

## МІЖНАРОДНІ ЕКОНОМІЧНІ ВІДНОСИНИ

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### ОСОБЛИВОСТІ СУЧАСНИХ СВІТОВИХ НАУКОВИХ ДОСЛІДЖЕНЬ З ЕКОНОМІКИ МОРСЬКОГО ТРАНСПОРТУ ТА ЗОКРЕМА МОРСЬКОЇ ТОРГІВЛІ

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**Анотація.** У статті аналізуються та систематизуються сучасні дослідження провідних світових науковців з економіки морського транспорту та морської торгівлі з метою виявлення поточних тенденцій та перспектив подальших наукових розробок у цьому напрямку. Особлива увага приділена дослідженням, які оцінюють вплив спалаху пандемії коронавірусу на судноплавну індустрію як головний для світової економіки постачальник товарів. Усі розглянуті дослідження концептуально згруповано у дві головні течії. Перша течія включає праці, сфокусовані на динаміці світової морської торгівлі, у тому числі офіційні морські звіти. На відміну від досліджень з морської економіки, виконаних українськими та російськими вченими, які переважно описують статистичні дані з офіційних морських звітів, що публікуються міжнародними організаціями та провайдерами послуг у сфері морського судноплавства, провідні світові науковці використовують цю статистику як основу для унікальних досліджень, здебільшого спрямованих на пошук кореляції між різноманітними судноплавними показниками та їхнє прогнозування. Друга течія включає праці, які досліджують торгівлю конкретним вантажем, а саме контейнерами, видобувною нафтою, сухим вантажем, що перевозять навалом. Встановлено декілька загальних особливостей досліджень обох течій. Майже у кожній публікації виконана спроба осмислення природи коливань фрахтової ставки та прогнозування розвитку або загального фрахтового ринку, або фрахтового ринку, який спеціалізується на окремому виді вантажу. У розглянутих працях використовується ідентична методологія: виходячи з мети дослідження та доступності даних, наукові діячі застосовують різні моделі регресійного аналізу, стандартного інструменту статистичного моделювання, який оцінює залежність між двома або більше величинами. Незалежно від того, який фрахтовий ринок досліджується, у наукових роботах здійснюються спроби з'ясування зв'язку цього ринку з іншими шляхом оцінки ефектів переливу між різними типами та розмірами суден. Відмінні риси досліджень полягають у зацікавлених сторонах, які можуть отримати користь від цих досліджень: індустрія в цілому чи окремі групи учасників ринку. Окрім того, оцінка торговельних даних у реальному часі є реальною проблемою, поставленою індустрією сучасній науці, яка намагається вирішити її інноваційними цифровими засобами.

**Ключові слова:** економіка морського транспорту, морська торгівля, оцінка торговельних даних у реальному часі, міжнародні морські перевезення, морський торговельний флот,

судноплавні компанії, фрахтовий ринок, фрахтова ставка, перевезення сухого вантажу навалом, пандемія коронавірусу.

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## **PECULIARITIES OF CURRENT WORLD SCIENTIFIC RESEARCHES ON MARITIME ECONOMICS AND SPECIFICALLY SEABORNE TRADE**

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**Abstract.** The article analyzes and systemizes current studies of leading world scientists on maritime economics and seaborne trade with the aim to reveal current trends and venues for future researches in this field. Special attention is paid to researches evaluating how the outbreak of coronavirus pandemic impacted shipping industry as a main global supplier of goods. All studies under review are conceptually grouped into two main branches. The first branch comprises papers focused on the world seaborne trade data dynamics, including official maritime reports. As opposed to Ukrainian and Russian maritime economics papers which predominantly describe and portray the statistical data available in official maritime reports issued by international organizations and shipping services providers, leading world scholars use this statistics as a baseline for individualized researches, mainly focused on investigation of correlation between various shipping indicators and prediction of same. The second branch comprises papers investigating trade of certain types of cargo, such as containers, crude oil, dry bulk. Several general peculiarities of both branches of researches are defined. Almost all of them attempt to provide an insight into the nature of a freight rate and to forecast the development of either general freight market or specific cargo related one. The utilized methodology is also identical. Depending on the aim of research and data availability, scholars employ various models of regression analysis, a standard tool of statistical modeling, which estimates the average relationship between two or more variables. No matter which freight market is under investigation, studies usually try to examine the connection of this market with others by evaluating the spillover effects between vessel types and vessel sizes. Distinguishing features of researches lie in the target stakeholders who could benefit from, either the industry in general or particular groups of market participants. In addition, nowcasting trade data is a real problem raised by the industry to modern science, which tries to tackle it by proposing innovative digitalized solutions.

**Keywords:** maritime economics, seaborne trade, nowcasting trade data, international maritime transportation, merchant fleet, shipping companies, freight market, freight rate, dry bulk transportation, coronavirus pandemic.

**Introduction.** World trade has fascinatingly increased for the last half of the century. Trade as a percentage of global GDP has grown from 27.34% in the early 1960s to 60% in 2019 [1]. At the same time maritime transportation accommodates for the movements of approximately 80% of the goods transferred worldwide [2]. So, occupying a considerable segment of the world economy, the shipping industry plays a vital role in the global supply chain. This role was especially perceptible during the outbreak of coronavirus pandemic when wide range of industries appeared unprecedentedly frozen, while the demand on maritime

transportation as a main global supplier of goods, including the essential ones, experienced lesser impact in comparison to other spheres.

