER THROUGHPUT	0.83 (0.00)	1	0.73 (0.01)	0.63 (0.05)
GDP	0.67 (0.03)	0.73 (0.01)	1	0.97 (0.00)
TRADE VOLUME	0.53 (0.11)	0.63 (0.05)	0.97 (0.00)	1

Notes: (1) Correlation analysis applied for logarithmic values. (2) Probabilities are shown in ().
Source: World Bank (2023a, 2023b, 2023c); UNCTAD (2023a, 2023b).

On the other hand, another important factor affecting the LSCI variable is geographical location. If a country's location is at a strategically optimum point, this country may be used as a transit port in container transportation. For instance, Singapore's total GDP in 2020 is 23% of Russia's, but its LSCI is 3.23 times that of Russia. Such a difference is due to Singapore's unique position in the world. Containers transported to this country by large ships are sent to their final destinations by smaller ships. Similarly, Malaysia has become one of the main transit ports in the world with the advantage of its geographical location. Therefore, according to the last quarter of 2022 in LSCI value, Singapore ranked 3rd after China and South Korea, while Malaysia ranked 4th (UNCTAD, 2023b). Apart from this, since some states are landlocked and do not have coastlines, container handling operations are carried out by neighboring states with coasts (De, 2014, p. 186). This situation leads to the emergence of countries that do not have a large economy but have high connectivity.

Since the LSCI variable is a factor that is affected by demand but also generates demand, it has a significant impact on the foreign trade of countries. In a study conducted by

Atacan *et al.* (2022) specific to Türkiye, the effect of changes in LSCI value on container traffic in the country's ports was examined. As a result, they determined that a 1% increase in the index caused an increase of approximately 1% in container traffic, which indicates that improvements on the supply side are also reflected in international trade. A similar approach was also investigated by Lin *et al.* (2020) with a spatial approach over the situation between China and its neighboring countries. The results of the applied regression and spillover analysis revealed that LSCI made a positive and significant contribution to the merchandise trade. The 1% increase in the index constitutes an approximate 0.87% increase in the trade volume. Also, since the LSCI variable consists of five (5) different components, it has been a research question that the developments in which component contribute more to international trade.

The LSCI variable has also been used as a proxy for port efficiency in another study. As increased connectivity means larger ships and busier line traffic, they assumed that the efficiency of the port with higher connectivity would also be higher. Using LSCI as a proxy for productivity, the effect of that variable on the trade balances of African countries was analyzed by Sakyi and Immurana (2021). The panel regression results applied by including 27 African countries showed that the increased LSCI value had a negative effect on the trade balance and increased exports, which means increased connectivity reduces trade costs and boosts exports. In the study conducted by Mohamad *et al.* (2015), which LSCI component had the greatest effect on port outputs of ASEAN countries was examined by panel regression analysis. The results showed that ship size is the most influential component and if improvements were made, the region could become one of the major transit ports in the world. The trade facilitating role of the LSCI variable does not only represent the infrastructure offered, but also reduces costs as it increases supply. The factors affecting trade costs for ASEAN and India were researched by Nagraj and Ghosh (2021) using a panel regression model. LSCI was included in the model as an independent variable, along with the variables of distance, cost of entry, tariffs and exchange rate. The results showed that as LSCI increased, trade costs decreased, which supports that increased connectivity increases supply and reduces costs.

Countries that have cultural, political, geographical and economic associations can also develop similarity features. Coexistence in any factor can lead to convergence in other factors. In this context, one of the most researched groups in the literature is ASEAN countries. This group of countries has very close geographical, cultural and economic relations. Whether the empirical convergence for this region is examined for GDP growth rates (e.g. Habibullah *et al.*, 2017), GDP per capita values (e.g. Matsuki, 2019), inflation rates (e.g. Valera & Valera, 2014), stock market indices (e.g. Chien *et al.,* 2015), worker productivity (e.g. Rath, 2019), and environmental carbon footprints (e.g. Yilanci & Pata, 2020).

Similarly, the validity of convergence in the literature for European Union (EU) countries has been tested in many studies by using GDP values (e.g. Siljak, 2015; Cabral &

Castellanos-Sosa, 2019), unemployment rates (e.g. Cuestas *et al.*, 2015; Monfort *et al.*, 2018), inflation rates (e.g. Cuestas *et al.*, 2016), interest rates (e.g. Arghyrou *et al.*, 2009), trade volumes (e.g. Jena & Barua, 2020), energy consumptions (e.g. Kasman & Kasman, 2020; Simionescu, 2022), carbon emissions (e.g. Herrerias, 2012; Marrero *et al.,* 2021), transportation networks (e.g. Atacan *et al.*, 2022), life satisfactions (e.g. Welsch & Bonn, 2008). Whether integration leads to convergence in LSCI values for EU countries was investigated by Açık (2021) using the panel unit root test method. The results obtained revealed that the EU countries, which were found to converge in economic, commercial, environmental, and energy related topics in the literature, also converged in LSCI values. In other words, the gap between countries with weaker transport networks and those with strong transport networks is closing in the long run.

