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Relationship Between Maritime Transport and Economic Growth: Highest Maritime Transport European Countries

Deniz Taşımacılığı ile İktidadi Büyüme Arasındaki İlişki: En Yüksek Deniz Taşımacılığına Sahip Avrupa Ülkeleri

Türk Denizcilik ve Deniz Bilimleri Dergisi

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ABSTRACT

Maritime transport is one of the most widely used transport channels used by countries in foreign trade. The development of maritime transport affects the economic growth levels of countries. In addition, the increase in the level of economic growth of countries increases their share in international foreign trade and this situation increases the importance given by countries to maritime transport day by day. The identification of the effects of maritime transport in countries will provide important information on what countries should do against the shocks they will face in the future. In this context, the study aims to determine whether there is any causality relationship between maritime transport and economic growth variables in Belgium, France, Germany, Italy, Netherlands, Spain, Türkiye, and the United Kingdom, which have the highest maritime transport among European countries. The bootstrap panel causality test was employed to examine the causality relationships between the variables over the time frame of 2008:Q1-2020:Q2. According to the findings, there is a causality relationship from economic growth to maritime transport in all countries except Italy and the Netherlands. There is a causality relationship from maritime transport to economic growth in Türkiye and the United Kingdom. As a result, the relationship between maritime transport and economic growth varies from country to country. This situation reveals the necessity of developing national policies for maritime transport by considering the economic structures of the countries. These findings suggest that countries need more efficient and sustainable maritime transport policies.

Keywords: Maritime transport, Freight transportation, Economic growth, European countries

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ÖZET

Dış ticarette ülkelerin en çok kullandığı nakliye kanallarının başında deniz taşımacılığı gelmektedir. Deniz taşımacılığının gelişimi ülkelerin iktisadi büyüme düzeylerine etki etmektedir. Ayrıca ülkelerin iktisadi büyüme düzeyindeki artışlar, uluslararası dış ticaretten aldıkları payını da artırmakta ve bu durum ülkelerin deniz taşımacılığına verdiği önemi her gecen gün daha da artırmaktadır. Deniz taşımacılığının ülkeler üzerindeki etkilerinin belirlenmesi, ülkelerin gelecekte karşılaşacakları şoklara karşı ne yapmaları gerektiği konusunda önemli bilgiler sağlayacaktır. Bu bağlamda çalışmada, Avrupa ülkeleri arasında en yüksek deniz taşımacılığına sahip olan Belçika, Fransa, Almanya, İtalya, Hollanda, İspanya, Türkiye ve Birleşik Krallık'ta deniz taşımacılığı ile iktisadi büyüme değişkenleri arasında herhangi bir nedensellik ilişkisinin olup olmadığının belirlemesi amaçlanmaktadır. Değişkenler arasındaki nedensellik ilişkileri 2008:Q1-2020:Q2 dönemi verileri ve bootstrap panel nedensellik testi yardımıyla incelenmektedir. Bulgulara göre, İtalya ve Hollanda hariç tüm ülkelerde ekonomik büyümeden deniz taşımacılığına doğru bir nedensellik ilişkisi bulunmaktadır. Türkiye ve Birleşik Krallık'ta ise deniz taşımacılığından ekonomik büyümeye doğru bir nedensellik ilişkisi bulunmaktadır. Sonuç olarak deniz taşımacılığı ile iktisadi büyüme arasındaki ilişkiler ülkeden ülkeye göre değişmektedir. Bu durum ülkelerin kendi ekonomik yapılarını dikkate alarak deniz taşımacılığına yönelik ulusal politikilar geliştirme gerekliliğini ortaya koymaktadır. Bu bulgular, ülkelerin daha verimli ve sürdürülebilir deniz taşımacılığı politikalarına ihtiyaç duyduğunu göstermektedir.

Anahtar sözcükler: Deniz taşımacılığı, Yük taşımacılığı, İktisadi büyüme, Avrupa ülkeleri

1. INTRODUCTION

International trade and competitiveness of national firms in international markets contribute to economic growth (Grossman and Helpman, 1991; Rivera-Batiz and Romer, 1991; Ayesu *et al*., 2023). Therefore, many countries increase their investments in transportation infrastructure in order to expand their share in international trade to achieve economic growth and development. Banister and Berechman (2001) claim that planned infrastructure investments that integrate alternative transportation channels will both increase domestic trade activity and increase competitive advantage in international trade. Investments in transportation infrastructure also provide external benefits to other sectors of the economy. This, in turn, results in increased economic activity, more employment opportunities, reduced unemployment, and an increase in income levels, contributing to overall economic growth (Barro, 1990). There are many studies in the literature that examine the relationship between the development of transportation infrastructure and economic growth. Most of these studies indicate the impact of investments in highways, maritime harbors, airports and railways on economic growth(Aschauer, 1989; Rephann and Isserman, 1994; Fernald, 1999; Cantos *et al*., 2005; Zhang *et al*., 2005; Yamaguchi, 2007; Anaman and Osei-Amponsah, 2007; Lall, 2007; Fan and Chan-Kang, 2008; Tervo, 2009; Crafts, 2009; Jiwattanakulpaisarn *et al*., 2010; Cohen, 2010; Akbarian and Ghaedi, 2011; Banister and Thurstain-Goodwill, 2011; Chia, 2011; Banister, 2012; Deng, 2013; Badalyan *et al*., 2014; Jaffee, 2015; Park and Seo, 2016; Song and Mi 2016; Jiang *et al*., 2017; Khan *et al*., 2018; Saidi *et al*., 2018; Park *et al*., 2019; Sharif *et al*., 2019; Mudronja *et al*., 2020). According to Brunel (2005), the development of a sophisticated civilization and steady growth have traditionally been regarded as dependent on the transportation industry. Thus, compared to less developed countries, industrialized countries have built and developed their transportation sectors more successfully (Özer *et al*., 2021).