Despite the augmentative nature of the shipping industry, the economic principles of how main shipping indicators develop, what they are determined by, by what means they can be predicted, had used to be under-researched for a long time. However, with an increased contribution of the shipping to the world economy normal functioning and development, more and more attempts to theoretically conceptualize seaborne trade appeared in the scientific literature. This paper investigates the existing world scientific literature with the aim to reveal both current trends and venues for future researches in maritime economics. And since the shipping is versatile, this study is confined specifically to that part of the industry which is more closely connected with the international economic relations.

**Problem statement.** As M. Stopford notes [3, p. 177-178], sea transport services are provided by four closely related markets, each trading in a different commodity: the freight market trades in sea transport; the sale and purchase market trades second-hand ships; the newbuilding market trades new ships; and the demolition market deals in ships for scrapping. The waves of cash flowing between the four markets drive the shipping market cycle.

This article endeavors to fill the gap in the literature by analyzing and systemizing the current studies on seaborne trade, which happens on the first market defined by M. Stopford – the freight market. The purpose of this paper is to ascertain general peculiarities and common trend of the current researches on seaborne trade conducted by the leading scholars from all over the world, as well as to identify directions of further perspective of maritime economics scientific activity. The range of general research methods is employed in this paper, namely analysis, synthesis, comparison, statistical and logical methods.

**Results.** Originally, it was intended to classify the analyzed publications by aim, however in fact the aim of each of them is similar – the insight into the nature of freight rate as a main variable of interest for all stakeholders of the shipping industry and the attempt to forecast short- and long-term freight market dynamics.

Therefore, the studies under review are conceptually grouped into two main branches. The first branch includes papers focused on the world seaborne trade as a whole. They are subsequently divided into two sections – one contains official reports issued by international organizations and shipping services providers with a different periodicity, while the other comprises scientific researches which study seaborne trade data dynamics. The second branch also embraces several sections which are defined by the type of traded cargo under analysis. One group is concentrated on dry bulk trade, including a sub-group of studies dedicated specifically to capesize bulk sector. The second group is relatively small and studies container shipping trade. The third group investigates crude oil maritime transportation.

Before analyzing official reports, it is worth to characterize the monograph by M. Stopford “Maritime Economics” [3]. T. Lirn in the review of this monograph [4], to emphasize its abundance, called the book a shipping management bible to both shipping professionals and students in shipping management department. “Maritime Economics” covers historical development of shipping, many economic theories of maritime industry, as well as includes a considerable quantity of detailed shipping management knowledge, such as shipping market cycles, supply and demand variables, shipping companies economics and cash flows, financing ships and shipping companies, risk return, transport of various cargoes.

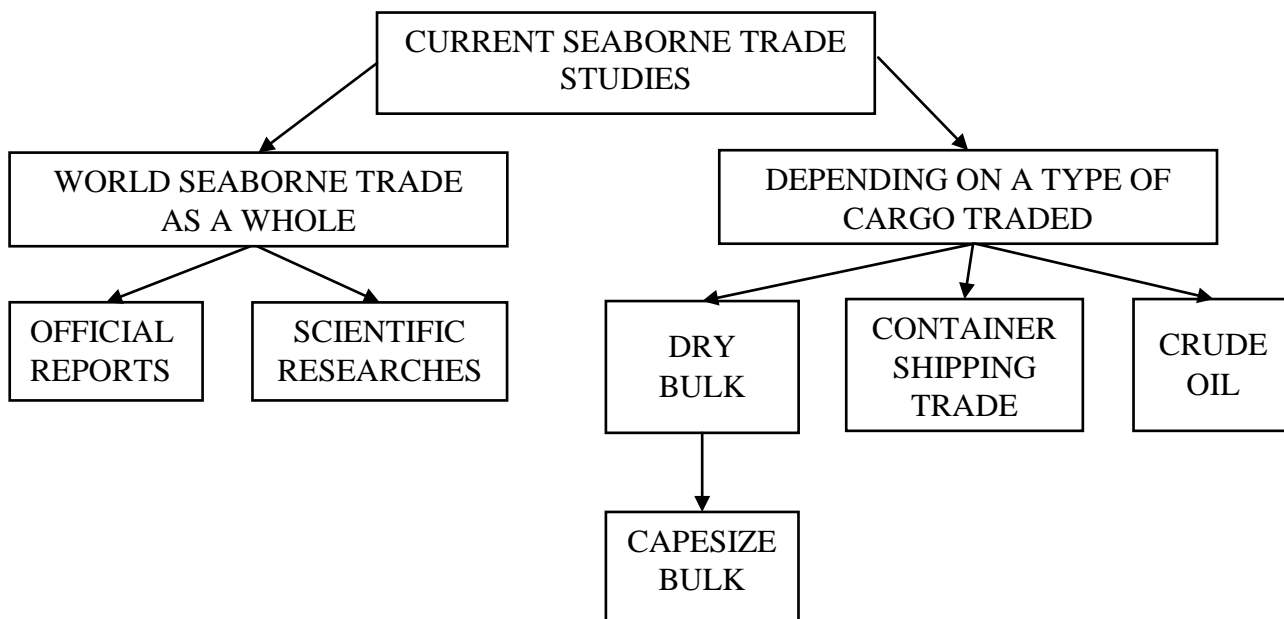


Fig. 1. Classification of current studies on seaborne trade  
Source: compiled by the author.