After evaluating the function of LSCI and the relationship between the LSCI variable and other macro variables, it is necessary to explain why Türkiye and other countries should have a convergence in their LSCI values. First, it is necessary to mention Türkiye's strategic geographical position in the world. As a result of its geographical structure, Türkiye is a natural bridge between the Asian and European continents. It is on one of the effective routes where safe road transportation from Asia to Europe can be provided. For this reason, it was in the most strategic position on the ancient Silk Road and modern Silk Road routes. It is located at the connection point of Central Asia, Middle East and Caucasus countries with Europe. It also has strategic waterways such as the Istanbul and Çanakkale Straits. Thus, it plays an active role in maritime trade in the Aegean, Marmara and Black Sea regions.

One of the most important reasons for this is the trade between Europe and China. In 2022, trade between China and the European Union countries increased to 856 billion dollars and this amount corresponds to approximately 30% of the total trade volume of EU countries (Eurostat, 2023). In these intense commercial activities between Europe and China, which country will be used as a transshipment port and which transportation mode(s) will be used to continue the remaining journey of the cargo determine the container traffic in the relevant country. For example, an alternative would be to bring the cargoes from China to Egypt and unload them in Egypt, from there to be loaded on smaller ships and sent to their final destinations. Or another alternative would be for large ships to unload their cargo in Greece and from there to transport the cargo by rail or road to the interior of Europe (e.g. the Western Balkans Corridor). Further, it may be the unloading of cargo in Bulgaria or Romania and their transport into Europe by inland waterways (e.g. Baltic – Black – Aegean Seas Corridor). The opposite scenarios can also be seen in the cargoes going from Europe to China. There are also alternative routes for trade between China and Europe, such as the Trans-Siberian Railway, the New Silk Road and the Arctic Route. In addition, there are routes passing over Türkiye that will provide transportation through the Development Road, the route that continues by road and railroad after the sea route to the Persian Gulf, and the Zangezur Corridor, which is

in talks between Azerbaijan and Armenia. If these routes can be faster and more economical alternatives, they may reduce the regional importance of Egypt and Greece in container transshipment. Multimodal transportation routes aim to generate a more efficient and flexible trade network by harnessing the advantages of different modes of transportation. These routes can reduce transit times, lower costs, and facilitate logistical arrangements. However, the successful implementation of such routes requires suitable infrastructure, effective coordination among transportation operators, and cooperation between countries.

Although each loading, unloading and transshipment activity burdens a cost element for the cargo owner, it is a gain element for the country where those transactions are made. This gain can be classified into two (2) groups: (i) monetary gain, (ii) infrastructural gain. Monetary gain is the income obtained from each transaction, such as handling, storage, packaging, etc. since all of them are applied at a certain tariff. Infrastructural gain, on the other hand, as mentioned in the literature, increased cargo traffic and causes larger and more frequent ships to visit. This situation causes a decrease in the trade costs of the country in export and import activities due to the economies of scale. It contributes to the generation of more employment and causes an increase in port investments. For all these reasons, there is a competition and race between countries to become a transshipment port on the main cargo routes in the world (Yetkili *et al.*, 2016). In such a competitive environment, it is important to determine which countries are more advantageous, to predict which countries will be competitors in the future, even if not now, and to analyze the situation in the market according to the competitors. Although the LSCI index is not only affected by international transshipment cargoes and local demand is also important, it can be considered as an important indicator for the competitive power of countries. In this direction, statistical inferences can be made on the long-term behavior of the LSCI values of the countries in the region. The aim of this study is to try to determine what will be the competitive power of Türkiye and its competitors in the region in the long run. It is aimed at contributing to the literature by testing the convergence theory in the transportation industry, which is rarely studied in the literature, econometrically.

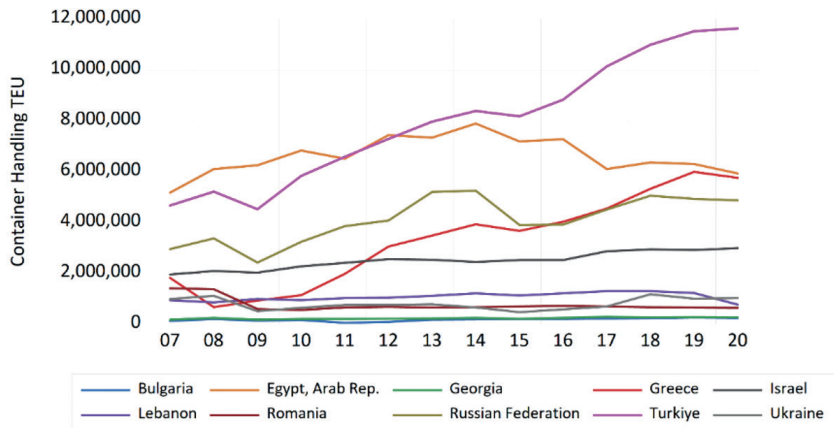
DATA AND METHODOLOGY

As a sample in our study, we chose the maritime neighbors around Türkiye because any trade improvement or deterioration in any neighboring country will also affect other countries. In addition, since countries serve as transshipment ports, there may be a competition between countries. Whether there are convergences between LSCI of Türkiye and other countries can show which neighbor countries are threat to the Turkish liner shipping industry. The selected neighbor countries are Bulgaria (BUL), Egypt (EGY), Georgia (GEO), Greece (GRE), Israel (ISR), Lebanon (LEB), Romania (ROM), Russia (RUS), and Ukraine (UKR).