Throughout history, societies separated by long distances have favored maritime transport to maintain social and economic relations with one another (Saeed *et al*., 2021). The liberalization of international commerce has caused a change in shipping routes, particularly since the early

1980s. This has resulted in the creation of new ports and the growth of connection networks for the international trade of commodities (Özer *et al*., 2021). During this period, the maritime sector witnessed the most significant developments (Li and DaCosta, 2013). For landlocked nations, effective and widespread maritime transport has been essential to the expansion of their international trade ties and their overall economic prosperity (Akbulaev and Bayramli, 2020). Due to these advancements, sea transportation has emerged as the main means of conducting international trade and is currently the biggest freight carrier in the world, playing a crucial role in the global economy (Mansouri *et al*., 2015; Özer *et al*., 2021; Saeed *et al*., 2021).

Recent advancements in maritime policies and technological innovations have significantly strengthened the link between maritime transport and economic growth. Research emphasizes the growing importance of digitalization and automation in ports, illustrated by the integration of smart port systems and autonomous shipping technologies, which improve operational efficiency and lower costs in international trade (Rodrigue and Notteboom, 2020; Wu *et al*., 2024). Additionally, the implementation of green shipping practices and policies aimed at reducing carbon emissions has become central to fostering sustainable growth in the maritime sector, with direct implications for economic development (Xylouris *et al*., 2024). These innovations in maritime transport are crucial for creating more competitive and sustainable international trade networks, reinforcing the connections between maritime policies, technological advancements, and economic growth. In light of these developments, maritime transport has emerged as the primary mode of international trade and is now the largest freight carrier, playing a critical role in the global economy. Considering the importance of maritime transport for international trade and economic growth, this study has decided to focus on maritime transport. Maritime transport accounts for over 70% of the value and over 80% of the physical volume of international trade (Li, 2022; United Nations Conference on Trade and Development [UNCTAD], 2023). Roads, highways, and railways play a crucial role in domestic transportation, providing alternative options for both local and international connections. However, they are not always the most practical choice for long distances and can be relatively costly. In contrast, air transport is faster, but when it comes to the long-distance transportation of physical goods, shipping is preferred due to its advantages in terms of both cost and capacity (Berrill, 1960; Saeed *et al*., 2021). Shipping is a popular option for delivering industrial raw materials, petroleum products, and containerized freight across medium and long distances since it offers superior economic efficiency in addition to its cost benefits (Huang *et al*., 2023). European Union, comprised mostly of developed countries, boasts a maritime fleet from 22 member countries, accounting for over 40% of the world fleet (Fratila *et al.*, 2021). The primary reason for developed countries to prioritize maritime transport to this extent is its role as a cornerstone of global trade (Bai *et al*., 2021). Moreover, marine transportation contributes significantly to economic growth and development in addition to its direct and indirect effects on a number of other sectors (Fratila *et al.*, 2021). Furthermore, engaging in international marine trade is essential for drawing in capital from throughout the world (Lane and Pretes, 2020). In this context, the aim of this study is to determine whether there is any causality relationship between maritime transport and economic growth in Belgium, France, Germany, Italy, the Netherlands, Spain, Türkiye, and the United Kingdom, which are among the European countries with the highest maritime transport activities.

Although there are studies examining the relationship between maritime transport and economic growth in the literature, the issue has not been examined comprehensively in the context of European countries. Moreover, some of the current studies include microeconomic analyses (Fratila *et al*., 2021). In this context, considering that a significant portion of global trade is carried out by developed countries through maritime transport (United Nations Conference on Trade and Development [UNCTAD], 2023), studies revealing the relationship between maritime transport and economic growth increase their importance.

Therefore, this study will examine the causality relationships between maritime transport and economic growth in the 8 European countries within the G-20 that have the highest maritime transport volume. The analysis covers the period from 2008: Q1 to 2020: Q2 using the bootstrap panel causality test developed by Kónya (2006). In particular, since the methodology used also takes into account cross-sectional dependence, the effects of economic and political shocks occurring in one of them on each other are not excluded. This study differs from previous research in its contemporary relevance, the selection of the group of countries studied, and the use of the analysis method, which has not been previously employed. These unique aspects of the study strengthen its potential contribution to literature.

In the following sections, literature review, data and methodology, findings and conclusions are presented respectively. The conclusion includes economic, political and theoretical implications.