The last part of the book is closely related to the majority of publications which are considered in the current study, as it introduces various shipping forecasting methodologies, describes key elements of the forecast, types of relationships and variables, illustrates the difference between maritime market forecasting and market research, discusses forecasting challenges and several forecasting techniques. M. Stopford exemplifies three possible ways of approaching the forecast (market report, forecasting model and scenario analysis) by building real models and explaining stages of producing regressions. The economist acknowledges that reliable forecast is difficult to be produced and concludes that the purpose of forecasting activity is not to predict precisely but to help decision-makers to reduce uncertainty by obtaining and analyzing the right information about the present and show how that information can help to understand the future.

In comparison to M. Stopford's monograph, the publication by P. Gounaris [5] has a descriptive character and limited practical use. The author also tried to retrospectively describe stages of international trade development and a role of seaborne trade in this process. Some important milestones of the shipping history were pointed out, like the advent of steamship and intermodal container, containerization of trade, drastically increased volumes of sea trade since the 1960s due to liberalization of trade policies and minimization of transportation costs. However, such a research is not of a type this article aims to be focused on.

In the shipping industry, although there is a significant amount of organizations which specialize on maritime data analysis, only several of them arrange not only raw data collection but also provide so called 'intelligence', e.g. attempts to construe the data from both the business and scientific perspectives. One of such reports is "Shipping Intelligence Weekly" by Clarksons Research [6] which contains historical and fresh indicators of four shipping markets, with a distinct emphasis on freight market (spot, trip charter, time charter freight rates for different merchant fleet vessel types), along with economic indicators driving directly or indirectly the demand for seaborne trade (GDP growth, industrial production, interest rate trends, oil, steel, iron ore, coal and other main commodities production). The

publishers conclude every part of the statistical report by an attempt to identify a trend of each indicator and to offer a rationale behind any movement.

In turn, “Review of Maritime Transport” by the United Nations Conference on Trade and Development (UNCTAD) [2] presents an overview of international maritime trade development, with a special attention paid on breakdown of trade data by types of cargo, by exports and imports, by groups of countries depending on economic development which take part in trading activities. The report also contains detailed information on current world fleet posture and its breakdown by principal vessel type, size, ownership, age, flag. Different sectors of freight market are considered. Data granularity is a distinctive feature of this report. Importantly, apart from port activity and port performance, in the recent issues a single chapter is dedicated to port calls and turnaround time, e.g. time spent in port by a vessel. It underlines the incipient trend in maritime economics that data captured from the automatic identification system (AIS) initially introduced as a tool to support navigational safety by collecting regular signals with information on vessel’s position and movement details and which are transmitted from every vessel through GPS, is now used for trade forecasts and monitoring shipping performance. Maritime transport digitalization will take its course leading to an increase of AIS data popularity.

“Big Data on Vessel Traffic: Nowcasting Trade Flows in Real Time” by S. Arslanalp, M. Marini and P. Tumbarello [7] was a primary study in a series of IMF publications, which will be further referred to, aimed to connect AIS data with trade activity and convert these massive data into practical use for economics. Having taken Malta as a benchmark and having used AIS-based port calls data, the authors tried to develop two indicators – ‘cargo number’ and ‘cargo load’ – to trace maritime and trade activity. ‘Cargo number’ stood for number of ships visiting ports, and ‘cargo load’ stood for changes in vessels’ draughts representing the fact of either loading or discharging operations happened at port. Thereafter researchers tested produced data by comparing with official reports and the results (0.75 and 0.65 correlation coefficients respectively) could act as a proof of sustainability of employed method to predict trade volumes by means of AIS data and to nowcast them (assess in real time).

The latter appears to be a real problem raised by the industry to modern science. Nowcasting trade flows is key for all market participants since official trade data is always published with delays while the earlier credible information is available the sooner risks can be identified as well as business cycle turning points. This matter was further addressed by D. Cerdeiro, A. Komaromi, Y. Liu, M. Saeed in “World Seaborne Trade in Real Time: A Proof of Concept for Building AIS-based Nowcasts from Scratch” [8]. Although there are differences, this IMF research is similar to the previously discussed one by the applied methodology and aim. By introducing the GTI (Global Trade Intelligence) index counted purely on AIS-based data and by comparing it with official global, sectorial and by country trade data, the scholars came to the conclusion that based on the high final correlations such a methodology achieved a good fit with official statistics. As soon as this paper relies solely on AIS messages and publicly available information without combining them with other proprietary data, its self-reliance underlies the speed of trade estimates being produced with 5-10-day lag in comparison to 11-15 weeks it takes officials to publish the same data. Thus, to certain extent the proposed methodology was proved to construct port-to-port voyages and to gauge overall trade activity in a quick fashion.