Before examining the Liner Shipping Connectivity values of the countries, it is im-

portant to mention the cargo traffic in their ports, to have an idea about their capacity in container transportation. Also, container traffic in countries is a result of their LSCI levels. Accordingly, the handled average container amounts between 2007 and 2020 are 7,987,198 for Türkiye, 6,622,964 for Egypt, 4,115,814 for Russia, 3,310,403 for Greece, 2,506,445 for Israel, 1,079,766 for Lebanon, 801,947 for Ukraine, 765,200 for Romania, 235,656 for Georgia and 182,206 for Bulgaria respectively (UNCTAD, 2023a). In Figure 1, the course of container traffic in the ports of the countries between 2007 and 2020 is presented. According to the figure, it can be observed that Türkiye and Greece have an increasing trend, Egypt has a decreasing trend, and the remaining countries follow a stable course.

Figure 1
Port Throughputs of the Sample Countries



Source: UNCTAD (2023a).

The LSCI values of the countries are used to test the convergence in the analyses. The period that we will use in our research consists of 65 quarterly observations covering the period between the first quarter of 2006 and the first quarter of 2022. The descriptive statistics of the LSCI variables of the countries are presented in Table 2. Accordingly, the countries with the highest connectivity in terms of liner transportation are Egypt (54.3), Türkiye (48.23) and Greece (43.05), while the countries with the lowest are Georgia (5.56), Bulgaria (7.51), and Romania (23.04). When we look at the coefficient of variation (standard deviation/mean), the countries with the most variability are Bulgaria (30%), Russia (28%) and Greece (27%), while those with the least variability are Georgia (13%), Egypt (14%), and Lebanon (15%). The low variability naturally reflects on the distribution characteristics (Jarque-Bera) and normalizes their distribution.

Table 2
Descriptive Statistics of the LSCI Values of the Countries

	BUL.	EGY.	GEO.	GRE.	ISR.	LEB.	ROM.	RUS.	TÜR.	UKR.
Mean	7.51	54.30	5.56	43.05	31.46	33.42	23.04	35.69	48.23	23.55
Median	6.96	54.65	5.65	41.65	30.33	35.19	23.16	36.01	51.11	24.87
Maximum	16.57	68.51	6.84	60.92	41.92	43.21	27.66	53.12	62.84	28.97
Minimum	5.28	43.07	3.93	25.02	21.85	20.55	16.00	18.52	29.82	12.35
Std. Dev.	2.27	7.55	0.74	11.48	7.10	6.49	3.34	9.86	10.08	4.28
Skewness	2.82	0.31	-0.40	0.26	0.16	-0.35	-0.39	-0.21	-0.42	-0.63
Kurtosis	11.55	1.99	2.35	1.81	1.52	1.89	1.77	1.74	1.74	2.46
Jarque-Bera	284.24	3.80	2.88	4.59	6.20	4.69	5.69	4.75	6.20	5.07
Probability	0.00	0.15	0.24	0.10	0.05	0.10	0.06	0.09	0.05	0.08
Obs.	65	65	65	65	65	65	65	65	65	65

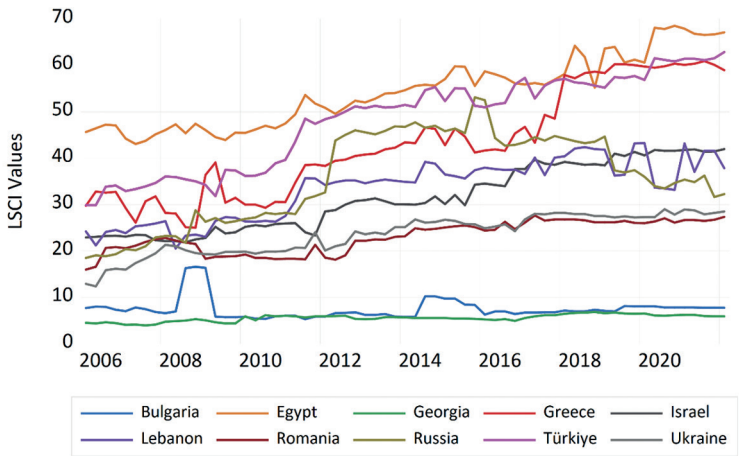
Source: UNCTAD (2023b).

The movements of the LSCI variables of the sample countries in the period under consideration are presented in Figure 2. Naturally, as the LSCI value improves, the container traffic in the country is likely to increase, as there is an improvement in the transportation opportunities of foreign trade stakeholders (Atacan *et al.,* 2022). For instance, when we considered the correlation between LSCI and container port throughputs of the countries in the period under consideration, we found six significant positive relationships. The significant correlation coefficients were 0.96 for Greece, 0.94 for Türkiye and Israel, 0.74 for Russia, 0.72 for Lebanon and 0.65 for Georgia respectively. These confirm that there is a positive significant relationship between the variables in general. Therefore, countries with higher container traffic volumes can be expected to have higher LSCI values.

