

Article

Volatile Freight Rates in Maritime Container Industry in Times of Crises

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Abstract: In recent years, the stability of supply chains has been undermined due to many disruptions. Although it is normal for the disruptions in supply chains to occur periodically, they have great impact on the rise of the costs and they create strong imbalances in business. For years, most world trade has been performed by maritime transport due its cost-effectiveness. The COVID-19 pandemic has disrupted the global supply chain like nothing before, and the Russian invasion of Ukraine has only deepened the crisis that is affecting the global supply chain. The focus of this paper has been placed on volatile freight rates in the maritime container industry due to the COVID-19 pandemic and the Russian invasion of Ukraine and the consequences of these crises on the changes of the prices of consumer goods in the European Union.

Keywords: supply chain; volatile freight rates; maritime container industry; crises



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1. Introduction

Supply chain is a very complex system, with the most important goal of connecting all the operations within the company, i.e., linking the production, transport, channeling and delivery [1]. Various pressures over the recent years have been strongly disrupting the stability of the supply chains. Disruptions in supply chains occur periodically and are always characterized by the rise of costs, i.e., strong business disruptions [2].

Maritime transport represents the most prominent transport mode on a global scale, and it is crucial for successful world trade. Around 90% of world trade is performed via oceans and seas [3], which is the best indicator of what consequences an increase in freight rates in maritime container shipping can have on many economies. Maritime industry has always played a key role in driving prosperity [4]. Transport can have considerable impact on international trade, and the transportation cost is the variable that determines whether or not trading will happen and to what extent. Transportation costs should be considered from a broader perspective, i.e., they are “the aggregate cost of all freight, insurance and other charges” [5,6]. Limão and Venables in [7] give an approximation of the increase in cost to trade volume ratio, a 10% increase in transport costs reduces trade volume by 20%. Hummels in [8] explains costs by relating language, distance and adjacency to trade barriers, preferences and production composition. The author also provides a potential method for separating the three alternatives, paying attention to functional form and level of aggregation.

We are currently witnessing the largest increase in container freight rates in decades as a result of the COVID-19 pandemic and the Russian invasion of Ukraine. The inflation occurring in many countries is unprecedented. Variable transport rates have huge impact on consumer goods prices. Therefore, it is necessary to present reasons for volatile container freight rates and look for solutions that can help stop the freight rates from going mad and the prices of consumer goods to remain at a reasonable threshold.

Besides the obvious efficiency, maritime transport is also cost-effective, which is its key characteristic that has enabled this transport mode to occupy the central role in global trading [9]. Social and economic consequences of the COVID-19 pandemic have spread globally almost as quickly as the virus itself [10]. The pandemic has caused rises in freight rates in the maritime container industry that have never been recorded before. This unprecedented rise in freight rates we have been witnessing for over two years now has been additionally intensified by the closing of the Suez Canal in March 2021 [11] and the Russian invasion of Ukraine [12,13]. It is expected that the Russian invasion of Ukraine will have the biggest impact on the maritime market, first and foremost in the form of the higher transportation prices [12]. Generally, because of the effects of the above-mentioned events, the recovery of the global economy will be undermined due to the rapid rise of the freight rates in the maritime container industry [14]. The increase in freight rates has already been influencing the prices of the products that arrive to their final consumer market via the containers shipped along the maritime routes, and it is not very likely that this impact will soften in the near future.

The focus of this paper, in line with the above-mentioned facts, is the volatile freight rates in maritime container industry in times of crises: the COVID-19 pandemic and the Russian invasion of Ukraine. Furthermore, the paper will analyze the impact of the volatile freight rates in maritime container industry on the prices of consumer goods in the European Union. Current scientific papers do not address the topic of the impact of crises on volatile freight rates in the maritime container industry and their overall impact on the changes of the prices of consumer goods in the European Union. This paper combines all previous research with particular focus on volatile freight rates in the maritime container industry in times of crises, with special reference to the changes of the New ConTex index and the EU consumer price index in order to determine the impact of freight rate volatility on the prices of consumer goods. Furthermore, the values of the global maritime container freight index have been presented with the aim of comparing the freight rates on the global container market and the European container market.

The introduction is followed by the literature review that explores the maritime container market in the pandemic times and the Russian invasion of Ukraine. The third section concentrates on the impact the crises have on the maritime container industry, and the analysis of the maritime freight rates. Concluding remarks are presented in the fourth section.

2. Literature Review on the Maritime Container Industry in the Times of the Pandemic and the Russian Invasion on Ukraine

2.1. Methodology

To provide clear insight into the maritime container industry in the times of the COVID-19 pandemic and the Russian invasion of Ukraine, the authors have made a detailed literature overview. Crisis impact on the maritime container industry and container transport prices volatility have been in the focus of this paper and research. To present how each crisis affects the maritime container industry and its price volatility, we divided literature overview into three sections. First section addresses problems in the maritime container industry during the COVID-19 pandemic. The effects of the COVID-19 pandemic on the maritime container market have been elaborated. Special attention is placed on the research related to oscillations in demand for maritime container shipping and congestions in ports, together with delivery delays and, finally, increase in operational costs.

Second section is related to the research on the problems arising in the maritime container industry during the Russian invasion of Ukraine and how this crisis impacts port operations, navigation through the Black Sea and the Sea of Azov and problems related to the workforce, since global maritime workforce depends greatly on Russian and Ukrainian workers.

Third section is related to the importance of maritime transport in global transportation activities. The focus is on resilience of the maritime container industry to previous and

current crises and on the present most related and newest strategies and guidelines as tools for overcoming crises more quickly. Freight rates on the maritime container market in times of crises have been specially elaborated.

This paper is based on the available data from the scientific and academic papers and the publications by the International Maritime Organization, the European Union and the United Nations.

2.2. Overview of the Literature on the Maritime Container Industry during the Pandemic

This section discusses the cause and effect of the pandemic on the container transport industry that have been presented in previous research. For this purpose, the most recent scientific papers and other publications have been considered. The basic changes in society, which have been causing disruptions in maritime transport profit, have been presented. Remedial measures that have been implemented by companies in order to be resilient to a possible new crisis situation are indicated hereafter.

Over the last decade, the maritime industry has been working towards the goal of providing global economies with undisrupted supply chains and enabling their continuous delivery of goods on time to their manufacturers and final consumers [8]. Regarding the importance of maritime transport and its complexities, any disruption in the maritime transport will definitely have an impact on global trade and its progress [4]. The COVID-19 pandemic has, in spite of the high quality supply chains, caused considerable disruptions on the maritime transport market. Those disruptions have been even more intensified due to the fact that, over the last decade, the production of durable goods has become more fragmented and more dependent on the stability of the global supply chain. The rise in demand for durable goods put against the disruptions caused by the pandemic has reflected the vulnerabilities of the current production of this type of goods [2]. The pandemic and the measures for its containment have considerably affected the operations at ports and container terminals. First, there have been congestions in ports, then delivery delays, increase in operational costs, which will eventually influence the rise of the prices of consumer goods [15]. The imbalance on the maritime container market is a common phenomenon occurring when there are oscillations in demand, while the supply remains relatively stable [16]. However, it is said that port and transport networks were not prepared for the rapid transition of demand that has occurred in this pandemic [17]. Namely, in September, October and November of 2020, most ports reported record turnovers, but in the months previous to these spikes, they had been facing huge drops in demand.