“Supply Spillovers During the Pandemic: Evidence from High-Frequency Shipping Data” by D. Cerdeiro, A. Komaromi [9] further expanded scientific opportunities offered by AIS data to maritime economics. The painful for the world economy period of COVID-19 crisis and associated containment measures was studied. The authors explored pandemic’s impact on supply and demand conditions through construction of a measure called ‘lockdown exposure’ enabling to trace the spillover effects of supply-side disruptions. The scientists

concluded that as opposed to overall activity in the domestic economy which was mainly determined by disease intensity and subsequent fears leading to decline in consumption, the supply and transportation of goods was indeed influenced by government lockdowns. Furthermore, the supply disruptions in trading partners might have been a more important driver of imports than domestic lockdown measures. The results of this research implied that supply disruptions due to lockdowns reduced global seaborne imports in February-March 2020 by 10 percent, with China's lockdowns contributing about 4 percentage points. Countries that historically had stronger trade links with and are closer to countries under heavy lockdowns experienced larger and faster contraction in their imports. However, these spillover effects were short-lived – present during the first 2-3 months of the pandemic. After then, demand effects likely dominated the evolution of global trade.

N. Michail and K. Melas in the joint article [10] also tried to evaluate how the particular shipping markets reacted to an exogenous shock, namely coronavirus disease spread. The scholars reviewed the Baltic freight indices of the dry bulk (BDI), the clean tanker (BCTI) and the dirty tanker (BDTI) markets all of which significantly dropped after the pandemic outbreak, and concluded that the pandemic had negatively affected the dry bulk and the dirty tanker indices, while it had not directly affected the clean tanker segment. Moreover, the authors noticed second-round effects, mostly via decline in oil prices and third-round effects via impact from the stock market. Via a combination of these effects, freight markets were pushed in a downwards spiral. Likewise the previous three IMF publications, this research also employed the daily number of calls of vessels in ports (although non-AIS data) as a proxy variable for the demand of transportation services to reveal that both the BDI and the BCTI are highly affected by the demand side of the economy, while the dirty tanker freight index (related to vessels which transport crude oil) doesn't register such a relationship. The suggested rationale behind this scientific observation is quite business-driven: while commodities transported by dry bulk vessels and clean tankers cannot be easily stored given both their nature and the need for specific facilities, crude oil can be stored much more easily given that it can simply remain in the vessel. Using tankers as storage capacity is a common practice for the periods of oil market distress, and this was confirmed in 2020 when during the first two months of covid pandemic floating storage volumes increased by 37%.

Two more articles by N. Michail and K. Melas are worth to be reviewed. They can also be ascribed to the group that was initially named as "Scientific researches on the world seaborne trade as a whole". Both articles are interconnected and supplement each other, forming a single comprehensive attempt to quantify the relationship between economic growth and seaborne trade, and consequent impact on freight rates of different market sectors. In the first publication [11] N. Michail in order to assess how the world economic growth affects the global demand for seaborne trade, divided the world economy into three groups of countries by income (high, middle and low) and the seaborne trade market into three main sectors (dry cargo, crude oil and petroleum products). The results of the research suggest that all three cargo categories are affected by changes in the world economic growth, albeit to a different extent: processed petroleum products, related to clean tanker transport, register the strongest effect from an increase in world GDP in comparison to crude oil and dry cargo. The price of oil appeared to have a small negative effect on the amount of goods transported, supporting the view of demand inelasticity with regards to price. The positive reaction of seaborne trade demand on GDP shock has to be mainly attributed to the high- and middle-income countries. As to low-income countries, who are known as net exporters of oil and petroleum products, economic growth appeared to have a negative effect on seaborne trade, as higher income is likely to be associated with more domestic consumption and less exports.

Together with K. Melas, N. Michail contributed to this topic by an attempt to link above results with freight rates behavior. In the common article [12] the scientists explored the

relationship between seaborne trade and several freight indices and found out a strong impact the quantity of seaborne commodity trade had on the BDI and the BDTI, but not on the BCTI, most likely due to the fact that clean tankers can simultaneously operate both in the clean and dirty sectors. Additionally, it was observed that a shock in the price of Brent oil had the expected positive response from the Baltic Dry Index, while its relationship with the Baltic Clean Tanker Index and the Baltic Dirty Tanker Index was negative because, as already mentioned earlier in the current study when describing publication [10], tanker vessels can operate as floating storage units when oil prices decline. All in all, this series of articles by the Southern European economists can serve to confirm that the world GDP determines the freight rates through the quantity of seaborne trade, while the former determines the freight rates directly. Thus, the ability to properly model and forecast both the world economic growth and the seaborne trade supply-demand balance can be a strong benefit for shipping companies whose priority is to minimize risks by foreseeing the freight rates development in order to take the strategically correct steps on the market.

Another approach to determine seaborne trade volume was offered by C. B. Kim [13], who tried to analyze factors affecting seaborne import volume by taking South Korea as an example. The author used Korea's industrial production index as a real income variable, real effective exchange rate (REER) of the Korean Won as a price variable, world commodity prices, and conditional heteroscedasticity of USD/KRW exchange rate fluctuations as an exchange rate volatility variable, to develop a determinant function of Korea's seaborne import volume. The results of the research didn't confirm the expectations to their fullest. If the positive relationship between real income and import volume, and the negative one between both commodity prices and USD/KRW exchange rate volatility and import volume was totally expected, the negative relationship between REER and import volume wasn't anticipated (although REER was unable to secure statistical significance). The importance of the results not only for shipping but for governments makes this research unique, as well as use of REER as a variable does.