To measure whether the neighboring countries converge with Türkiye, we subtract the logarithmic LSCI variables of all countries from Türkiye's logarithmic LSCI variables and obtain the following variables whose descriptive statistics are presented in Table 3. Differenced variables are defined with the prename TD. For example, the TDBUL variable was obtained by subtracting Bulgaria's log (LSCI) variable from Türkiye's log (LSCI). The same process is true for the variables of the remaining countries. In the next process, unit root tests are applied to these variables, and it is determined whether they converge or not. A positive average value indicates that the LSCI value of the relevant country is generally lower than the Turkish LSCI value, while a negative value indicates that the value of the relevant country is generally higher than the Turkish value. For instance, the value of the variable

calculated for Egypt is negative and the country with the highest LSCI value on average is the same country. If the average is positive and the minimum value is negative (e.g. Greece, and Russia), it indicates that the relevant country has surpassed Türkiye at some times during the period under consideration, although they have a lower value on average.

Figure 2
LSCI Values of the Sample Countries



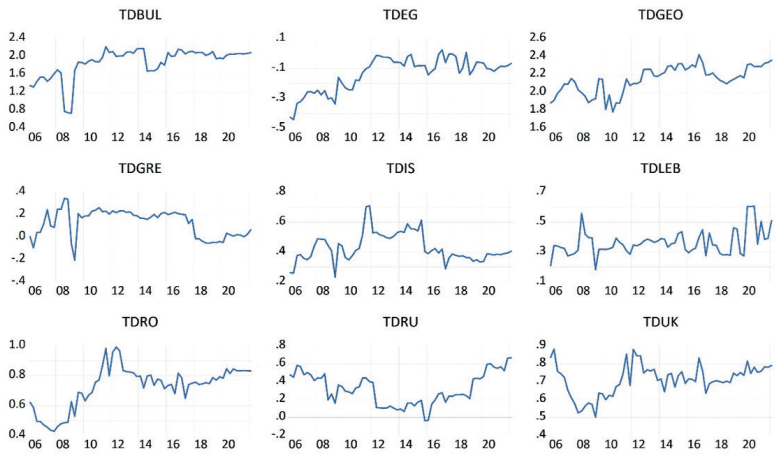
Source: UNCTAD (2023b).

Table 3
Descriptive Statistics of the Log Differences of Countries' Indices with Türkiye

	TDBUL	TDEG	TDGEO	TDGRE	TDIS	TDLEB	TDRO	TDRU	TDUK
Mean	1.87	-0.13	2.15	0.13	0.43	0.36	0.73	0.32	0.71
Median	2.00	-0.10	2.16	0.17	0.40	0.35	0.76	0.29	0.72
Maximum	2.22	0.02	2.42	0.34	0.71	0.61	0.99	0.67	0.88
Minimum	0.74	-0.44	1.78	-0.21	0.23	0.18	0.43	-0.04	0.50
Std. Dev.	0.33	0.11	0.15	0.12	0.10	0.08	0.14	0.18	0.08
Skewness	-1.89	-0.88	-0.55	-0.56	0.72	1.07	-0.61	0.08	-0.32
Kurtosis	6.61	2.97	2.49	2.36	3.69	4.53	2.80	2.04	2.89
Jarque-Bera	74.16	8.42	3.98	4.46	6.87	18.86	4.13	2.59	1.17
Probability	0.00	0.01	0.14	0.11	0.03	0.00	0.13	0.27	0.56
Obs.	65	65	65	65	65	65	65	65	65

The graphical representation of the log difference values of the countries with Türkiye is presented in Figure 3 in alphabetical order. For some countries, the gap tends to open in a positive or negative direction, while for other countries the gap has downward tendencies. In order to obtain scientific evidence, econometric tests should be applied, but some inferences can still be made visually. For instance, although Greece was almost equal in the initial period, it fell back over time, but managed to close the gap after a while. Egypt, on the other hand, started to lose this superiority over time, although it was well ahead in the initial period. Therewithal, it can be said that the difference between Georgia, Bulgaria and Russia has widened over the time.

Figure 3
Log Differences of Countries' Indices with Türkiye



The TD prename variables obtained by taking the log differences between Türkiye's LSCI value and the values of other countries are used to test whether there is convergence. In our research, we used unit root analyzes to test whether the LSCI values of Türkiye and other regional countries converge by using the logarithmic differences of the LSCI values of Türkiye and other countries. The fact that a series contains a unit root indicates that it is not stationary, in other words, its mean and variance change in the long run. This makes it difficult to analyze and predict such data, because the series bear the effects of the shocks to which they are exposed. On the other hand, if a series is stationary and does not contain a unit root, this indicates that its mean and variance do not change over time.

In this study, we first applied traditional augmented Dickey Fuller (ADF) (1979) and Phillips-Perron (PP) (1988) unit root tests. In general, the PP test is more resistant to serial correlation than the ADF test and can be used in non-normal error distributions. Basically,

these tests analyze whether the mean and variance of the series changes over time. However, these tests are used in linear series and do not consider possible structural breaks. Therefore, after applying these tests, we also applied the structural break and linearity tests. According to the results obtained from those tests, unit root tests were applied that robust to structural break and non-linearity in the series.