The disruptions caused by the COVID-19 virus can have a considerably stronger effect than the disruptions companies have been facing so far. The results of the research suggest that it is an unprecedented situation the world has not yet faced [2,18] and it cannot be compared to any of the crisis events in history. Unlike previous crises that were caused by excessive debt and the insolvency of the financial institutions, this crisis is one of a kind because it is caused by a virus, i.e., the external shock than has nothing to do with the actions performed from inside the economy [19]. Although today most companies follow the practice of continuous development of risk management systems and striving to develop an adequate level of resilience to the changes in their environment [20], nobody could have foreseen the disruptions to the market caused by the COVID-19 virus [21,22] that was declared a pandemic disease on 11 March 2020 [23].

Working from home and online shopping have placed challenging demands in front of global supply chains [14]. Since most market players were not prepared for such volatile demand, the supply chains faced a lack of transshipment mechanization, drivers and workers at maritime ports. This was followed by port congestions and the time for the ships' rotation was considerably prolonged. This pandemic has shown how vulnerable the supply chains really are. Many companies in Europe and the United States have focused on localization, 3D prints, moving the production sites closer to home and establishing better connections with the supply chains [18]. At the end of 2020, there was a quick recovery in demand for maritime container shipping, but the supply was limited, and the costs

increased. This resulted in disruptions in reliability and questioning the effectiveness of the functioning of the value chains [13].

The resilience and adaptiveness of the entire world economy and the maritime industry have been tested by certain economic shocks. With the aim of establishing the differences between the implications of the COVID-19 pandemic and the implications of the major shocks of similar scale and the assessment of resilience on the maritime market [24], conducted a piece of primary and secondary research. The external shock caused by the COVID-19 pandemic rapidly influenced all the elements of the supply chain almost simultaneously. Resilience to disruptions remains the key challenge for the global maritime industry. Every crisis the industry faces has to be seen as the event that enables the testing of the adjustability to the fast-changing environment. The COVID-19 pandemic has proven the extraordinary power of negotiation exerted by the shipping companies, which reflected in the growth of the freight rates in maritime container industry and also in the positive financial result [24]. In Europe, the costs of maritime transport tripled after the lockdown was relieved. However, it is important to note that this time, the possibility of reintroducing lower prices to facilitate the quick recovery of the national and global trade is not an option [25]. Cariou and Notteboom analyzed the effects of the pandemic on the import container shipping routes and on the example of the port system in the United States [26]. During the research, the authors observed more than half a million of shipments by Nike and Walmart sent via container ships to the ports in the USA. The ability of adjusting the supply chain to the strong disruption was determined by the choice of the location for the production facilities, the transport company and the capillarity of the distribution network via the port system [26].

Indisputably, the pandemic has seriously affected the stability of the operations in the supply chain and disrupted the maritime container industry [26], and it has also revealed all the vulnerabilities of the supply chain [27]. Although the maritime industry has been facing considerable challenges in the last two years, it is reasonable to expect that the recovery from those challenges will enable the establishment of and transfer to a more resilient system [27]. In 2021, the share of container ships in the entire world fleet was 13.20%, which places them third in the entire fleet. In relation to 2020 (observed in DWT), there was growth of 2.48%, despite the market turmoil. Shipping companies recognized the need for the increase in supply capacities, and thus for the purpose of the possibility of satisfying more demand for container transport in the future as well, at the beginning of 2021, they ordered new container ships. These new orders for container ships are the largest in the last two decades [28]. The size of container ships has been growing over the recent decades to staggering dimensions. It is important to note that the size of container ships increased by 10.9% in the period between 2014–2020. Container ships are now built to be as big as oil tankers and even bigger than dry bulk and cruise ships. The problem arises concerning the size of the channels and ports these vessels have to navigate, which is probably why, for now, the container ship sizes have reached their peak [29]. However, there remains the question of the spike in orders, partly occurring because of the need for the obligatory use of fuels with lower sulfur levels. The decision about the fleet regeneration must not be made lightly and many factors need to be considered because they are different for each company operating in the market [30].

Nwokedi et al. [27] point out that the COVID-19 pandemic has also caused disruptions in container industry in the last-mile delivery, i.e., in the last step of distribution to the final consumer. Bigger disruptions have occurred in the processes between the maritime ports and the markets in the hinterland. Those who deliver recovery decisions need to consider the inflationary impact as the consequence of the rising costs of transport, especially in the last-mile delivery [29,31]. Mańkowska et al. [32] conducted research with the aim of identifying the source and types of disruptions in different supply chains on the maritime market that have occurred during the COVID-19 pandemic. The goal was to determine what impact they had on the operations of different types of terminals in maritime ports, i.e., different types of freight. Some maritime lines were extinguished, while others were facing

the problem of much less freight and more transshipment bulk in relation to pre-pandemic times. Operators on the terminals are fighting the current situation by applying new proactive (offensive) and adaptive (defensive) measures. A company that has been working on entering new maritime supply chains and eventually participating in establishing new maritime supply chains has been dealing with the existing challenges proactively. On the other hand, the implementation of measures as a necessary response to the changes that have occurred in the existing maritime supply chains relate to the adaptive, i.e., defensive measures. It appears that the decision on the measures that each individual participant in the supply chain opts for depends first and foremost on their function in the supply chain [26]. Russel, Rumasook and Roso [33] state that, to be able to adequately respond to the disruptions in the supply chain, it is important to introduce the flexibility of the capacities in maritime ports. The flexibility of the capacities seems to be the ideal response to the disruptions in the supply chain. To ensure sufficient flexibility, it is necessary to direct the attention towards the static and adjustable components of the capacities in maritime ports. Flexibility in the static components is based on the mechanisms of expansion, while the flexibility of the adjustable components lies in the adjustable mechanisms for improving the use of the existing capacities [27].

As a rule, the costs related to maritime transport are higher for smaller economies. This is mainly because of the poor connection with the maritime routes, the lack of port infrastructure and inadequate measures undertaken to support the trade. Smaller countries can find the solution to ensure lower costs in upgrading the existing ports and strengthening the connections with the ports' hinterland to enlarge their capacities and therein enable faster and better delivery service [13]. To recover from the pandemic, companies must integrate short-term strategies (crisis teams, 3PL operators, transport costs structuring, transport management, outsourcing, cooperation with the suppliers or flexible contracts) and long-term strategies of risk management (cooperation in the supply chain, intelligent transport systems, 4.0 industry, supplier management, digital supply network) with flexible and innovative use of the resources at hand. This would enable better protection of the supply chain from future disruptions. Challenging times, such as the pandemic and the restrictive measures (quarantines, social distancing, travelling restrictions) that most governments around the world introduced to prevent the spreading of the virus, made the challenges even greater for the companies on this market. They have been facing problems with workers and, therefore, implemented human resource management strategy, and due to the rise of the oil prices, they have been directing their efforts towards finding alternative energy sources [34].

2.3. Overview of the Literature on the Maritime Container Market during the Russian Invasion

This section presents the effects of the Russian invasion of Ukraine in the context of the Black Sea ports in the first half of 2022. The conflict in Europe has caused an increase in oil prices, and the imposed sanctions have changed the port handling of selected ships or cargo in selected ports.

Navigating the Black Sea during the invasion represents a great challenge [3]. One should not ignore the fact that the maritime industry in Ukraine has been under immense pressure ever since 2014, i.e., since Russia appropriated Crimea [35]. The pressure peaked in 2022, more precisely on 24 February 2022, when Russia invaded Ukraine [36]. The navigation around Crimea has been difficult for years due to Russian efforts to disrupt access to this area [37]. Goods flow at sea has been almost disabled because the navigation through the Black Sea and the Sea of Azov has been blocked and many Ukrainian ports are under Russian command [35]. Before the invasion of Ukraine started, the strategies for returning under Ukrainian influence on the area of the Black Sea had been as follows [36]:

1. Recognize the rights belonging to Ukraine in its territorial waters, i.e., the zone within 12 nautical miles off the Russian coast.
2. Establish the balance of forces in coastal waters closer to the Ukrainian coast, which Ukraine can legally claim regardless of the status of Crimea.