2. LITERATURE REVIEW

The literature on maritime transport encompasses a wide range of research areas, including economic, environmental, logistical, and security dimensions. Among the most studied topics are the contributions of maritime transport to global trade volume and economic growth, with the critical role of sea routes in global supply chains also standing out (Notteboom *et al*., 2022). In addition, port management, logistical efficiency, and digitalization in shipping are prominent research themes in the literature (Notteboom *et al*., 2021). From an environmental perspective, issues such as air and water pollution caused by maritime transport, sustainability, and green port strategies are extensively debated (IMO, 2020). Furthermore, threats like maritime security, piracy, and smuggling are frequently discussed in the literature, focusing on security policies and preventive measures (Bueger, 2015). These studies shed light on the contributions of the maritime sector to economic growth and its role in promoting environmental sustainability.

In this part of the study, we first review the studies that examine the relationship between other transportation channels and economic growth. Then, the studies examining the relationship between maritime transport and economic growth are shown in Table 1.

Although a considerable number of studies in the literature examine the relationship between transportation and economic growth, this topic still maintains its relevance. One of the pioneering studies in investigating this relationship belongs to Fogel (1962). In Fogel's (1962) study, he attributed the rise of the United States at the end of the 19th century to railroad transportation. In subsequent periods, some researchers inspired by this study began to examine the relationships between rail transport and economic growth. Among these researchers, Badalyan *et al*. (2014), Sharipbekova and Raimbekov (2018), Khan *et al*. (2018), and Zou *et al*. (2021) have all found that rail transport leads to economic growth, while Hayaloğlu (2015) determined that economic growth positively influences rail transport. On the other hand, Apanisile and Akinlo (2013) and Otu and James (2015) obtained results that differ from previous studies, suggesting an inverse relationship between the variables. Additionally, Gherghina *et al*. (2018) identified a bidirectional causality relationship between the variables, whereas Sezer and Abasız (2017), Sun *et al*. (2018), and Özer *et al*. (2021) did not observe any causality relationship between the variables.

Several studies in the literature investigate the relationship between road transport and economic growth. Among these researchers, Uma *et al*. (2014), Badalyan *et al*. (2014), Otu and James (2015), Siyan *et al*. (2015), and Clinton *et al*. (2017) have all found that road transport contributes to economic growth. On the other hand, Beyzatlar *et al*. (2014) and Saidi and Hammami (2017) discovered evidence of a bidirectional causality relationship between the variables. However, Sun *et al*. (2018) did not find any significant relationship between road transport and economic growth. Based on the existing studies in the literature, it is apparent that there is a mutual interaction between rail/road transport and economic growth. Most study results support the idea that transport positively impacts economic growth. While a few studies suggest a slightly negative effect of road

transport on economic growth, there is also a limited number of findings indicating no relationship between both forms of transport and economic growth.

Many studies have examined the correlation between economic growth and air transport, particularly in the last several years. Most of these studies suggest that air transport contributes to economic growth (Saheed *et al*., 2015; Arvin *et al*., 2015; Baltaci *et al*., 2015, Hu *et al*., 2015; Brida *et al*., 2016a; Sezer and Abasız, 2017; Sharipbekova and Raimbekov, 2018; Khan *et al*., 2018; Gherghina *et al*., 2018; Park *et al*., 2019; Zhang and Graham, 2020; İslamoğlu, 2022; Song *et al*., 2023). A group of researchers has found that economic growth has a positive effect on air transport (Fernandes and Pacheco, 2010; Yao and Yang, 2012; Chi and Baek, 2013; Hayaloğlu, 2015; Hakim and Merkert, 2016; Brida *et al*., 2018). Chang and Chang (2009), Baker *et al*. (2015). Brida *et al*. (2016b) identified a bidirectional causality relationship between economic growth and air transport. Almost all of the past studies consistently indicate a strong relationship between air transport and economic growth. The majority of findings conclude that air transport positively supports economic growth.

Since maritime transport has an important share in international trade, many researchers have investigated the economic effects of maritime transport. The available literature on the relationship between maritime transport and economic growth is presented in Table 1.

Table 1. Maritime Transport and Economic Growth

Study	Periods	Country/Countries	Methodologies	Conclusions
Zhang *et al*. (2005)	1995-2003	The Pearl River Delta Region of China	Cobb-Douglass production function	Maritime → GRW +
Korkmaz (2012)	2004-2010	Türkiye	Regression	Maritime → GRW+
Igberi and Ogunniyi (2013)	1980-2010	Nigeria	OLS and SUR	Maritime → GRW -
Morrissey and O'Donoghue (2013)	2007	Ireland	Input-output (IO)	Maritime → GRW +
Shan *et al*. (2014)	2003-2010	China	Regression	Maritime → GRW +
Bottasso *et al*. (2014)	1998-2009	13 European countries	Spatial Autoregressive model (SAR)	Maritime → GRW +
Hayaloğlu (2015)	1994-2011	32 OECD countries	Panel data method	GRW → Maritime +
Park and Seo (2016)	2000-2013	South Korea	Augmented Solow model	Maritime → GRW +
Tunali and Akarçay (2018)	2010-2014	Türkiye	Regression	GRW → Maritime +
Gherghina *et al*. (2018)	1990-2016	EU-28 countries	Panel data method	GRW ↔ Maritime
Khan *et al*. (2018)	1990-2015	16 low & lower middle income and 24 upper middle & high income countries	Panel data method	Maritime → GRW +
Mohamad Taghvaee *et al*. (2019)	1978-2012	İran	Multaneous equations system	Maritime→ GRW +
Park *et al*. (2019)	1996-2014	17 OECD members and 17 nonmember countries	Panel two-stage least squares method	Maritime → GRW +