The inference obtained from unit root tests on convergence is evaluated according to whether the series contains a unit root or not. If the difference series contains a unit root, that is, I(1), this indicates that the countries diverge from each other. On the other hand, if the difference series is stationary, that is, I(0), this indicates that the countries converge with each other. However, in the selection of unit root tests, structural break and linearity properties should be examined and choices should be made accordingly.

Variables can change over time for some reasons. This change may be due to breaks in their levels and trends. The reasons for the breaks can be economic events, policy changes, technological developments, demographic changes, global integration, natural disasters, and armed conflicts. Fiscal and monetary policies implemented by governments may affect the supply-demand balances in the markets and may cause a break. In addition, technological innovations and digitalization can cause a break by increasing production efficiency. Additionally, natural disasters may disrupt the supply-demand balance in the market and cause a break in the course of the variable. For this reason, the series may experience breaks in level and trend. The break in level is related to the change in the mean of the series on a certain date. In such cases, the series continues to move stationary at a new higher or lower average level. A break in the trend is related to the change in the direction of the series. A stable series may enter an increasing trend due to the break and the trend may become stationary. Classical linear unit root tests cannot capture such breaks and may give false inferences about the stationarity of the series.

Therefore, after applying unit root analysis to our variables, we also applied the Bai and Perron (2003) test to determine possible breaks in the variables. The purpose of the Bai and Perron (2003) test is to determine whether there is a break in the series and, if so, when. Once a break occurs, there are changes in the statistical characteristics of the series such as mean, variance and distribution. In this way, the significance and time of the break can be determined. In this method, the series is first estimated with a single regressor (constant). Afterwards, a multiple structural break test is applied to the model. In application, this method is very practical because no prior knowledge of the break date is required (He, 2022, p. 19).

After detecting possible breaks in the series, we applied the Zivot and Andrews (ZA) (1992) unit root test, which considers structural breaks. The ZA test is an improved version of the traditional ADF test and applies the unit root test, considering potential unknown breaks in the series. The advantage of this is that if there is a break in the series and unit root tests are applied that ignore the potential breaks, the result may appear as if there is a unit root. This situation makes the validity of the

obtained results open to discussion. For this reason, the application of tests that consider the breaks while applying the unit root analysis may provide more accurate results in case of structural breaks in the series. However, the ZA test is one of the linear unit root tests like the ADF and PP tests.

In some cases, linear unit root tests may also be insufficient because they assume linear relationships between the components of the series. However, the return to mean process, dependencies, seasonality and regime changes in the series may be non-linear. Therefore, by testing the linearity of our series, we applied a nonlinear unit root test to the required variables according to the results obtained. We tested the linearity of our variables with the Brock, Dechert, and Scheinkman (BDS) (1987) independence test. The BDS test detects nonlinear dependencies by examining the deviations from linear dependencies in the series between different pairs. Thus, it can reveal possible nonlinear structures.

After applying the BDS test, we also decided to apply nonlinear unit root tests to the variables considering their nonlinearities. The tests we chose are the Wavelet-based KSS (WKSS) and Fourier Wavelet-based KSS (FKSS) tests proposed by Aydin (2020). These tests come to the fore by considering both nonlinearity and structural breaks in the series. Thus, we examined the convergence by considering both the structural breaks and nonlinearity in the series.

While EViews software was used for ADF and PP unit root tests, GAUSS software was used for ZA, WKSS and FWKSS unit root tests. ADF, PP and BDS tests are embedded in EViews software. However, other tests can be executed with GAUSS codes that can be run with the software of the same name. To summarize our analysis process: (i) apply linear ADF and PP tests, (ii) apply ZA structural break unit root test, (iii) apply WKSS and FWKSS nonlinear unit root tests, (iv) apply BDS to test the linearity of variable, (iv) apply the Bai-Perron test to determine structural breaks in the variable, (iv) consider the ADF and PP tests if the variable is linear and there is no break, (v) consider the ZA test if the variable is linear and there are structural breaks, (vi) consider the WKSS and FWKSS tests if there are structural breaks and the variable is nonlinear. At the end of this whole process, if there is a unit root, the relevant country diverges with Türkiye, if there is no unit root, it converges.

RESULTS

The results of the ADF and PP tests applied to the series are presented in Table 4. In addition, based on the Bai-Perron structural break test results presented in Table 5, the ZA test, which takes into account structural breaks, was also applied and the results are presented in Table 4. The null hypothesis of ADF and PP tests indicates unit root. According to the results obtained, the outcomes of both tests are the same for all countries except Ukraine. For Ukraine, considering the advantages of the PP test over the ADF test, PP result was taken as a basis. Unit roots were determined in the variables of Bulgaria, Georgia, Romania, and Russia, that is, these countries diverge with Türkiye, while the remaining countries are converging.

Of course, these results assume that the series are linear and do not have structural breaks.