The first branch of analyzed publications concentrated on the world seaborne trade as a whole has several common attributes. Official maritime reports contain useful maritime statistics which is pivotal to further scientific researches. As opposed to Ukrainian and Russian maritime economics papers which predominantly describe and portray the statistical data available in these official reports [14], the leading world scholars use this statistics as a baseline for individualized researches, mainly focused on investigation of correlation between various shipping indicators and forecast of same. To achieve the results, scholars employ various models of regression analysis depending on the aim of the research and data availability, since credible shipping data used to be scarce for a long time and hindered potentially meaningful conclusions. The most popular regression models utilized in above reviewed papers are vector autoregression, vector error correction model, Bayesian vector autoregressive approach, generalized autoregressive conditional heteroskedasticity, autoregressive distributed lag model, shift-share regression. So, the intermediate conclusion on the first branch papers is that despite nuances in applied methodology, the similar framework and purpose make these publications harmonized and able to be united into a separate scientific direction.

The second branch of researches includes those papers which are oriented on specific freight markets, namely depending on the type of cargo transported. And the first group studies dry bulk trade. As UNCTAD notes [2, p. 12], in 2019 dry bulk trade accounted for 5.3 billion tons out of 11.1 billion tons of the world seaborne trade, so dry bulk share in global commodities trade was 47%. It underlines the leading role of dry bulk segment which drives the global trade and transmits different signals to other segments. Moreover, special attention towards dry bulk trade is paid by the world-renowned Baltic Exchange which publishes seven

indices on daily basis, with five of them being dry oriented (the Baltic Dry Index and four vessel-specific ones classified by tonnage of associated bulk carriers).

In the early 2010s, B. Ko in a series of consecutive researches tried to analyze the dry bulk freight market from a quite unique perspective. The first article [15] considered freight rates behavior in a mixed-regime – low-volatility and high-volatility. The findings of the paper stated that in all markets of different size (capesize, panamax, handymax) the spot earning was above than 3-year on average. So, in contrast to the financial market, there was negative risk premium to the shipowner on average. In the aspect of volatility, the spot market was more volatile than the 3-year time charter market. However, highly statistically significant effect of time charter market condition on the volatility of the market was ascertained. The scholar concluded that market players considered the backwardation shock in low uncertainty as more important than in high uncertainty.

The second article by B. Ko [16] suggested developing a new generalized dry bulk index, since according to the scientist, dynamics of the commonly used Baltic Dry Index closely repeated the Baltic Capesize Index (BCI) and didn't work well to trace the status of smaller ships (handysize and supramax). Occasionally, the BDI over- or under-stated the status of global dry bulk freight market. By using a common stochastic trend model, this paper offered an alternative method of calculating new index which appeared to closely reflect lower than capesize dry bulk tonnage. Further, through decomposition into common permanent and idiosyncratic transitory components, the author discovered that idiosyncratic component for capesize vessels was significant and relatively negligible for other types, meaning that actual panamax, supramax and handysize rates were closer to equilibrium while capesize type on its own demonstrated much higher volatility. The cause behind this observation lies in higher flexibility of smaller ships in their use cargo wise. And capesizes' cargo variety being limited to iron ore and coal was accused of the high idiosyncratic volatility.

In the third article [17] B. Ko explored the term structure in the dry bulk freight market, grouping the spot and 6-month time charter rates under short-term and the 1-year and 3-year time charter rates under long-term. The results of the research suggested that the short-term freight rate was determined by both the historical short-term and long-term shocks, but the long-term freight rate was determined mainly by the long-term shock but slightly by the short-term shock. So, the short-term freight rate contains the information on long-term shock, but the long-term freight rate does not contain the information on short-term shock. Also, the scholar noted a close relationship between the effect of the IFTC (implied forward time charter) rate on the actual time charter rate and the market condition (i.e. backwardation).

Similarly to the second article by B. Ko, the paper by V. Tsioumas, S. Papadimitriou, Y. Smirlis, S. Zahran [18] aimed to enhance the forecasting accuracy of the Baltic Dry Index and proposed a new composite indicator, the Dry Bulk Economic Climate Index (DBECI) which was embedded into the model as an exogenous variable. The DBECI is composed of eight sub-indicators: the new residential construction, the Euro/USD and Yuan/USD exchange rates, the Brent crude oil price, the federal funds rate, the consumer credit outstanding, the world industrial production and the manufacturing and the trade inventories. By combining these sub-indicators with the Chinese steel production and the dry bulk fleet development, the authors tried two different modelling approaches towards dry bulk index by generating ex-post and ex-ante forecasts and comparing them with actual. The scientists concluded that the addition of a new indicator (DBECI) reinforced robustness and predictive success of the proposed model.