Table 1. Maritime Transport and Economic Growth (continued)

Bagoulla and Guillotreau (2020)	2010-2014	France	IO	Maritime → GRW +
Freire-Seoane *et al.* (2020)	2008-2015	Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Mexico, Nicaragua, Panama and Peru	Panel data method	Maritime → GRW +
Akbulaev and Bayramli (2020)	2016-2018	Russia, Azerbaijan, Turkmenistan, Kazakhstan and Iran	SWOT analysis	Maritime → GRW +
Osadume and Uzoma (2020)	1980-2019	Nigeria	ARDL and Granger Causality test	Maritime ↔ GRW
Ochei and Mamudu (2020)	1981-2019	Nigeria	Pairwise Granger Causality techniques and the error correction mechanism	Maritime → GRW -
Emeç (2021)	2013-2020	Türkiye	FMOLS method	Maritime → GRW +
Usta and Sarı (2021)	2010-2019	Türkiye	ARDL	GRW → Maritime +
Fratila *et al.* (2021)	2007-2018	20 EU countries	Panel data method	Maritime → GRW +
Özer *et al.* (2021)	1991-2016	Türkiye	ARDL bounds testing	Maritime → GRW +
Saeed *et al.* (2021)	2016	China, Singapore, Korea, Hong Kong, Malaysia, Netherlands, Germany, USA, Great Britain, and Belgium	Path analysis	Maritime ↔ GRW
Wang *et al.* (2021)	1990-2017	South Korea	VAR and VECM	Maritime→ GRW +
Yıldız (2022)	2013-2021	Türkiye	Granger causality	Maritime + ↔ GRW +
Tunali and Akarçay (2022)	1995-2019	11 OECD countries	Panel data method	Maritime → GRW +
Yurdakul (2023)	2013-2021	Türkiye	ARDL	Maritime Exp→ GRW + Maritime Imp→ GRW -
Song *et al.* (2023)	2010-2018	South Korea	Panel VECM and Granger causality	Maritime ↔ GRW
Ayesu *et a*l. (2023)	2010-2018	28 African countries	The system generalized method of moments approach	Maritime → GRW +

Maritime	Maritime Transport
GRW	Economic Growth
→	The direction of the one-way causality relationship
↔	Bidirectional causality relationship
+	Positive
-	Negative

This literature review provides a thorough analysis of studies investigating the pivotal role of maritime transport and port infrastructure on economic growth across various countries and periods. Zhang *et al*. (2005) emphasized the significant influence of container ports in the Pearl River Delta region on regional economic growth from 1990 to 2002. Similarly, Korkmaz (2012) demonstrated, through time series analysis, the positive effects of maritime transport on GDP and trade volume in Türkiye between 1980 and 2010. Conversely, Igberi and Ogunniyi (2013) identified adverse impacts of maritime transport on Nigeria's industrial sector from 1980 to 2010 using the OLS method. In line with these findings, Morrissey and O'Donoghue (2013) highlighted the strong economic linkages of Ireland's maritime sector using input-output analysis, while Shan *et al*. (2014) illustrated that Chinese ports substantially promoted trade and investment through panel data analysis.

Bottasso *et al*. (2014) explored the direct and indirect effects of port activities on regional development by employing spatial econometric methods to analyze 13 European regions between 1998 and 2009. In a similar vein, Hayaloğlu (2015) found that advancements in the logistics sector contributed positively to economic growth in OECD countries between 2000 and 2012. Park and Seo (2016) demonstrated that South Korean seaports played a crucial role in supporting regional economies from 1995 to 2012. In Türkiye's case, Tunali and Akarçay (2018) revealed a positive correlation between maritime transport and industrial production from 2005 to 2017 via time series analysis. These results are supported by Gherghina *et al*. (2018), who examined the contributions of transport infrastructure to sustainable growth in the EU-28 countries between 1990 and 2016 using fixed-effects regression analysis. Khan *et al*. (2018) adopted a different approach, analyzing the effects of air, rail, and container transport on energy demand, customs tariffs, and economic growth from 1995 to 2014, and concluded that container transport stimulated economic growth. Mohamad Taghvaee *et al*. (2019) examined the elasticities of maritime and air transport on environmental pollution and economic growth in Iran from 1978 to 2012, finding a significant relationship between maritime transport and growth. Similarly, Park *et al*. (2019) explored the effects of maritime, land, and air transport on economic growth in both OECD and non-OECD countries from 2000 to 2015, concluding that maritime transport contributed positively to growth. Bagoulla and Guillotreau (2020) focused on the environmental impacts of maritime transport on France's economy, particularly regarding air pollution, and concluded that maritime transport boosted economic growth. Freire-Seoane *et al*. (2020) identified positive impacts of container transport on economic growth in Latin America during the late 1990s and 2010s.

Akbulaev and Bayramli (2020) demonstrated the positive relationship between maritime transport and economic growth in Caspian Sea countries. Additionally, Osadume and Uzoma (2020) found bidirectional positive effects of maritime trade on economic growth in Nigeria from 1980 to 2017 through Granger causality tests. In contrast, Ochei and Mamudu (2020) concluded that maritime transport had a negative impact on Nigeria's economic growth. Emeç (2021) analyzed the factors influencing Türkiye's maritime exports during the 2010s, while Usta and Sarı (2021) examined the strong relationship between maritime trade and economic growth in Türkiye between 2000 and 2020 using the ARDL method.