3. Strive to maintain strong presence in those waters claimed by Russia after the Crimea annexation.

The Russian invasion of Ukraine has rapidly caused disruptions in the entire global transport due to delivery delays in some parts of the supply chain, port congestions and problems with the work force. Because of the invasion, the maritime market has been affected by problems, such as loss of work force and vessels in the Black Sea area, disruptions in trading with Russia due to the sanctions most world countries imposed on Russia and the volatile fuel prices. The biggest problem is the workforce, since Russian workers make up 10% of the global maritime workforce and the share of Ukrainian workers is 4% [3]. Furthermore, there is a problem with the rest of the workforce on the maritime market, since at some parts, the possibility to access or disembark ships has been limited, and numerous flights have been cancelled, obstructing the movement of the people working on ships and for shipping companies [38]. Many shipping companies whose vessels have navigated these waters, with the aim of preserving stable relations with the clients, have, as the Ukrainian ports were closing, implemented the following steps [39]:

1. Changed the course (the destination port) with no port charges or with minimum costs of relocation;
2. Completely erased the charges for cancelling the reservations in Ukrainian ports;
3. Defined special conditions for demurrage fees and storing the unloaded containers in alternative ports;
4. Special conditions for storing the unloaded containers.

This invasion has put challenges in front of the insurance industry, too. There is a rising number of claims based on the policies that contain the war clause. Moreover, the insurance companies need to deal with the claims for the blocked shipments in the Ukrainian waters [3]. It is highly unlikely that the situation will improve soon and the fear of floating mines further postpones the beginning of navigation even in those areas that are declared relatively safe [34]. Because they fear for their employees' safety and because the insurance fees for sending ships to Ukraine or Russia have skyrocketed, the shippers are choosing to avoid these territories even if their safety is guaranteed [38].

3. Maritime Container Market and the Freight Rates in Times of Crises

This section outlines the importance of maritime transport for the normal functioning of the economy and supply chains. It shows how, in previous crises, companies with great handling capacities dealt with the resource challenge of large container ships. The impact of the pandemic and the war in Ukraine on trade and longer trade routes was compared, which should lead to an optimization of resource use.

Life and economy on global scale would not be the same without the activities performed via seas and oceans, which is best supported by the challenging events over the last two years that have undermined the stability of the maritime trade [16]. Maritime transport plays an important role in global transportation activities, and its key segment is container traffic. Logistically, as with all other economy sectors, they have experienced unseen challenges in these critical times. First and foremost, when talking about the COVID-19 pandemic, it is necessary to highlight four significant differences between this crisis and the previous crises the world had faced [22]:

1. Pre-existing unfavorable conditions. The scope of trade has been growing at considerably lower rates than in the period before the crisis of 2008.
2. This crisis is global and has been affecting almost every world economy. Earlier crises were more regional.
3. The worst effects of the crisis that had begun in the middle of 2008, followed months after it had started, while the crisis of 2020 immediately shook the global market.
4. The effects of the pandemic caused by the coronavirus represent the greatest drop in international trade since World War II.

If the growth rates of the world trade after the financial crisis of 2008 and 2009 are observed, it is evident that the global market has not yet recovered from it. The average growth rate in the period from 2012 to 2019 was 2.3%, while it went up to 6.2% in the period from 1990 to 2012 [39,40]. Although it can be said that during the second half of 2020 and during 2021, world trade was on the path to recovery, it is obvious that the supply was less flexible and limited by delays and congestions occurring due to the COVID-19 pandemic, which prompted the increase in the freight rates on the maritime container market [12]. During the first quarter of 2022, the value of the total global trade grew to a record USD 7.7 trillion, which is an increase of USD 1 trillion in relation to the first quarter of 2021. However, it is expected that the growth rate will slow down due to slower economic growth as a consequence of the rising interest rates, inflationary pressures and concerns regarding the debt viability in many world economies that have arisen due to the Russian invasion of Ukraine [41].

3.1. Impact of the Crises on the Maritime Container Market

Maritime container industry is the key component of the process of globalization [42] and also an important factor in sustainable economic development [43]. The ability of the maritime container industry to transfer large quantities of goods from the point of production to the point of final consumption is the ability that supports the contemporary way of living. The importance of this type of transport is also evident in the fact that, in the European Union, maritime transport makes for 80% of total import and export (observed in volume), i.e., 50% if observed in the value of goods [9]. Maritime container industry represents the capitally intense industry where assets are either owned or rented. Therefore, adequate management of the maritime container fleet is crucial for the operational and commercial success of the maritime container ship lines [25]. Experience teaches us that maritime traffic is extremely sensitive to external factors, such as international trade, political situations, financial trends, technology development and changes of regulatory frameworks, that can directly or indirectly affect the demand on this market. Following to that, it is expected that the companies operating in this market will direct their attention towards the development of crisis management to increase the resilience to external pressures and respond more adequately to new crises [44]. In the recent years, global supply chains in maritime ports are characterized by increased uncertainties caused by a series of elements, such as the socio-economic factors, but also the change of the strategies by the supply chain management, all as a response to the changes in the environment. Although these factors had influenced the supply chains before, the COVID-19 pandemic has made their impact literally explode [33]. Earlier crises and the pandemic caused by the coronavirus have confirmed the resilience of demand for basic goods, especially food and medical products [45].

The comparison of the currently recorded effects of the COVID-19 pandemic with those from the crisis of 2008 and 2009 point to idiosyncratic implications of each crisis on the supply chains on the maritime market. However, during all of the time of the pandemic, the shipping companies, operators at the terminals and ports show greater resilience than during the earlier crisis. This is probably the result of the measures implemented within the companies and better risk management [24]. The global economic crisis of 2008 resulted in the collapse of production and international trade. The recession that spread globally reflected in a huge drop of demand for transport in general, and thus the maritime market was engulfed in the crisis as well. Earlier crises on the maritime container market have shown how companies faced [43]:

1. Overcapacity of the cargo area;
2. Drop of freight rates;
3. Freight rates grow;
4. Job loss;
5. Debt, financial losses, bankruptcy or complete shut-down.

The recovery from the crisis of 2008 was additionally obstructed by the delivery made by the ships ordered before the beginning of the crisis. Those deliveries considerably increased the supply that was already bigger than demand. The consequences of the over-capacity and the drop in production and trade on a global scale were reflected in the dramatic fall of freight rates on the maritime container market. What arose as a serious problem during the crisis of 2008 and 2009 is the drop of prices below the limits of liquidity, a strategy implemented by big players. The main goal of this policy was to survive on the market and to put the competitors in danger. In the long run, this policy can only create additional losses and, eventually, result in company's demise [43]. The financial crisis of 2008 showed how vulnerable this market is, and how important it is to develop adequate information–communication channels to overcome future crises more easily. Shipping companies need to implement good information mechanisms by adjusting them to different types of information they plan on receiving [46].