L. Dai, H. Hu, D. Zhang in the common article [19] attempted to explore the volatility spillover effects across three out of four shipping markets as per M. Stopford's classification – newbuilding vessel market, secondhand vessel market and freight market, namely the



relationship among the freight rate volatility, newbuilding and secondhand vessel price volatility. Significant volatility transmission effects existence was revealed in each market sector, i.e. capesize, panamax, supramax and handysize, with the volatility transmission mechanism varying among different vessel types. It appeared, fair enough, that dry bulk freight rate market was the most volatile among three markets while newbuilding market was the least volatile one. With regards to direction of spillover effects, theoretically it is believed that the demand (freight rate) would influence the supply (newbuilding and secondhand vessels). A possible explanation may be that from the perspective of demand-supply, newbuilding market is the real supply market, as many speculative transactions are made in the secondhand market, that the information from the freight market takes the lead and induces volatility change in the newbuilding market. While as the newbuilding market underlies the intrinsic market value, news spreads from newbuilding market to secondhand market and causes volatility spillover. Although the research detected bilateral volatility transmission effects between freight and secondhand markets, the spillover effect was much stronger from the secondhand vessel market to the freight market. This could be explained that after the 2008 world financial crisis, the global dry bulk shipping market has been totally distorted, the freight rate could not reflect the real demand status, or even, in turn, the freight rate volatility could be determined by the instant secondhand vessel transaction price volatility, which could lead to the spillover from the secondhand market to the freight rate market.

Attempts to introduce conceptualization context behind the lead-lag relationship of the commodities prices and freight rates were jointly taken by N. Michail and K. Melas. The first research [20] was more specific and elaborated on the prices of grain commodities as the biggest part of agricultural trade and their influence on ocean-going dry bulk freight rates. Since agricultural commodities (cocoa, coffee, rice, soyabean, wheat) are mainly transferred by handymax, supramax and panamax vessels, the spot market was taken into analysis due to production seasonality and goods perishability. Importantly, that freight rates have inherent volatility. The results reveal that bulk carrier rates have a strong connection between them as changes in one can strongly affect the other. Supramax vessels are the most volatile and primarily acting as transmitters of volatility shocks to the rest of the dry bulk market. In addition, handymax vessel rates are more directly affected by agricultural prices than panamax or supramax ships. Besides, commodity prices have a strong impact on most vessel classes, with the exception of rice and soybeans. In general, changes in commodity prices also appear to show some evidence of a substitution effect between vessel classes, as higher prices usually suggest a shifting preference towards larger vessels in order to benefit from the reduction in per tonne cost.

The second joint research of the Southern European scholars [21] tried to address the same issue by employing a different methodology of threshold regression. The authors again divided the dry bulk market into several sub-markets (handysize, supramax, panamax, capesize) and came to a general conclusion that across all types of vessels, changes in commodity prices mattered the most in regimes of large negative price growth (underlying that shipping is a derived demand system), providing a backstop to any potential freight rate increase. In positive growth regime no impact of commodity prices on freight rates was observed. In turn, Brent oil was mostly positively associated with freight rates, but usually with a smaller coefficient than compared to commodity prices. When commodity prices decline significantly, freight rates are not only contemporaneously affected but the impact continues over a longer period. And this supports the existence of lead-lag relationships. The research findings appear to be also in line with the view that the cost of transportation matters as a percentage of the final price the consumer will end up paying for good, as when commodity prices drop freight rates also need to decline to more or less maintain a

transportation cost as a fixed percentage of the price. Also, the results confirm the hypothesis that the lower the price the lower transportation risk, and thus the lower the freight rate, which is again a finding holding in the negative growth regime only.

Two more papers on dry bulk market analyze precisely capesize sector as a key barometer of commodities shipping trade. The role of capesize trade is emphasized by the fact that the Baltic Dry Index is affected by the indices of the relevant dry bulk markets in weighting, with the Baltic Capesize Index contributing by far the highest weighting, as T. Pelagidis together with I. Karaoulanis suggested in the joint article [22] which tried to assess the capesize markets behavior focusing on expectations and time lags. Having taken into consideration time charter, trip charter and spot market rates as well as the average earnings of the capesize vessels of various ages, the scientists selected the important lag which determined each capesize freight rate level, conducted static and dynamic forecasts and found out a strong correlation between time lags and capesize freight market, which enabled a possible forecasting of behavior of the market and could improve the planning decisions and investments of shipowners and charterers.

In another article [23] T. Pelagidis and G. Panagiotopoulos investigated the connection between the trading of forward freight agreements (FFAs) and the volatility of capesize freight market of 4 time charter average (4TC) and some specific routes. A forward freight agreement is a financial forward contract that gives the contract owner the right to buy or sell the price of freight for future dates. In other words, the forward prices of non-storable commodities are the forecasts of future spot prices [22]. As M. Stopford notes [3, p. 196], in the late 1990s FFAs took over from futures contracts as the main form of freight derivative. T. Pelagidis and G. Panagiotopoulos reviewed the existing literature on the matter and concluded that there was no single unified opinion on the volatility transmission between the FFA trading and the capesize spot market. Thus, the empirical conclusion states that for the 4TC in the pre-FFA period negative shocks tended to have a diminishing effect on volatility indicating that the spot market overreacted the first day of the negative news and corrected the following. However, FFAs had a positive impact in terms of no effect of negative news in spot rates, which translated to a more efficient flow and integration of information into the physical market. While FFAs could not have eliminated volatility of the physical market entirely, they assisted in keeping uncertainty in lower levels.