Finally, Fratila *et al*. (2021) emphasized the positive effects of maritime transport on economic growth in EU countries between 2007 and 2018. Özer *et al*. (2021) and Tunali and Akarçay (2022) confirmed the positive impact of container transport on economic growth in Türkiye and OECD countries through the ARDL method. Saeed *et al*. (2021) underscored the importance of maritime connectivity for international trade, while Wang *et al*. (2021) discovered a strong causal relationship between logistics infrastructure and economic growth in South Korea. Yıldız (2022) found bidirectional causality between maritime transport and economic growth in Türkiye. Yurdakul (2023) explored the connections between maritime trade, GDP growth, and the construction sector

in Türkiye, concluding that maritime transport increased exports and reduced imports. Song *et al*. (2023) investigated the interrelationships between industrialization, urbanization, and CO2 emissions in South Korea, revealing the significant effects of maritime and air transport on economic growth. Ayesu *et al*. (2023) emphasized the contribution of port efficiency to economic growth in Africa.

This comprehensive overview clearly illustrates the critical role that maritime transport and infrastructure play in fostering economic development globally.

An examination of the investigations outlined in Table 1 discloses a substantial association between maritime transport and economic advancement across all studies. The majority of these inquiries underscore that maritime transport serves as a catalyst for economic growth. Conversely, the outcomes reported by Hayaloğlu (2015), Tunali and Akarçay (2018), and Usta and Sarı (2021) propose a reciprocal influence, indicating a positive contribution from economic growth to maritime transport. Notably, Ochei and Mamudu (2020) deviate from this trend by presenting an unconventional finding, asserting that maritime transport negatively impacts economic growth. The literature review confirms the impact of maritime transport on economic growth, as is the case with various transportation types.

This study sets itself apart from most prior research by virtue of its methodological approach, the specific cohort of countries under scrutiny, and the temporal variations considered. As a result, it is poised to make a substantial and distinctive contribution to the existing body of literature.

3. DATA AND METHODS

3.1. Data

For the study, the 2008: Q1 and 2020: Q2 periods of Belgium (BEL), France (FRA), Germany (GER), Italy (ITA), Netherlands (NLD), Spain (SPA), Türkiye (TUR), and United Kingdom (UK) is discussed in the model. In the model, economic growth (GRW-Percentage change, same period previous year) and maritime transport (MAR- gross weight of goods handled in main ports) variables are used. The time series of the MAR variable of specific nations in the sample, in particular, has been restricted, which is the reason for this period taken into account in the model. MAR (European Statistics, 2023) was accessed on the European Commission Eurostat database, while GRW was sourced from (Organization for Economic Co-operation and Development [OECD], 2023) database.

The quarterly trends of the variables for the countries in the model are presented in Figure 1 and Figure 2. The 2008 global financial crisis and the 2020 COVID-19 pandemic significantly impacted the GRW of countries such as BEL, FRA, GER, ITA, NLD, SPA, TUR, and UK. After the 2008 crisis, countries like Germany and the NLD demonstrated strong recovery, while ITA and SPA showed weaker performance. TUR recorded high growth rates in the early 2010s but was adversely affected by the 2018 economic crisis and the pandemic. In 2020, due to the pandemic, all countries experienced sharp declines in their growth rates. Particularly, growth recovery in ITA and SPA remained weak, whereas GER and the NLD exhibited more stable growth.

When examining the MAR data of the countries in the Figure 2, it is evident that the NLD leads significantly, with the highest trade volume in its ports. TUR has shown a steady increase since 2008, demonstrating consistent growth in port activities. GER maintains a stable and high MAR level, preserving its strength in maritime trade. FRA and SPA follow relatively flat trends, while ITA and the UK display more volatility, with the UK experiencing a sharp decline in recent years. BEL stands out as the country with the lowest MAR levels.

Table 2 provides descriptive statistics for the variables of the various countries. The data shown in Table 2 indicates that NLD has the highest per capita income (MAR), whereas BEL has the lowest. In terms of national income, the TUR has the greatest rate of GRW, while the ITA has the lowest rate. Additionally, it is seen that most of the variables do non-normal distribution. Therefore, it is important to use analyzes that take into account non-normal distribution.