Reactions to previous crises on the maritime container market show that each had different consequences. The COVID-19 pandemic is not limited only to individual regions and its duration is uncertain. This pandemic has spread all over the world and caused different components of production, distribution centers, logistics and markets to disrupt the stability of the supply chains [47]. The COVID-19 pandemic has affected global supply chains and ports and the entire container industry like nothing before. Previous experience shows that each sudden drop in demand has an indirect impact on various activities on the maritime market and the activities at ports [24]. On the other hand, the Russian invasion of Ukraine has affected all segments of Ukrainian economy, and, regarding the numerous sanctions many countries have placed on Russia, the disruptions from that market have spilled over to the rest of the world. The predictions for future economic development for most countries are not optimistic. A huge problem lies in the fact that many containers need to be shipped through the Southern and the Middle Corridors, but, because of their limited capacities, it is impossible to expect this will be realized sometime soon; rather, this will be a long lasting process [46]. Strategies that companies on this market should consider during the times of crisis are [43]:

1. Capacity consolidation (for example, by reducing the navigation speed).
2. Optimization and operating expenses reduction—OPEX. Main operating expenses that should be reduced are fuel and lubricants, crew, maintenance, spare parts and consumable supplies.
3. Economies of scale. This is nothing new on the maritime container market, but it is very difficult to realize due to high financial investments necessary for achieving economies of scale.
4. Integration. Earlier, liner conferences were responsible for controlling the tariffs for specific routes. However, over the last decade, there are more and more strategic trading alliances that share information, resources and control to expand their businesses.

Chua et al. [48] recommend the following guidelines as tools for overcoming the pandemic more quickly:

1. Increase the number of the vaccinated employees for their own protection;
2. Implement a horizontal cooperation and provide coordination and facilitation of the change of the vessels crew members;
3. Increase investments in crewless vessels;
4. Energy sources diversification;
5. Increase the use of automatization and digitalization.

Unlike earlier crises, it is now evident that the decision makers have been forced to make tough calls during the pandemic and to operate in unprecedented conditions [48,49]. Disruptions caused by the pandemic have reflected in both supply and demand, and they suggest the need for developing great flexibility to soften the risks from the pandemic and to balance the demand [23]. In order to remain competitive, maritime traffic in the European Union needs to focus on reducing the pollution and continuously invest in

sustainable new technologies and adopt digital solutions and develop automatization [50]. The Russian–Ukrainian conflict has brought additional disruptions on the financial markets. It is expected that, due to this, companies in this market will be facing short and long-term uncertainties and risks.

3.2. Freight Rates on the Maritime Container Market in Times of Crises

Whereas the previous chapters place their focus on the changes in maritime transport rates during the pandemic and the Russian invasion of Ukraine, the following section focuses on the changes in the value of freight rates during this crisis, which have been elaborated based on the available data.

In the last months of 2021, when the COVID-19 pandemic was still going strong, moving goods along the main maritime routes created many problems for logistics departments at companies around the world. The expenses related to maritime transport have tripled since Europe was in lockdown and there are several reasons why this has happened [51]:

1. Due to restrictions in mobility that were in force in most countries, many shipping companies had no choice but to send their ships to navigate their routes, but with much unused loading capacity due to cancellations or reductions.
2. China was faced with more volume of goods for export to main world ports. Many world ports were facing long waits for unloading, which led to slower container ship rotation and, consequently, to higher prices of the contracts for container shipping.
3. At the beginning of 2020, freight rates were going up because of the provisions laid by the International Maritime Organization concerning the change of fuel. In line with the provisions, since 1 January 2020, shipping companies are under obligation to use VLSFO (very low sulfur fuel oil). The level of sulfur in the fuel the ships use during navigation must not be over 0.5% m/m [52].

In the period from March 2020 to September 2021, the rate for one 20' container rapidly grew due to the disruptions in the supply and the trading chains [53]. The uncertainty that characterizes the maritime container market today has been the greatest since the beginning of the “containerisation” [33]. The evolution of the freight rates that has been happening in the last two years is the reflection of the stress in the global supply chains and the pressures exerted on the private consumption. At the moment when the market started to recover from the COVID-19 pandemic, Russia started its full invasion of Ukraine [54], so March 2022 recorded the highest freight rate indices ever [55]. It is the imbalance between the rising demand and reduced supply capacities that prompted the rise of the freight rates on all maritime container routes. The growth in demand was much higher than expected [14]. Despite the fact that the increase in the freight rates suggests that the market is successfully dealing with supply and that it compensates the drop in demand with higher prices, most key players on the market have requested financial support from their governments. More precisely, even six out of ten largest shipping companies have done so: CMA CGM, COSCO Shipping Lines, HMM, Evergreen Marine, Yang Ming and Pacific International Lines [40].

Figure 1 shows the New ConTex index values for the period from 1 January 2013 to 10 July 2022. It clearly shows that the index value began to grow in the last quarter of 2020 and it grew exponentially until September 2021. During September and October of 2021 there were no major oscillations and the beginning of November recorded a drop after a longer period of stability, which is related to the COVID-19 pandemic and its influence on the maritime container industry. It was discontinued by the Russian invasion of Ukraine when the index started to rise again. Although the companies on this market have been through difficult two years, they all agree that 2022 is even more challenging because of the disruptions caused by the Russian invasion and the growing inflation (17 June 2022).

Figure 2 shows that since the beginning of the pandemic, the consumer price index in the European Union has been continuously growing, even during the Russian invasion of Ukraine. Moreover, it is evident that the biggest growth was recorded at the end of February and beginning March 2022. In February, the index value was 113.65, growing by 2.3% in March. In the entire observed period, the index grew by 12.10%. These values

present a correlation between maritime transport rates volatility and the consumer price index in the European Union.



Figure 1. ‘New ConTex’ index for the period from 1 January 2013–10 July 2022, Source: [53].

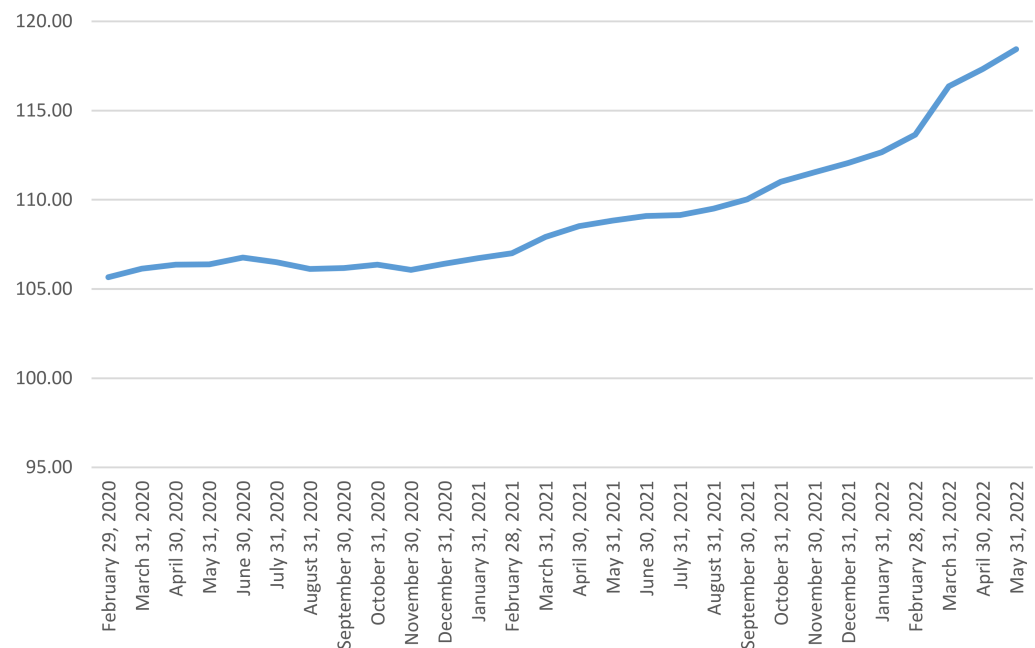


Figure 2. EU consumer price index, February 2020–May 2022, Source: according to [53].