The second group among papers which study specific cargo traded, is relatively small and analyses container shipping trade. As UNCTAD notes [2, p. 9], over the 1990-2019 period the container shipping trade demonstrated the most significant volume growth (8 times) in comparison to other cargo types. In 2019, 811.2 million TEUs were handled in container ports worldwide [2, p. 16]. An attempt to find the relationship between the amount of containers transported and real GDP growth was taken by N. Michail, K. Melas and D. Batzilis [1]. The significant positive effect was revealed – a 1% increase in transported TEUs led to an approximate 1.7% increase in GDP. It can be explained via the fact that TEUs have a positive effect on trade flows between countries and trade flows have long been shown to have a strong positive impact on real GDP growth. A worthy note is that the scholars included exchange rate into the model, so that it accounted for any potential movements in GDP that have already been incorporated by the markets and were thus unrelated to the growth in trade.

The third group is oriented on the studies dedicated to crude oil maritime transportation. As per data published by UNCTAD [2, p. 11], in 2019 tanker trade accounted for 3.2 billion tons out of 11.1 billion tons of the world seaborne trade (29%), with crude oil being the major contributor towards general tanker volumes – crude oil accounted for 1.9 billion tons (17% of the world seaborne trade). The maritime economics researches on crude oil transportation mainly concentrate on market's periodicity and cycles duration. J. Chen,

K. Xue, L. Song, J. X. Luo, Y. Mei, X. Huang, D. Zhang, C. Hua [24] selected the one-year charter freight rate of aframax tankers and tried to analyze freight market variation law by dividing the cycle into three categories – short-term, medium-to-long-term and long-term. By finding the periodic characteristics of the particular aframax tanker freight market, the scholars offered a reference for tanker market players to learn the future market trends. However, the use of this research is not limited to the aframax market only. Using the proposed methodology as a baseline, other scientists can examine other specific freight segments against periodical features to help entrepreneurs to have a better understanding of the market volatility for taking correct decisions.

Y. Fei, J. Chen, Z. Wan, Y. Shu, L. Xu, H. Li, Y. Bai, T. Zheng [25] also tried to define fluctuation characteristics of crude oil market and the impact of critical events. Three crude oil transportation lines in maritime shipping were selected whose Baltic Dirty Tanker Index was abnormally disrupted. By applying the Hurst value, the researchers attempted to analyze and predict the BDTI trends for certain routes. As the results suggested, the various qualitative events exerted different impact on the development tendency of BDTI, showing that both the financial crisis and the international competition depressed BDTI, while the environmental awareness and the crude oil agreement were able to stimulate BDTI. The findings can also be of use for investors as soon as the research can serve to guide on the routes and efficient terms of investments to choose at the specific moment of time.

The article by A. Galierikova and M. Materna [26] considered oil spills in view of constantly growing world oil seaborne trade. Although the paper consists of various factual and statistical data, such as share of seaborne transportation in global oil movements, average annual oil trade volume, main oil supplying and consuming countries, share of oil spills from tankers in global ocean oil pollution, review of the biggest oil spills, oil spills frequency trends; from an economic perspective, this study has limited practical use in comparison to the previous articles of the group and can hardly assist in forecasting or post factum analysis of seaborne oil trade.

The second branch of analyzed publications which are concentrated on the certain types of cargo, with the rare exception, aims to scrutinize specific freight markets and introduce the way of how to predict the certain freight rate development more correctly. It differentiates the second branch of studies from the first one, which attempts to perform more generalized seaborne trade forecasts. The second branch of papers has precise specialization on the freight market of certain type while the spillovers between vessel types and vessel sizes are also regularly examined. There are differences in how different freight markets are approached by scientists. If dry bulk sector is mainly scrutinized against freight rates and factors which determine it, crude oil transportation is analyzed from the cyclical standpoint, since crude oil's cycles are more complicated and difficult to decompose than other. Likewise the authors whose researches were included into the first branch, the scholars who study more narrow fields still operate the similar methodology – mainly various models of regression analysis, again depending on the aim of the research and data availability. The most popular regression models employed in above reviewed papers are vector autoregression, time-varying coefficient model, exponential generalized autoregressive conditional heteroskedasticity, stochastic method, vector autoregressive model with exogenous variables, vector error correction model, variance decomposition, threshold regression, GJR-GARCH model, GARCH with BEKK parametrization, panel vector autoregressive approach, wavelet analysis, rescaled range analysis.

**Conclusions.** The study performed an analysis of two types of regular official maritime reports, one monograph, one book review and twenty-two scientific articles on world seaborne trade. These publications were conceptually grouped into two main branches. The first branch included papers focused on the world seaborne trade dynamics. The second

branch comprised papers investigating trade of certain types of cargo, such as dry bulk, containers, crude oil.