On the other hand, the results in Table 5 showed that there were breaks in all variables at certain dates. When the results of the ZA test applied in this context are examined, the result changes only for Bulgaria, and the diverging countries remain Georgia, Romania and Russia. However, since ADF, PP and ZA tests assume that the series are linear, they do not take nonlinearity into account. For this reason, the BDS linearity test was applied to the series to determine whether nonlinear unit root tests are needed.

Table 4
Unit Root Test Results

	ADF	PP	CONCLUSION	ZA BL	CONCLUSION
Bulgaria	-1.92	-2.39	I (1)	-5.78*** (2009Q4)	I (0)
Egypt	-2.84*	-2.80*	I (0)	-5.70*** (2010Q2)	I (0)
Georgia	-2.41	-2.30	I (1)	-4.08 (2011Q1)	I (1)
Greece	-3.25**	-3.28**	I (0)	-5.50*** (2009Q1)	I (0)
Israel	-3.22**	-3.20**	I (0)	-5.51*** (2015Q2)	I (0)
Lebanon	-5.35***	-5.36***	I (0)	-6.60*** (2019Q4)	I (0)
Romania	-1.35	-1.65	I (1)	-4.11 (2010Q2)	I (1)
Russia	-1.64	-1.44	I (1)	-3.77 (2011Q4)	I (1)
Ukraine	-2.54	-3.22**	I (0)	-4.59* (2010Q4)	I (0)

Notes: (1) ADF CVs are -3.54 for ***1%, -2.91 for **5%, -2.59 for *10%. (2) PP CVs are -3.53 for ***1%, -2.90 for **5%, -2.59 for *10%. Barlett Kernel Spectral Estimation Method and Newey-West bandwidth were used. ZA Break in Level CVs are -5.34 for ***1%, -4.80 for **5%, -4.58 for *10%.

Table 5
Structural Break Test Results

	SCHWARZ	LWZ	BREAK DATE(S)
Bulgaria	-3.09 (1)	-2.95 (1)	2009Q2
Egypt	-5.78 (2)	-5.56 (2)	2009Q3, 2011Q4
Georgia	-4.60 (1)	-4.47 (1)	2012Q4
Greece	-4.76 (2)	-4.53 (1)	2009Q3, 2018Q1
Israel	-5.48 (2)	-5.25 (2)	2011Q2, 2015Q4
Lebanon	-5.05 (1)	-4.91 (1)	2020Q1
Romania	-5.03 (2)	-4.87 (1)	2009Q3, 2011Q2
Russia	-4.46 (2)	-4.23 (2)	2012Q2, 2019Q2
Ukraine	-5.17 (2)	-4.98 (1)	2008Q2, 2010Q4

The Bai-Perron structural break test results applied to the series are presented in Table 5. The results obtained with the Global Information Criteria method showed that some variables had 1 break, and some had 2 breaks. In general, the structural break dates were after and before the 2008 global economic crisis. This crisis disrupted the supply-demand balance in the world, causing shrinkage in economies and thus contraction in the demand for maritime transport.

The BDS Independence Test results that we applied to the variables are presented in Table 6. The null hypothesis of this test indicates the linearity of the series. However, if the null hypothesis is rejected in any of the dimensions, the series is considered to contain nonlinear structures. This test is applied to residuals of certain deterministic models. Therefore, after estimating the optimum ARMA models that minimize the Aic value for each variable, the BDS tests were applied to the residuals of all models. While estimating ARMA models, we chose to automatically determine the stationarity of the series with the KPSS test and to estimate the models accordingly. For this reason, while the level values of some variables were used, the first differences of some variables were used. According to the results obtained, the null hypothesis of linearity was accepted only for Bulgaria and Georgia, while it was rejected in at least one dimension for the remaining countries. This shows that the results of ADF, PP and ZA linear unit root tests can be trusted for Bulgaria and Georgia, while WKSS and FWKSS nonlinear unit root tests should be considered for other countries.

Table 6. Linearity Test Results

VARIABLE	ARMA MODEL	AIC VALUE	DIM (2)	DIM (3)	DIM (4)	DIM (5)	DIM (6)	CONCLUSION
D(Bulgaria)	(0, 3)	-0.64	-0.009	-0.032	-0.006	0.004	0.006	L
D(Egypt)	(0, 1)	-3.17	0.003	0.025	0.043**	0.048**	0.051**	NL
D(Georgia)	(1, 1)	-2.15	-0.006	0.0139	0.0216	0.0214	0.0166	L
Greece	(1, 2)	-2.06	0.033**	0.114***	0.167***	0.206***	0.226***	NL
Israel	(1, 0)	-2.63	0.048***	0.085***	0.089***	0.079**	0.617*	NL
D(Lebanon)	(1, 1)	-2.15	0.035***	0.077***	0.095***	0.106***	0.099***	NL
D(Romania)	(0, 3)	-2.75	0.015	0.058**	0.070**	0.072**	0.071**	NL
Russia	(1, 0)	-1.97	-0.022	-0.056**	-0.054*	-0.046	-0.042	NL
Ukraine	(3, 2)	-2.90	0.019*	0.036**	0.041**	0.035*	0.025	NL

Notes: (1) Null of linearity rejected at ***1%, **5%, *10%. (2) D means first difference.