The values of the global maritime container freight index for the period from the beginning of the COVID-19 pandemic until the end of May 2022 are displayed in Figure 3. It shows that the index value slightly drops in March and April of 2021, after a steady growth from April 2020 to February 2021. It peaked in September 2021, which is in line with the New ConTex index. However, it can be concluded that, unlike the New ConTex index, the values of this index have been continuously dropping since February 2022. On the other hand, it is important to note that in September 2021, the freight rates reached their record values of almost USD 10,400, which is 6.8 times the price from February 2020.

The impact the increase in freight rates has on the maritime container industry does not only bring the speed of the recovery of the entire global economy into question, but also [13]:

1. Causes increase in import and consumer prices.
2. Price fluctuations affect entire economies and various goods and are not occurring only in underdeveloped or developing countries.
3. Affects global production and costs.

Figure 4 shows top ten consumer goods according to an estimated price increase displayed in percentages. The highest increase in prices is estimated for the computer, electronic and optical products. The reason for that lies in the fact that most of these products are manufactured in eastern Asia and need to travel long distances to reach their final consumers. Higher freight rates do not affect all the consumer prices equally. They

impact more the prices of those products that are more integrated in the global supply chains [13].

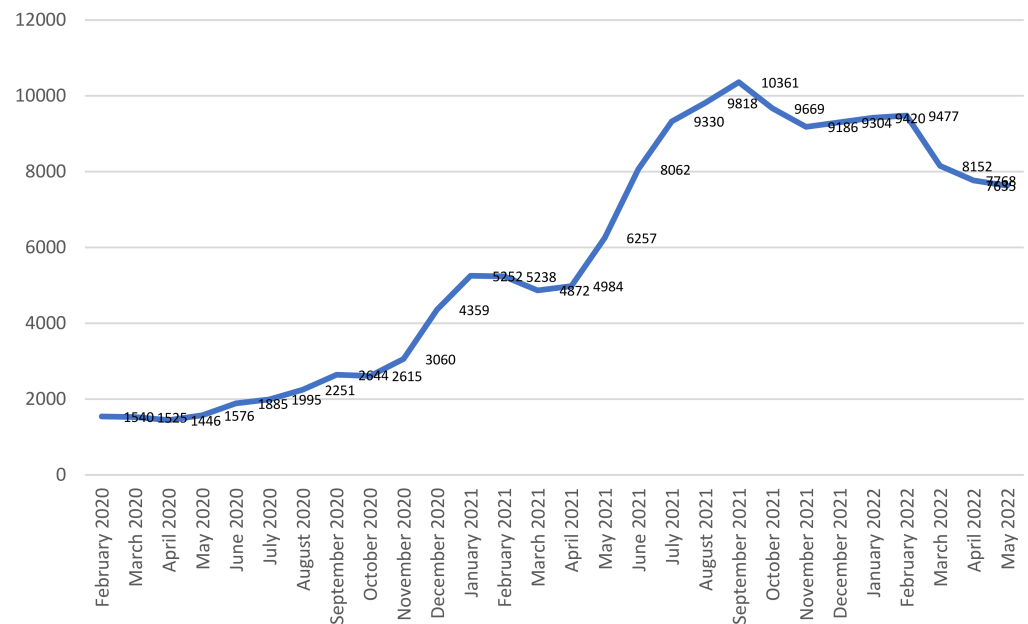


Figure 3. Global maritime container freight rate index, 29 February 2020–31 May 2022. Source: compiled by the author according to <https://www.statista.com/statistics/1250636/global-container-freight-index/> (accessed on 9 July 2022).

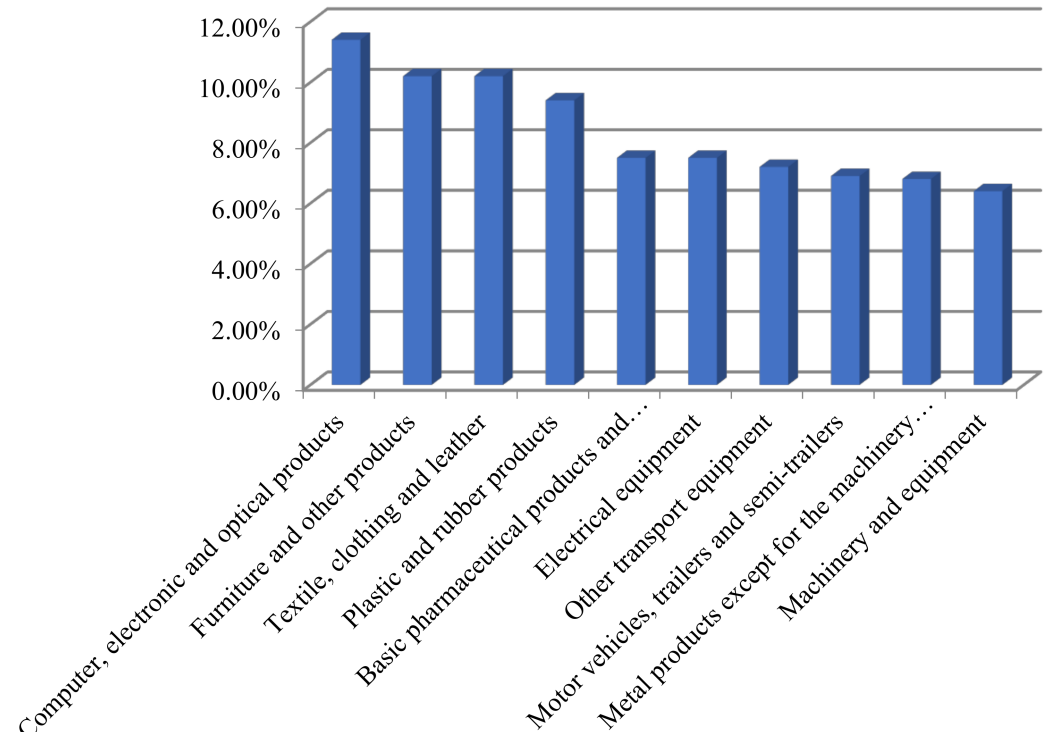


Figure 4. Top 10 consumer goods products according to the estimated price increase (%). Source: compiled by the author according to [13].

Changes in consumption patterns are first of all connected with the type of goods or services. As a rule, the basic (essential) goods, such as food, and the luxury items are most resilient [23]. This increase in the freight rates on the maritime container market could on

average lead to the increase in the consumer prices by 1.5% in the next year. This increase will be even more evident in the countries that depend on the import activities [50].

Rise of the freight rates will reflect on the production costs as well, which can eventually influence the dynamics of the development of national economies. It is to be expected that this influence will not be equally distributed, but rather be greater in smaller economies [13]. Higher freight rates in maritime container industry followed by disruptions in the supply chains by 10% will result in the drop of industrial production in the United States and the euro area by over 1% [13]. Although the United States started their recovery of industrial production in July 2021, followed by strong growth of private consumption, industrial consumption is still recording negative growth rates. This is the best indication of how disruptions on the maritime container market dictate the speed of the recovery of the global economy [13]. The Russian invasion of Ukraine has shaken the freight rates stability on the maritime container market even more in the moments when the industry was just starting to recover from the effects of the pandemic. It is expected that the freight rates for ocean shipping, together with air transport, will skyrocket. This actually projects another blow to the already shaken global supply chain [56].