Apart from few descriptive articles which have limited practical applicability, the majority of the considered studies have several common characteristics. The first and foremost is related to the purpose of each paper – to certain extent all of them attempt to provide an insight into the nature of freight rate as a main variable of interest for all stakeholders of the shipping industry and to forecast short- and long-term freight market dynamics. The second similarity lies in the way the declared aims are achieved methodology wise. The leading world economists employ regression analysis, a standard tool of statistical modelling, which estimates the average relationship between two or more variables. A choice of a regression model type depends on the aim of the research and data availability, since credible shipping data used to be scarce for a long time and hindered potentially meaningful models. For the sake of forecasts fine-tuning, some papers attempt to develop and count new indices which are intended to support and reflect freight rate dynamics in a more correct manner than existing ones. However, the biggest quantity of analyzed studies rely on the indices published by the Baltic Exchange, which are commonly used by the industry as a part of pricing mechanism for a charter party. The third common feature is that even the studies which pursue some specific freight markets usually try to examine the connection of this market with others, by evaluating the spillover effects between vessel types and vessel sizes. The leading role of dry bulk segment which regularly transmits different signals to other segments, is widely acknowledged.

At the same time there are distinguishing features of the researches under review. The first branch of researches can be predominantly useful for governments, port authorities, industry practitioners, policymakers and big international shipping corporations who own, operate or manage vessels of various types. Benefit for administrative authorities lies in assistance in formulating policies, for instance, fiscal and tax; for policymakers – in insight to maintain stability of the industry. The second branch of publications is more vessel-specific, that means it can bring more practical use to certain cargo owners and smaller shipping companies specializing in certain vessel type and which, although should be conversant with general industry's state and dynamics, need to timely predict changes happening on a specific freight market segment. The studies of the second branch can help enterprises to have a better understanding of the volatility of any freight rate market and can serve to guide decision-makers regarding proper investment and ship purchasing.

Some features attributable to individual researches or groups were ascertained. Dry bulk trade is broadly scrutinized against the freight rates correlation with macroeconomic indicators, commodity prices, exchange rates, derivatives, vessel asset prices, while the approaches applied towards other types of cargo are restricted, the cycles periodicity analysis being the main for crude oil transportation.

The common peculiarity of the IMF papers on maritime economics is the use of AIS messages for the purpose of nowcasting and forecasting international trade data. Such a solution is totally innovative and despite it has already demonstrated relevance and viability, this approach still requires ongoing developments. It is important that maritime transport digitalization itself is quickly progressing and this attracts scholars and researchers. It was also noticed that the researches aimed to build a model to predict trade data used import volume as a trade indicator.

Another venue for future scientific activity in this field is assessment of impact of oil price changes on different freight rates. Currently oil price as a variable is incorporated into models produced by N. Michail and K. Melas while other papers prioritize different factors when studying freight rates. To the current moment, the positive correlation between oil price and freight indices is observed, with the exception of the Baltic Dirty Tanker Index because

using tankers as floating storage capacity is a common practice for the periods of oil market distress and this was reconfirmed during the first two months of covid pandemic.

Supply-side disruptions of global seaborne trade caused by the pandemic outbreak and subsequent containment measures are also intensively studied by world economists and will remain at the center of scientific activities due to unprecedented nature of the 2020 shock, second-round effects of it and extended range of stakeholders affected, such as policymakers, governments, port authorities, shipowners, cargo owners, charterers, operators, shipbuilders, machinery manufacturers, bankers and employees occupied in shipping. Furthermore, one more covid-related venue for future scientific activity can be the magnitude of swings in secondhand ships pricing and volume during the pandemic outbreak (price drop) and recovery (price surge) periods, as well as long-term relationship between these swings in asset prices and seaborne trade demand; in the strict sense this is the research of interaction between the freight market and the sale and purchase market.

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## ВПЛИВ ДИСПРОПОРЦІЙНОСТІ РОЗВИТКУ КРАЇН НА ЇХ ГОТОВНІСТЬ ДО ТРАНСФОРМАЦІЙ В РАМКАХ РЕАЛІЗАЦІЇ КОНЦЕПЦІЇ СТАЛОГО РОЗВИТКУ: ГІПОТЕТИЧНИЙ ПІДХІД

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**Анотація.** Стаття піднімає проблему готовності світу до трансформацій, що передбачає реалізацію загальноприйнятої концепції сталого розвитку, заснованої на складних модифікованих соціально-економічних процесах: перехід до зеленої, низьковуглецевої, кругової економіки на основі екоінновацій та декаплінгу, який покликаний мінімізувати залежність економічного зростання від обсягу затрат невідновлюваних природних ресурсів.

Висунуто гіпотезу про те, що до сталого розвитку більшою мірою залучені розвинені держави світу з високим рівнем життя, лідери у процесах глобалізації, так як їх виробництво уже давно не поміщається в рамках державних кордонів і саме тому їх капітал мігрував в інші країни з метою пошуку дешевших факторів виробництва, максимізації економічної вигоди та експансії їх політичного впливу. Первинні потреби населення розвинених країн є більшою мірою задоволеними, а отже домінують потреби вищого рівня, культивуються загальнолюдські цінності та суспільне благо, що мотивує їх до активного розвитку процесів екологізації економіки, піклуючись про долю нашої планети як спадок для наступних поколінь.

Метою дослідження є виявлення кореляційного зв'язку між рівнем життя країн світу та ступенем їх залучення до процесів реалізації концепції сталого розвитку.

Для підтвердження висунутої гіпотези, на базі методики розрахунку коефіцієнта кореляції Фехнера, досліджено наявність кореляційного зв'язку між рівнем життя країни та ступенем її залучення до процесів сталого розвитку на основі рейтингів за показником ВВП за паритетом купівельної спроможності на душу населення, як індикатора рівня життя країни та