After testing the linearity of the series, WKSS and FWKSS nonlinear unit root tests were applied to the series and the results are presented in Table 7. We presented test results without linear-nonlinear distinction to enrich the results. The final situation, which is examined discriminately, is presented in the following section. Since it is known that the FWKSS test is stronger than the WKSS test in structural break situations, the final decision was made

according to the FWKSS test. The results obtained by nonlinear unit root tests show that Lebanon, Romania and Ukraine converge, while Egypt, Greece, Israel and Russia diverge.

Table 7
Nonlinear Test Results

	WKSS	FWKSS	CONCLUSION
Bulgaria	-8.12***	-1.35 (5)	I (1)
Egypt	-0.81	0.32 (1)	I (1)
Georgia	-3.16**	-3.72** (2)	I (0)
Greece	-1.07	-2.54 (3)	I (1)
Israel	-1.80	-1.13 (1)	I (1)
Lebanon	-3.22**	-3.30** (1)	I (0)
Romania	-4.32***	-3.08* (4)	I (0)
Russia	-2.26	-1.64 (3)	I (1)
Ukraine	-2.37	-3.09* (4)	I (0)

Notes: (1) WKSS CVs are -3.45 for ***1%, -2.79 for **5%, -2.49 for *10% when T=50. (2) FKSS CVs when T=50, k=1: -4.00 for ***1%, -3.24 for **5%, -2.89 for *10%, k=2: -4.10 for ***1%, -3.34 for **5%, -2.98 for *10%, k=3: -4.13 for ***1%, -3.30 for **5%, -2.93 for *10%, k=4: -4.04 for ***1%, -3.24 for **5%, -2.88 for *10%, k=5: -4.00 for ***1%, -3.20 for **5%, -2.84 for *10%.

Up to this section, aggregated results for all countries in each unit root test have been presented indiscriminately. The final evaluations for all variables, considering their linearity and structural breaks, are presented in Table 8. Structural breaks were detected in all of the variables with the Bai – Perron test. For this reason, ZA tests for linear variables and FWKSS tests for nonlinear variables were taken as reference tests. According to the results obtained, the countries that converged with Türkiye were Bulgaria, Lebanon, Romania, and Ukraine. The LSCI values of all these countries are below Türkiye's. The variance and mean of the difference with Türkiye do not change over time.

The LSCI value of Türkiye diverges with the rest of the countries. For example, as can be seen from Figure 1, the gap with Egypt, whose index value is above Türkiye, is closing, and Türkiye will probably surpass its competitor in the region in the near future. On the other hand, the difference with Georgia is increasing. The gap with Russia, which was closed until 2016, started to increase again after this date and Türkiye managed to surpass its rival in the region. Although Türkiye was ahead until the last quarter of 2017, Greece, the biggest competitor in the region, fell behind its rival afterward. Therefore, Greece diverges from Türkiye. Finally, while the difference with Israel increased until 2015 Q3, there was a break after that.

Table 8
Conclusion

	REFERENCE TEST	STRUCTURE	CONCLUSION
Bulgaria	ZA	L	I (0)
Egypt	FWKSS	NL	I (1)
Georgia	ZA	L	I (1)
Greece	FWKSS	NL	I (1)
Israel	FWKSS	NL	I (1)
Lebanon	FWKSS	NL	I (0)
Romania	FWKSS	NL	I (0)
Russia	FWKSS	NL	I (1)
Ukraine	FWKSS	NL	I (0)

CONCLUSION

The trade between China and Europe has significantly increased in recent years. Factors such as China's economic growth, expansion of production capacity, and increased demand from Europe have contributed to this growth. The increase in trade volume has resulted in a significant rise in container traffic. These trade activities are predominantly conducted through sea transportation, relying heavily on container shipping. Sea transportation is preferred due to its cost-effectiveness, high capacity, and extensive coverage. However, in recent years, alternative transportation routes have been developed due to the congestion, logistical challenges and security risks in sea transportation.

Railway transportation between China and Europe has been gaining popularity as an alternative. The railway and road networks known as the "New Silk Road" provide connections from China's inland regions to Europe. These routes can be faster and, in some cases, more cost-effective than sea transportation. In Europe, road transportation can also serve as a significant alternative. Road transportation is suitable for quick deliveries, especially between neighboring regions. Air transportation is an important option for urgent and valuable goods. However, air transportation is generally more expensive and less suitable for large-volume shipments.

The Northern Sea Route, which passes through the Arctic region, connects Northern Asia to Europe by sea. The melting of ice during the summer months, influenced by global warming, has increased the usage of this route. The Northern Sea Route can shorten the travel time from China to Europe and reduce costs. However, there are still challenges and safety risks due to the presence of ice during the winter months.