Estimations regarding percentage changes in prices for individual countries' categories are presented in Figure 5. Underdeveloped countries can expect the increase in the prices of imported goods by 8.7%. The biggest increase, both of consumer and import prices, is estimated for small island countries in development. Whereas the estimated increase on the global level is 10.6% on average, small island countries are facing increases as high as 24.2%.

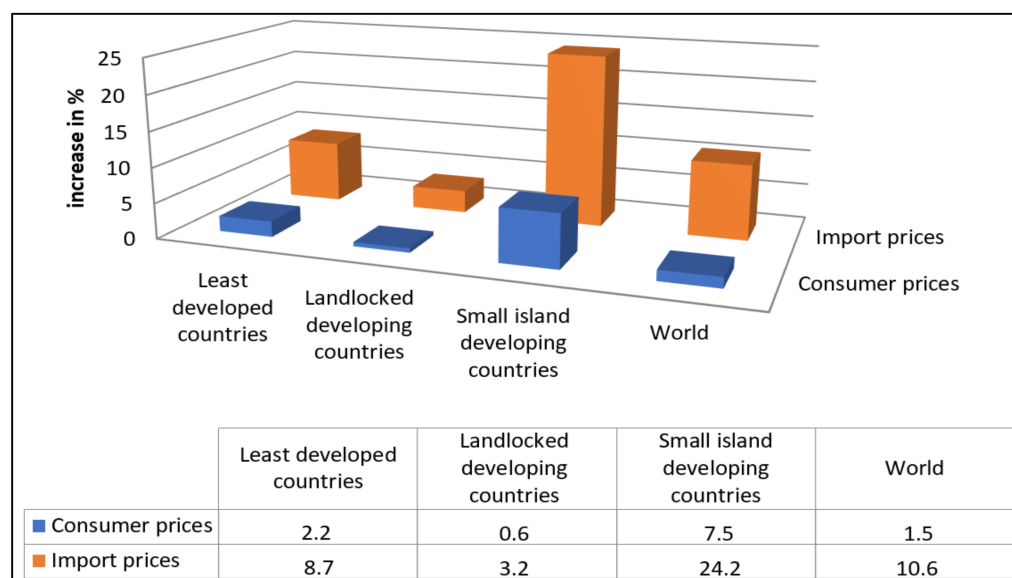


Figure 5. Simulation of the effects of current freight rates on the maritime container market on import and consumer prices. Source: compiled by the author according to [13].

Additional obstruction to the reduction in the freight rates in the maritime container industry are demands for the reduction in the greenhouse gases emissions of marine fuels. The initial IMO strategy on reduction of greenhouse gas (GHG) emissions from ships was adopted in April 2018 by the International Maritime Organization—the United Nations' specialized agency for international shipping. The goal has been to reduce total annual GHG emissions by at least 50% by 2050, compared to the year 2008. This is in line with the provisions laid down in the Paris Agreement [57]. However, if the activities are left as they are, with no further efforts to reduce the emissions, it is expected that they increase by between 90% and 130% by 2050 compared to 2008 [58]. To make sure that these predictions do not come true, additional measures to reduce GHG emissions from shipping will have to be adopted.

The strategy laid down in 2018 provides a list of short, mid and long-term measures that can be implemented to mitigate climate change. When preparing the document and the measures, the IMO took into account the needs of the developing countries, especially Small Island Developing Countries and Least Developed Countries (LDCs) and conducted an assessment of their short-term measures. This assessment showed that the effects the measures would have on the maritime industry and the costs are relatively small in relation to usual volatility of the freight rates [59].

4. Conclusions

Maritime transport assumes central position in global economy and its key segment is the maritime container industry. Maritime container transport dominates, first of all, due to its cost-effectiveness and efficiency. Container ships support modern lifestyle by transporting large amounts of goods from the point of production to the point of the final consumption. However, the COVID-19 pandemic and the Russian invasion of Ukraine had an impact on the entire world, and this market is no exception. Although the market is familiar with the oscillations in demand and the shipping companies are prepared for such disruptions, no one could have predicted this kind of volatility in demand. Despite the lessons that the maritime container industry has learned from previous crises, no one could have predicted such significant fluctuations in the demand and supply of transport services as in the COVID-19 crisis. As outlined earlier, freight rates during the year 2021 increased almost sevenfold. Freight rates on the maritime container market have recorded record values due to this volatility in demand, followed by the provisions on the use of low sulfur fuels laid down by the International Maritime Organization and further prompted by the Suez Canal obstruction. This means that the activities taken so far are not effective and other solutions should be sought to prevent the increase in maritime container freight costs. However, it is not an easy task.

The recovery of global economy is under threat due to these rapid increases of the freight rates in maritime container industry, which also creates additional disruptions in the supply chains. Increase in the freight rates on this market will have an impact on the production cost and the prices of the products that depend on this industry's services. As already mentioned, consumer goods price increase resulting from the change in freight rates is predicted to be 1.5% in 2023. This is especially significant for least developed countries and islands. There, the expected increases of consumer goods prices, resulting from increases in freight rates, may reach almost 9% in 2023. For these countries, an additional barrier is the distance between them and the developed countries and efforts should be made towards reducing this barrier. We are already witnessing continuous growth of the consumer goods prices in the European Union, which started when the pandemic first broke out and was yet more intensified by the Russian invasion of Ukraine. This invasion has further undermined the stability of the global market that was just starting its way to the recovery. This invasion that is, unfortunately, still ongoing has caused strong disruptions that have spilled over around the world and it is assumed that the process of returning to the state from before the crisis will be extremely strenuous. More and more economies are facing inflationary pressures, imbalances on the financial markets, problems with the procurement of the goods that are imported from the Russian and the Ukrainian markets. Disruptions caused by the pandemic have reflected in both supply and demand and they suggest the need for developing great flexibility to soften the risks from the pandemic and to balance the demand. Freight rates have been rising since the beginning of the pandemic. However, their greatest growth dynamics was recorded shortly after the commencement of the Russian invasion of Ukraine. According to earlier experiences with crisis situations, it is expected that the disruptions will hit smaller economies more severely and will affect the dynamics of the recovery of certain national economies. The extent of the impact on the prices of products depends on how much the products are included in the global supply chains.

The major challenge the global maritime industry is facing is establishing a system of resilience to the disruptions. Companies must develop more flexible capacities to be able to adapt more quickly to the crises in the future. The flexibility of the available capacities is what has been an ideal response to this pandemic and the disruptions it has caused in the supply chains. Flexibility can be increased by directing the efforts towards static and adjustable components of the capacities at container ports. Moreover, to be able to overcome future crises more easily, it is also necessary to establish adequate channels of information. Another useful tool is the integration of short- and long-term risk management strategies to ensure additional protection from possible disruptions in the future. The maritime transport market must strive to make better use of its resources, primarily the available cargo space. Although much has been done in this area so far, we still need to make effort to maximize efficiency. It is very likely that this will lead to the creation of a multi-dimensional model of maritime connections management, in which the transfer of information and flexibility will be the basis for the creation of highly efficient and resistant-to-disruptions supply chains.