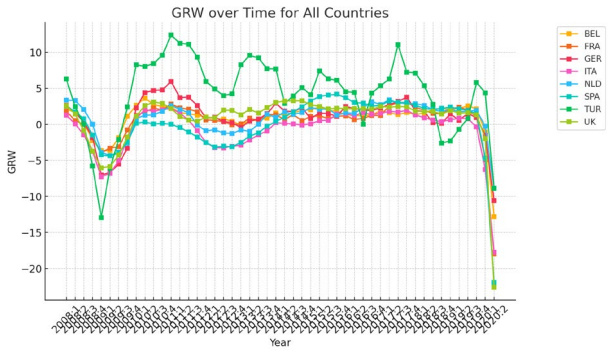

Figure 1. The trend of the GRW variable

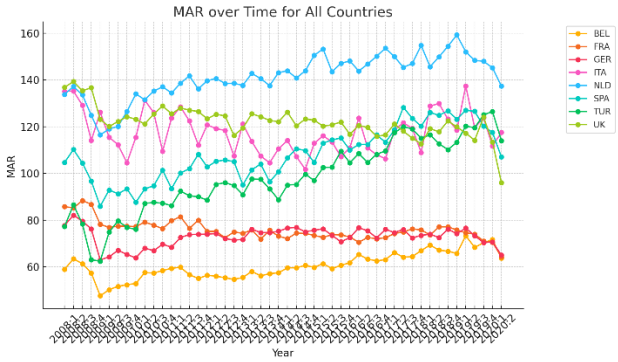

Figure 2. The trend of the MAR variable

Table 2. Descriptive Statistics

Variables	Mean	Median	Max.	Min.	Std. Dev.	Jarque-Bera	J-B Prob.
MAR_BEL	60.455	59.709	73.351	47.613	5.582	0.351	0.838
MAR_FRA	75.756	75.054	88.392	64.278	4.315	13.345	0.001
MAR_GER	72.893	73.876	82.140	63.002	4.124	3.567	0.168
MAR_ITA	17.504	116.790	137.414	101.780	8.791	2.019	0.364
MAR_NLD	141.214	142.242	159.216	116.473	9.302	4.066	0.130
MAR_SPA	108.105	106.834	128.246	85.952	11.344	1.636	0.441
MAR_TUR	98.110	96.494	126.452	62.472	15.675	0.986	0.610
MAR_UK	122.043	122.159	139.295	96.001	6.855	28.784	0.001
Variables	**Mean**	**Median**	**Max.**	**Min.**	**Std. Dev.**	**Jarque-Bera**	**J-B Prob.**
GRW_BEL	0.905	1.519	3.616	-12.816	2.456	794.326	0.001
GRW_FRA	0.473	1.184	3.049	-17.976	3.147	1161.664	0.001
GRW_GER	0.956	1.530	5.944	-10.573	3.050	59.069	0.001
GRW_ITA	-0.755	0.435	2.214	-17.729	3.420	292.587	0.001
GRW_NLD	0.858	1.632	3.402	-8.8534	2.348	75.663	0.001
GRW_SPA	0.080	0.877	4.168	-21.937	4.051	587.583	0.001
GRW_TUR	4.302	5.236	12.378	-12.933	5.235	16.674	0.001
GRW_UK	0.761	1.916	3.260	-22.627	4.007	1128.161	0.001

3.2. Method

In this study, causality relationships between variables are investigated with the Panel Bootstrap Causality test developed by Kónya (2006). This causality test has advantages over many panel causality tests. Firstly, it does not matter whether there is a cointegration relationship between the variables or not. Secondly, the stationarity levels of the variables are not important and there is no need to investigate stationarity before the test. However, there are two fundamantal conditions to perform the test. The first of these is that there must be cross-sectional dependence in the models and the coefficients of the models must be heterogeneous.

The examination of cross-sectional dependence in this study relies on the application of several widely employed tests, including the Breusch-Pagan Lagrange Multiplier (BP_{LM}) test devised by Breusch and Pagan (1980), the Pesaran Cross-Sectional Dependence (CD_{LM}) test introduced by Pesaran (2004), the Lagrange Multiplier adjusted (LM_{adj}) test developed by Pesaran *et al*. (2008), and the Baltagi Cross-sectional Dependence (LM_{BC}) tests developed by Baltagi *et al*. (2012). Additionally, the determination of coefficient homogeneity/heterogeneity is facilitated through the utilization of the $\tilde{\Delta}$ and $\tilde{\Delta}_{adj}$ test statistics proposed by Pesaran and Yamagata (2008).

Kónya (2006) developed a causality test grounded in the Seemingly Unrelated Regression (SUR) estimator, as initially proposed by Zellner (1962). This test posits its superiority over the Ordinary Least Squares (OLS) estimate. Notably, the SUR system is constructed based on Sim's (1980) Vector Autoregressive (VAR) methodology. In the context of the study, the SUR system is applied to model the interrelationships among the variables (Kónya, 2006).

Model 1 is used to test the causality relationship from GRW to MAR, from MAR to GRW in Model 2.

N represents the number of countries (i=1, 2, 3, ..., 8) expressed in the equations, and t represents the time interval (t=2008: Q1,....., 2020:Q2). Also, *ml* represents the lag length and $\xi_{1,1,t}$, $\xi_{1,2,t}$,..., $\xi_{1,N,t}$, $\xi_{2,1,t}$, $\xi_{2,2,t}$,..., $\xi_{2,N,t}$, $\xi_{3,1,t}$, $\xi_{3,2,t}$,..., $\xi_{3,N,t}$... are the error terms which are supposed to be white noises.

Kónya's (2006) panel bootstrap causality test, Wald test statistics are computed using the VAR equations established for each country within the Seemingly Unrelated Regression (SUR) system mentioned earlier. Critical values for the bootstrap approach are determined individually for each country. Thus, the problem of non-normal distribution will be prevented. The assessment of hypotheses involves comparing the generated Wald test statistics with the bootstrap critical values. The identification of causality relationships between the variables is achieved by imposing constraints on the coefficients, as outlined below. If not all $\beta_{1,N,l}s$ are zero, but all $\alpha_{2,N,l}s$ are zero; there is unidirectional Granger causality from GRW to MAR. If not all $\alpha_{2,N,l}s$ are zero, but all $\beta_{1,N,l}s$ are zero; there is unidirectional Granger causality from MAR to GRW (Kónya, 2006).