Multimodal transportation routes are increasingly being preferred for container traffic between China and Europe. These routes involve a combination of different transportation modes, including sea, railway, road, and air transport. The Middle East-Northern Europe Route allows containers from China to reach the Mediterranean via the Middle East and then continue to Northern Europe. This route can be an alternative option that bypasses the Suez Canal and, in some cases, reduces costs. The Basra Gulf, considered the main sea route in the Middle East, plays a significant role in trade between China and Europe. The China-Basra Gulf-Mediterranean-Europe route involves transporting containers from China to the Basra Gulf (e.g., ports like Dubai or Oman) by sea and then shipping them to Europe via the Mediterranean. In this route, sea transportation continues from Basra Gulf ports to Mediterranean ports, followed by road or railway connections to Europe. The Basra Gulf is filled with important ports and logistics centers in the Middle East, leading to the development of multimodal transportation routes that facilitate and expedite trade between China and Europe. However, the selection of each route requires careful consideration of factors such as logistics requirements, trade volume, security factors, and infrastructure conditions.

The combination of rail and sea transportation allows containers transported by rail

from China to Europe to be further shipped by sea to their final destination after reaching a European port. This multimodal combination takes advantage of the benefits of sea transportation while providing the speed and cost-effectiveness of rail transportation. In the combination of road and rail transportation, containers are transported by road from production centers in China to nearby railway terminals, and then they are delivered to Europe by rail. This combination merges the flexibility of road transportation with the efficiency of rail transportation. The combination of air transportation with rail/road transportation is particularly used for urgent and valuable cargo. It involves transporting containers from China to Europe by air and then delivering them to the final destination by rail or road. This combination combines the speed of air transportation with the cost-effectiveness of rail/road transportation.

Bulgaria, Egypt, Georgia, Greece, Israel, Lebanon, Romania, Russia, Ukraine and Türkiye, which are the subject of our research, constitute transfer points of this multimodal network. Some for Mediterranean region countries, some for Black Sea region countries and some for European countries. For this reason, in order to become an important center in the container transportation sector where the final products are transported, the connectivity must be high. Of course, besides connectivity, transportation and time costs, delivery times, reliability, flexibility and political factors are also important in choosing mode combinations. But still higher connectivity positively affects the mode selection as it means faster transportation, lower costs, and more flexibility due to higher voyage frequency. Therefore, having a high LSCI value can both accelerate the rate of increase of LSCI and provide a competitive advantage. Having an adequate level of connectivity to the transportation network contributes positively to container traffic (Mohamad *et al.*, 2015; Atacan *et al.,* 2022) and trade volume (Lin *et al.*, 2020; Sakyi & Immurana, 2021) while it contributes negatively to international trade costs (Nagraj & Ghosh, 2021).

In this study, we aimed to analyze the current situation and the future situation between the LSCI value of Türkiye, which has a rare strategic location in the world, and the LSCI values of other countries that can be considered as competitors in the region. In the analyzes we made by testing the convergence theory, we determined which countries converged and which countries diverged. The diverging countries may be ahead of Türkiye and widening the gap, or they may be behind Türkiye and widening the gap. The difference between the LSCI values of converging countries and Türkiye's value closes in the long run. While testing this situation, we applied unit root analysis by taking the difference between the log LSCI values of Türkiye and other countries. The fact that the difference values have a unit root indicates that the mean and variance of the difference change over time and do not tend to return to the mean. On the other hand, the absence of a unit root indicates that the mean and variance are constant, and the series tends to return to the mean in the long run. In other words, the stationary series show that there is convergence. In the selection of unit root tests, we took the structural breaks and non-linearity

in the series into account. According to the results obtained, the countries that converged with Türkiye were Bulgaria, Lebanon, Romania, and Ukraine. The LSCI values of all these countries are below Türkiye's.

The fact that other countries other than Lebanon are Black Sea countries can be interpreted as speeding up the trade within the European region through these countries. When the LSCI values are examined, it is seen that they have a positive trend, albeit weak. In Lebanon, on the other hand, while a positive trend was observed in the process until the port explosion in 2020, a break occurred after that date. Among the diverging countries, it can be said that Egypt and Greece will get ahead of Türkiye. Egypt, in particular, had a higher level of connectivity in the period under consideration, and it looks like it will continue to dominate. This is mainly because of its geographical position and its possession of the Suez Canal. It is located in a location where almost all ships going from China to Europe and from Europe to China have to pass. It is also located in one of the optimum locations for trade between China and Northeast African countries. Similarly, Greece has a position where time and cost savings can be made in the transportation of cargoes within Europe by using this country as a transshipment node. Cargoes brought to this country by large ships can then be distributed to the interior of Europe by road or rail transportation modes. Russia, on the other hand, has entered a trend of decreasing connectivity and the gap with Türkiye is getting wider.

In this context, Türkiye's strategy is to offer time- and cost-effective alternatives that can bypass the strategic positions of Egypt and Greece. Basically, investments to develop the railway-based trade route passing through China, Central Asia and the Caucasus countries should be accelerated. Efforts should be intensified to start the activities of the Zangezur corridor, which includes the route comes from China and passes the Caspian Sea through water and connects Türkiye via Azerbaijan. In addition, the Development Road project, which will connect Türkiye with the Persian Gulf by road and railway, which is jointly designed with the Iraqi government, should be accelerated. This way, if fast and cost-effective alternatives can be offered, the routes will enable Türkiye to increase its activities as a strategic bridge.

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