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References

- Shah, P.V.; Prajapati, B.J.; Panchal, J.J.; Thakker, S. *Disruptions in Indian Supply Chain Due to COVID-19. Recent Advances in Manufacturing Modelling and Optimization*; Springer: Singapore, 2022; pp. 799–811.
- Santacreu, A.M.; LaBelle, J. Global Supply Chain Disruptions and Inflation During the COVID-19 Pandemic. *Review* **2022**, *104*, 78–91. [CrossRef]
- Allianz Global Corporate & Specialty. Safety and Shipping Review. 2022. Available online: <https://www.agcs.allianz.com/content/dam/onemarketing/agcs/agcs/reports/AGCS-Safety-Shipping-Review-2022.pdf> (accessed on 16 May 2022).
- Nguyen, T.-T.; Tran, D.T.M.; Duc, T.T.H.; Thai, V.V. Managing disruptions in the maritime industry—A systematic literature review. *Marit. Bus. Rev.* **2022**; ahead of print. [CrossRef]
- Sanchez, R.J.; Hoffmann, J.; Micco, A.; Pizzolitto, G.V.; Sgut, M.; Wilmsmeier, G. Port Efficiency and International Trade: Port Efficiency as a Determinant of Maritime Transport Costs. *Marit. Econ. Logist.* **2003**, *5*, 199–218. [CrossRef]
- Vilke, S.; Mance, D.; Debelić, B.; Maslarić, M. Correlation Between Freight Transport Industry and Economic Growth—Panel Analysis of CEE Countries. *Promet* **2021**, *33*, 517–526. [CrossRef]
- Limão, N. Infrastructure, Geographical Disadvantage, Transport Costs, and Trade. *World Bank Econ. Rev.* **2001**, *15*, 451–479. [CrossRef]
- Hummels, D. *Towards a Geography of Trade Costs*; Mimeo: Chicago, IL, USA; University of Chicago: Chicago, IL, USA, 1999. Available online: <https://dx.doi.org/10.2139/ssrn.160533> (accessed on 4 July 2022).
- International Chamber of Shipping (N/A). Shipping and World Trade: Driving Prosperity. Available online: <https://www.ics-shipping.org/shipping-fact/shipping-and-world-trade-driving-prosperity/> (accessed on 12 June 2021).
- Eryarsoy, E.; Shahmanzari, M.; Tanrisever, F. Models for government intervention during a pandemic. *Eur. J. Oper. Res.* **2022**; in press. [CrossRef]
- Stevens, P. The Ship that Blocked the Suez Canal May be Free, but Experts Warn the Supply Chain Impact Could Last Months, CNBC. Available online: <https://www.cnbc.com/2021/03/29/suez-canal-is-moving-but-the-supply-chain-impact-could-last-months.html> (accessed on 18 June 2021).
- Orhan, E. The Effects of the Russia-Ukraine War on Global Trade. *J. Int. Trade Logist. Law* **2022**, *8*, 141–146.
- United Nations. *Review of Maritime Transport*; United Nations Publications: New York, NY, USA, 2021. Available online: https://unctad.org/system/files/official-document/rmt2021_en_0.pdf (accessed on 2 September 2021).
- UNCTAD Communications and Information Unit. High Freight Rates Cast a Shadow over Economic Recovery, PR. 2021/040. 2021. Available online: <https://unctad.org/press-material/high-freight-rates-cast-shadow-over-economic-recovery> (accessed on 19 November 2021).

15. Crossley, G.; Xu, M. Congestion at South China Ports Worsens on Anti-COVID-19 Measures, Reuters. 2021. Available online: <https://www.reuters.com/world/china/congestion-south-china-ports-worsens-anti-covid-19-measures-2021-06-11/> (accessed on 3 July 2022).
16. Grzelakowski, A. Global Container Shipping Market Development and Its Impact on Mega Logistics System. *TransNav Int. J. Mar. Navig. Saf. Sea Transp.* **2019**, *13*, 529–535. [CrossRef]
17. Adam, A.F.; Moldovan, I.G.; Nita, S.; Hrebenciuc, A. The Importance of Maritime Transport for Economic Growth in the European Union: A Panel Data Analysis. *Sustainability* **2021**, *13*, 7961. [CrossRef]
18. Cullinane, K.; Haralambides, H. Global trends in maritime and port economics: The COVID-19 pandemic and beyond. *Marit. Econ. Logist.* **2021**, *23*, 369–380. [CrossRef]
19. Choi, Y.; Kim, H.-J.; Lee, Y. Economic Consequences of the COVID-19 Pandemic: Will It Be a Barrier to Achieving Sustainability? *Sustainability* **2022**, *14*, 1629. [CrossRef]
20. Berger, N.; Schulze-Schwering, S.; Long, E.; Spinler, S. Risk management of supply chain disruptions: An epidemic modeling approach. *Eur. J. Oper. Res.* **2022**; in press. [CrossRef]
21. McMaster, M.; Nettleton, C.; Tom, C.; Xu, B.; Cao, C.; Qiao, P. Risk Management: Rethinking Fashion Supply Chain Management for Multinational Corporations in Light of the COVID-19 Outbreak. *J. Risk Financ. Manag.* **2020**, *13*, 173. [CrossRef]
22. Barleta, E.P.; Sánchez, R.J. Port Report: The impact of the Coronavirus Disease (COVID-19) Pandemic on the Shipping Trade, Trans-Shipments and Throughput of Container Ports in Latin America and the Caribbean, Bulletins, no. 2. 2021. Available online: https://repositorio.cepal.org/bitstream/handle/11362/47017/1/S2100301_en.pdf (accessed on 22 August 2021).
23. World Health Organization. WHO Director-General’s Opening Remarks at the Media Briefing on COVID-19. 2020. Available online: <https://www.who.int/director-general/speeches/detail/who-director-general-s-opening-remarks-at-the-media-briefing-on-covid-19---11-march-2020> (accessed on 23 June 2020).
24. Notteboom, T.; Pallis, T.; Rodrigue, J.-P. Disruptions and resilience in global container shipping and ports: The COVID-19 pandemic versus the 2008–2009 financial crisis. *Marit. Econ. Logist.* **2021**, *23*, 179–210. [CrossRef]
25. TEC CONTAINER. 3 Reasons for the Rise in the Price of Maritime Transport. 2021. Available online: <https://www.teccontainer.com/blog/rise-in-the-price-of-maritime-transport/> (accessed on 27 August 2021).
26. Cariou, P.; Notteboom, T. Implications of COVID-19 on the US container port distribution system: Import cargo routing by Walmart and Nike. *Int. J. Logist. Res. Appl.* **2022**, 1–20. [CrossRef]
27. Nwokedi, T.C.; Okoroji, L.I.; Nwolozi, C.N.; Efang, H.O.; Okafor, C.O. COVID-19: Disruption of Container Freight Transportation on Last Mile Corridors between Regional Hub Ports and Hinterland Markets in Nigeria, Himalayan. *J. Econ. Bus. Manag.* **2021**, *2*, 1–13. [CrossRef]
28. Rodrigue, J.-P. The Vulnerability and Resilience of the Global Container Shipping Industry. *Curr. Hist.* **2022**, *121*, 17–23. [CrossRef]
29. United Nations. *Review of Maritime Transport 2020*; United Nations Publications: New York, NY, USA, 2020; Available online: https://unctad.org/system/files/official-document/rmt2020_en.pdf (accessed on 25 September 2020).
30. UNCTAD. *Review of Maritime Transport 2020 (Executive Summary)*, UNCTAD/RMT/2020 (Executive Summary), New York and Geneva. 2020. Available online: https://unctad.org/system/files/official-document/rmt2020summary_en.pdf (accessed on 13 February 2021).
31. Zhao, Y.; Ye, J.; Zhou, J. Container fleet renewal considering multiple sulfur reduction technologies and uncertain markets amidst COVID-19. *J. Clean. Prod.* **2021**, *317*, 128361. [CrossRef]
32. Mańkowska, M.; Pluciński, M.; Kotowska, I.; Filina-Dawidowicz, L. Seaports during the COVID-19 Pandemic: The Terminal Operators’ Tactical Responses to Disruptions in Maritime Supply Chains. *Energies* **2021**, *14*, 4339. [CrossRef]
33. Russell, D.; Ruamsook, K.; Roso, V. Managing supply chain uncertainty by building flexibility in container port capacity: A logistics triad perspective and the COVID-19 case. *Marit. Econ. Logist.* **2020**, *24*, 92–113. [CrossRef]
34. Sudan, T.; Taggar, R. Recovering Supply Chain Disruptions in Post-COVID-19 Pandemic Through Transport Intelligence and Logistics Systems: India’s Experiences and Policy Options. *Front. Future Transp.* **2021**, *2*, 660116. [CrossRef]
35. Kormych, B.; Averochkina, T. Ukrainian Maritime Industry under Fire: Consequences of Russian Invasion. *Lex Portus* **2022**, *8*, 7–32. [CrossRef]
36. Green, J.A.; Henderson, C.; Ruys, T. Russia’s attack on Ukraine and the jus ad bellum. *J. Use Force Int. Law* **2022**, *9*, 4–30. [CrossRef]
37. Malyarenko, T. Strengthening Ukraine’s Black Sea Navy to be a Bulkhead against Russia. 2021. Available online: <https://www.ponarseurasia.org/strengthening-ukraines-black-sea-navy-to-be-a-bulkhead-against-russia/> (accessed on 19 November 2021).
38. Weizhen, T. How the Russia-Ukraine War Is Worsening Shipping Snarls and Pushing Up Freight Rates, CNBC. 2022. Available online: <https://www.cnbc.com/2022/03/11/russia-ukraine-war-impact-on-shipping-ports-air-freight.html> (accessed on 23 May 2022).
39. Gorovaya, K.; Gorachek, O. *Sea Line Carriers: Operation in Ukraine from 24.02.2022*; Interlegal: Odesa, Ukraine, 2022.
40. ECLAC. The Effects of the Coronavirus Disease (COVID-19) Pandemic on International Trade and Logistics, Bulletins, br. 6. 2020. Available online: https://repositorio.cepal.org/bitstream/handle/11362/45878/1/S2000496_en.pdf (accessed on 23 June 2021).
41. UNCTAD. Global Trade Hits Record \$7.7 Trillion in First Quarter of 2022. 2022. Available online: <https://unctad.org/news/global-trade-hits-record-77-trillion-first-quarter-2022> (accessed on 23 July 2022).
42. OECDiLibrary. Containerships—The Engines of Globalization and Trade. Available online: <https://www.oecd-ilibrary.org/sites/508bfb5b-en/index.html?itemId=/content/component/508bfb5b-en> (accessed on 23 July 2022).