4. FINDINGS

Table 3 presents the outcomes of the cross-sectional dependence and homogeneity test, a prerequisite for the panel bootstrap causality test. Table 3 presents the outcomes of the cross-section dependency test, a crucial prerequisite for initiating the bootstrap panel causality analysis. The condition tested is denoted as "H_0: the model contains no cross-section dependence." Rejecting the null hypothesis (H_0) is warranted as the probability values associated with the test statistics, as shown in the table, fall below the predetermined levels of statistical significance. Consequently, it is established that cross-section dependence is present in both Model 1 and Model 2. The existence of cross-sectional dependence shows that a shock occurring in any of the countries may also have an impact on the other (Breusch and Pagan, 1980; Pesaran, 2004; Pesaran *et al*.,2008; Baltagi *et al*., 2012).

Homogeneity test results also show that there is heterogeneity in the models. This finding shows that the coefficients and causality relationships to be obtained will vary from country to country. Consequently, based on the findings presented in Table 3, there are no impediments to conducting the panel bootstrap causality test.

The causality results between MAR and GRW are presented in Table 4.

Our findings when we apply the Kónya (2006) causality test to our data differ by country and model. There is a causality relationship from economic growth to maritime transport in all countries except Italy and the Netherlands. Studies such as Gherghina *et al*. (2018), Saeed *et al*. (2021) and Yıldız (2022) also found causality relationships from economic growth to maritime transport. This finding is due to the fact that maritime transport is the most preferred mode of transportation used in international trade and is cheaper than other modes of transportation. Most developed countries attach great importance to maritime transport.

$$\left.\begin{aligned} MAR_{1,t} &= \varphi_{1,1} + \sum_{l=1}^{ml\_MAR_1} \alpha_{1,1,l} MAR_{1,t-1} + \sum_{l=1}^{ml\_GRW_1} \beta_{1,1,l} GRW_{1,t-1} + \xi_{1,1,t} \\ MAR_{2,t} &= \varphi_{1,2} + \sum_{l=1}^{ml\_MAR_1} \alpha_{1,2,l} MAR_{2,t-1} + \sum_{l=1}^{ml\_GRW_1} \beta_{1,2,l} GRW_{2,t-1} + \xi_{1,2,t} \\ &\vdots \\ MAR_{N,t} &= \varphi_{1,N} + \sum_{l=1}^{ml\_MAR_1} \alpha_{1,N,l} MAR_{N,t-1} + \sum_{l=1}^{ml\_GRW_1} \beta_{1,N,l} GRW_{N,t-1} + \xi_{1,N,t} \end{aligned}\right\} (1)$$

$$\left.\begin{aligned} GRW_{1,t} &= \varphi_{2,1} + \sum_{l=1}^{ml\_GRW_2} \beta_{2,1,l} GRW_{1,t-1} + \sum_{l=1}^{ml\_MAR_2} \alpha_{2,1,l} MAR_{1,t-1} + \xi_{2,1,t} \\ GRW_{2,t} &= \varphi_{2,2} + \sum_{l=1}^{ml\_GRW_2} \beta_{2,2,l} GRW_{2,t-1} + \sum_{l=1}^{ml\_MAR_2} \alpha_{2,2,l} MAR_{2,t-1} + \xi_{2,2,t} \\ &\vdots \\ GRW_{N,t} &= \varphi_{2,N} + \sum_{l=1}^{ml\_GRW_2} \beta_{2,N,l} GRW_{N,t-1} + \sum_{l=1}^{ml\_MAR_2} \alpha_{2,N,l} MAR_{N,t-1} + \xi_{2,N,t} \end{aligned}\right\} (2)$$

Table 3. Cross-Section Dependence Test and Slope Homogeneity Test Results

Tests	Cross-section dependence				Slope homogeneity	
Models	BP_{LM}	CD_{LM}	LM_{BC}	LM_{adj}	$\tilde{\Delta}$	$\tilde{\Delta}_{adj}$
Model 1	389.74* (0.001)	6.15* (0.001)	48.25* (0.001)	-48.33 (0.001)	2.52* (0.012)	3.19* (0.001)
Model 2	948.78* (0.001)	30.35* (0.001)	122.96* (0.001)	123.04* (0.001)	2.45* (0.014)	3.10* (0.002)

*, ** indicates cross-sectional dependence and heterogeneity at 1 and 5 percent statistical significance levels.

The absence of causality between GRW and MAR in ITA and NLD may be due to differences in economic structures and trade policies. In NLD, MAR levels are more influenced by global trade flows, making port activities independent of domestic economic growth. In ITA, economic growth relies more on internal factors such as industrial production and services, weakening the direct link to port activities. Additionally, differences in trade policies, infrastructure, and port capacity utilization may also contribute to this outcome.