43. Jerebić, V.; Pavlin, S. Global Economy Crisis and its Impact on Operational Container Carrier's Strategy. *Promet* **2018**, *30*, 187–194. [CrossRef]
44. Agbaba, R. Maritime Challenges in Crisis Times. *J. Marit. Transp. Sci.* **2020**, *59*, 51–60. [CrossRef]
45. Min, D.; Wang, F.; Zhan, S. Impact analysis of the global financial crisis on global container fleet. In Proceedings of the 2009 6th International Conference on Service Systems and Service Management, Xiamen, China, 8–10 June 2009; pp. 161–166. [CrossRef]
46. Keuper, M. The Implications of the Russian Invasion of Ukraine on the Future of Sino-European Overland Connectivity, AIES, No. 6. 2022. Available online: <https://euagenda.eu/upload/publications/aies-fokus-2022-06.pdf> (accessed on 8 July 2022).
47. Tucker, H. Coronavirus Bankruptcy Tracker: These Major Companies Are Failing Amid the Shutdown, Forbes. 2020. Available online: <https://www.forbes.com/sites/hanktucker/2020/05/03/coronavirus-bankruptcy-tracker-these-major-companies-are-failing-amid-the-shutdown/> (accessed on 18 July 2021).
48. Chua, J.Y.; Foo, R.; Tan, K.H.; Yuen, K.F. Maritime resilience during the COVID-19 pandemic: Impacts and solutions. *Contin. Resil. Rev.* **2022**, *4*, 124–143. [CrossRef]
49. Nikolopoulos, K.; Punia, S.; Schäfers, A.; Tsinopoulos, C.; Vasilakis, C. Forecasting and planning during a pandemic: COVID-19 growth rates, supply chain disruptions, and governmental decisions. *Eur. J. Oper. Res.* **2020**, *290*, 99–115. [CrossRef]
50. Prevljak, H. EU Maritime Transport to Increase in Coming Years. So Will GHG Emissions. 2021. Available online: <https://www.offshore-energy.biz/eu-maritime-transport-to-increase-in-coming-years-so-will-ghg-emissions/> (accessed on 23 July 2022).
51. UNCTAD. Container Shipping in Times of COVID-19: Why Freight Rates have Surged, and Implications for Policymakers, UNCTAD Policy Briefs, No. 84. 2021. Available online: https://unctad.org/system/files/official-document/presspb2021d2_en.pdf (accessed on 23 June 2022).
52. International Maritime Organization. Technical Circular, No. 087/2018. 2018. Available online: <https://www.irclass.org/media/3880/technical-circular-no87.pdf> (accessed on 19 June 2021).
53. Cheng, E. Surging Shipping Costs Will Drive Up Prices for Some Consumer Products by 10%, New UN Report Finds, CNBC. 2021. Available online: <https://www.cnbc.com/2021/11/19/surging-shipping-costs-to-drive-consumer-price-inflation-unctad-says.html> (accessed on 23 November 2021).
54. VCFI. Valencia Containerised Indeks. Balance of the Year 2021. Available online: <https://biblio.ugent.be/publication/8751576/file/8751577> (accessed on 3 July 2022).
55. Verband Hamburger und Bremer Schiffsmakler e.V. New ConTex-II Rates in USD(\$). Available online: <https://www.vhbs.de/index.php?id=5&L=1> (accessed on 12 July 2022).
56. Kay, G. Russia's War on Ukraine Could Triple Ocean Shipping Rates to \$30,000 per Container, Expert Says. 2022. Available online: <https://www.businessinsider.com/russia-war-ukraine-could-triple-ocean-shipping-rates-experts-2022-3> (accessed on 9 July 2022).
57. International Maritime Organization. Initial IMO Strategy on Reduction of GHG Emissions from Ships. Resolution MEPC.304(72), adopted on 13 April 2018, MEPC 72/17/Add.1 Annex 11, London. 2018. Available online: [https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.304\(72\).pdf](https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/MEPCDocuments/MEPC.304(72).pdf) (accessed on 13 May 2022).
58. International Maritime Organization. *Fourth IMO GHG Study*; International Maritime Organization: London, UK, 2020. Available online: https://greenvoyage2050.imo.org/wp-content/uploads/2021/07/Fourth-IMO-GHG-Study-2020-Full-report-and-annexes_compressed.pdf (accessed on 15 July 2022).
59. International Maritime Organization. Comprehensive Impact Assessment of the Short-Term Measure Approved by MEPC 75. Note by the Secretariat, MEPC 76/7/13. 2021. Available online: <https://data.consilium.europa.eu/doc/document/ST-8277-2021-INIT/en/pdf> (accessed on 2 June 2022).