There is a significant causality relationship from maritime transport to economic growth in Türkiye and the UK. As confirmed by most of the studies in Table 1, there are causality relationships from maritime transport to economic growth in most of the studies. However, it is an important finding of this study that these relationships were not detected in other countries. Moreover, it should be noted that there is a bidirectional causality relationship between maritime transport and economic growth for Türkiye and the UK. Again, Gherghina *et al*. (2018), Saeed *et al*. (2021) and Yıldız (2022) show that there will be significant bidirectional relationships between these variables.

Table 4. Kónya (2006) Causality Test Findings

H_0: GRW is not the Granger causality of MAR (Model 1)				
Countries	**Test Statistics**	**Critical Values**		
	Wald	**10%**	**5%**	**1%**
BEL	30.549*	3.598	5.431	10.348
FRA	27.703*	3.608	5.139	8.817
GER	4.542**	3.813	5.654	10.711
ITA	0.183	3.469	4.900	8.504
NLD	1.034	3.789	5.430	9.915
SPA	4.102**	3.521	5.013	9.507
TUR	6.258**	3.786	5.596	10.403
UK	22.373*	3.550	5.341	10.093
H_0: MAR is not the Granger causality of GRW (Model 2)				
Countries		**Test Statistics**	**Critical Values**	
	Wald	**10%**	**5%**	**1%**
BEL	2.025	3.712	5.306	10.037
FRA	3.127	3.828	5.525	9.628
GER	1.316	3.694	5.387	10.417
ITA	0.536	3.621	5.112	9.002
NLD	0.460	3.699	5.282	10.097
SPA	0.596	3.470	4.896	8.602
TUR	3.964**	3.902	5.824	10.470
UK	5.229*	3.723	5.314	9.431

*, **, and ***indicate rejection of the null hypothesis at the 1, 5, and 10 percent levels of significance.

5. DISCUSSION AND CONCLUSIONS

This study explores the causality relationships between maritime transport and economic growth variables among the European countries with the highest maritime transport activity, namely Belgium, France, Germany, Italy, the Netherlands, Spain, Türkiye, and the United Kingdom. The data utilized for this investigation spans from the first quarter of 2008 to the second quarter of 2020. The findings from the analysis can be summarized as follows:

- There is cross-sectional dependence in the models used. Shocks experienced in countries have the possibility of affecting other countries. This is an expected finding in a globalizing world and for countries with similar geography.
- The coefficients of the models are heterogeneous. This means that causality findings vary across countries. The specific characteristics of each country have led to this finding.
- Causality findings vary from country to country and are as follows:
  - There are causality relationships from economic growth to maritime transport in all countries except Italy and the Netherlands.
  - There are significant causality relationships from maritime transport to economic growth in Türkiye and the UK.
  - There are bidirectional causal relationships between variables in Türkiye and the UK.

These findings show that a shock that may occur in any of the countries in the relationship between maritime transport and economic growth may have an impact on other countries. Although a shock in one country may affect the others, the relationship between the variables

differs from country to country. The countries included in our research subject have different economic characteristics and strengths. In addition, issues such as the importance these countries attach to maritime transport and the production of goods that will be subject to international trade affect the relations between these variables. The fact that developed countries attach importance to maritime transport shows that it is important in increasing the economic development levels of coastal countries.

The COVID-19 pandemic caused significant disruptions and logistical crises in maritime transport. During the pandemic, port closures, labor shortages, and supply chain interruptions led to major delays and increased costs across all maritime activities, especially container shipping. Container imbalances due to fluctuations in supply and demand throughout the pandemic adversely affected global trade flows. Disruptions in the transportation of essential goods were particularly pronounced, and in some regions, commercial activities nearly halted due to declines in trade and production (Notteboom *et al*., 2021). Furthermore, this external shock affected all stages of the supply chain simultaneously, resulting in a significant economic contraction and breakdown in supply chains. However, it was observed that the impacts of the pandemic were relatively temporary, with the sector showing signs of recovery as demand returned (World Bank, 2020; UNCTAD, 2020).

The findings of this study indicate that the strong relationship between maritime transport and economic growth necessitates a focus on sustainability and green maritime technologies in future maritime policies. Global crises, particularly the 2008 financial crisis and the COVID-19 pandemic, have highlighted the critical role of maritime transport in driving economic growth. This underscores the need to make maritime transport infrastructure more resilient and environmentally friendly. Green ports, low-carbon maritime technologies, and innovations that enhance energy efficiency are crucial for supporting economic growth while reducing environmental impacts. Furthermore, the integration of technological developments such as digitalization and automation into maritime transport will enable the creation of a more sustainable and efficient supply chain. In conclusion, restructuring maritime transport within the framework of sustainability principles will contribute to the simultaneous achievement of future economic growth and environmental goals.

The study has some limitations. Due to the lack of data, data up to the 2nd quarter of 2020 were used at most. When the data are available, the analysis can be extended for a longer period. The relationships between these variables can also be investigated using different techniques.

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Şerif CANBAY: Conceptualization, Methodology, Validation, Formal Analysis, Resources, Writing - Original Draft, Writing-Review and Editing, Data Curation, Software, Supervision. **Mustafa KIRCA:** Conceptualization, Methodology, Validation, Formal Analysis, Resources, Writing - Original Draft, Writing-Review and Editing, Data Curation, Software.

CONFLICT OF INTERESTS

The authors declare that for this article they have no actual, potential or perceived conflict of interests.

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