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THESIS

**DEVELOPMENT OF THE GLOBAL SHIPPING INDUSTRY
UNDER ASYMMETRIES IN INTERNATIONAL SEABORNE TRADE**

Speciality 292 – International Economic Relations

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This thesis contains the results of the author's own research. The ideas, findings and texts of other authors used in the thesis are properly referenced

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ABSTRACT

Zaidman G. B. Development of the global shipping industry under asymmetries in international seaborne trade. – A qualification academic paper in manuscript.

A thesis for the degree of Doctor of Philosophy (PhD) in the field of study 29 International Relations in speciality 292 International Economic Relations. – Odesa I. I. Mechnikov National University, Odesa, 2026.

This PhD thesis is an in-depth investigation of development of the global shipping industry under asymmetries in international seaborne trade.

The introduction establishes the relevance of the PhD research topic and its link to R&D projects, and formulates the research aim and objectives. This is followed by defining the object and subject of the research, and outlining the methods employed. Finally, the introduction presents the key contributions of the PhD study which corroborate the scientific novelty and practical significance of the findings.

Chapter 1 of the thesis discusses contemporary theoretical and methodological foundations of international seaborne trade. In this regard, the roles of international trade and maritime transport in the system of international economic relations are identified, the genesis of international seaborne trade and its asymmetries, shipping markets' cyclicity and shipping finance are examined, with a focus on four main shipping markets that facilitate the industry, four-stage short shipping cycle, and historical phases of shipping finance. The latter underscores the enduring role of capital in the shipping industry and reveals transformation of the relationship between shipping companies and financial institutions throughout the 20th century. Based on analysis and generalisation of the existing approaches to examining the origin, reasons and consequences of asymmetries in international seaborne trade, this PhD research suggests defining asymmetries in international seaborne trade as an economic phenomenon observed at the global, regional, national and company levels in the form

of geographical, sectoral and product disproportions in maritime trade flows due to a combination of underlying economic, geopolitical, historical, cultural, technological, environmental, social, institutional and regulatory, as well as technical and operational factors, predetermining uneven distribution of goods transported by sea among both producers and consumers.

Overall, it has been established that existing literature in the field of maritime economics can be classified into four categories. In addition to books and scientific publications, shipping research also relies on industry reviews and market intelligence reports regarding sea transport services. The key focus areas of shipping economics research include assessment of trends and dynamics of main shipping economic parameters, evaluation of influence of external events on shipping, impact of energy transition on shipping policies, strategies and economic results of maritime transportation, and development of fleet renewal investment strategies.

The systematisation of existing theoretical and methodological approaches to studying shipping economic variables has enabled enhancement of methodological apparatus and development of econometric models employed further in this research to investigate performance of freight indices in the dry bulk and oil tanker sectors, charter rates in the containership sector, and market capitalisation of shipping companies operating in the bulk sector, considering the influence of selected economic variables that capture the broader economic dynamics, particularly real economy, commodity and global financial markets' indicators.

Chapter 2 of the thesis is concerned with comprehensively analysing international seaborne trade, freight and stock markets performance from an empirical perspective. This study has revealed a generally upward trend in development of international seaborne trade, with temporary slowdowns due to critical events in the world economy, including the financial crisis, the COVID-19 pandemic and the war in Ukraine. A similar trend is replicated in development of global fleet. The three major

segments of the cargo shipping industry are identified: the dry bulk, the liquid bulk, and the container segments. The research outcomes have illustrated the existence of sectoral, geographical and product asymmetries in international seaborne trade. Based on the data analysis, the study suggests an enhanced analytical toolkit for the assessment of shares of the key shipping sectors that draws on the share of each segment in either of the following indicators, all of which proved equally reliable: cumulative world's fleet deadweight capacity, global seaborne trade volumes in tonnes, and global seaborne trade volumes in tonne-miles.

Through application of econometric modelling techniques, the dynamics of key shipping economic indicators has been assessed which contributed to a deeper understanding of their main determinants. In the dry bulk segment, global cost of capital is shown to affect the freight rates. With regard to oil tanker freight indices, the study has recorded positive effects of inflation that closely correlates with interest rates thus enabling to partially generalise the findings across both sectors, and negative impact of oil prices and global oil production. The latter requires complex substantiation in light of wider economic environment shaping demand-supply equilibrium through such channels as alternative oil sources exploration or adjustments in sellers' market behaviour aimed at securing demand. In containership transportation, charter rates have been affected by vessel prices, industrial growth in China and the USA, prices of steel, and market capitalisation of one of the leading companies in the sector. In turn, industrial production and container port throughput indicators of emerging Asian countries have shown dependence on container charter rates, as opposed to the more advanced U.S. and European economies. This finding illustrates a manifestation of asymmetries in international seaborne trade.

Furthermore, econometric modelling of market capitalisation indicators of the leading shipping companies engaged in the dry bulk and oil trade has revealed predominantly individualised behaviour of companies' stocks, restricting ability to

fully generalise outcomes. In the dry bulk segment, consistency has been observed for the most highly valued companies which displayed sensitivity to the Standard and Poor's (S&P) 500 index and price of aluminium. In the oil tanker sector, market capitalisation indicators of companies with similar characteristics have shown a dependence on similar factors; in particular companies operating relatively large fleets have been affected by interest rates, those shipping companies running smaller fleets – by freight rates, companies with longer listing history – by the S&P 500 index. Companies' geographical origin has not proved impactful. Based on the results of the modelling and given limited opportunity to unify behavioural patterns of shipping companies' stocks, conceptual principles of the investment portfolio management are enhanced, and investors are advised to adopt an individualised approach and perform company-based assessment when contemplating the inclusion of shipping stocks into their investment portfolios.

Chapter 3 of the thesis is devoted to the strategic outlook of international seaborne trade in the world economy, placing a special emphasis on the impact of evolving environmental regulations on shipping economic parameters. The core scenarios forecast a steady global economic growth and an increase in international seaborne trade. Despite the increased volumes and probable structural transformations in trade and fleet, asymmetric characteristics of both are likely to still be present. These asymmetries, in conjunction with decarbonisation requirements and financial frameworks, have to be taken into consideration when formulating and executing shipping strategies. As the decarbonisation trend progresses, the forecasts suggest strengthening regulations, lower availability of capital, and medium-term growth of shipping markets with long-term stabilisation as far as compliant vessels and companies are concerned. Besides, the chapter also discusses alternative decarbonisation scenarios which diverge from the current trend. These scenarios are classified according to the dominant policy in the global economy, wherein levels of

decarbonisation compliance control measures vary, exhibiting a direct economic impact on global shipping markets. Moreover, this study suggests an elaborated extension of periodisation of shipping finance from six to eight phases through introduction of listing and decarbonisation phases that reflect modern trends in shipping finance.

This PhD research pays particular attention to the role of Ukraine in global shipping. Based on the analysis of statistical data, the study has characterised the current state of Ukraine's foreign economic activity and Ukraine's maritime economy, categorising the identified characteristics as either advantages or disadvantages. As a result, the research proposes a maritime competitive advantage strategy for Ukraine, which is built upon existing strengths and contains recommendations on mechanisms for Ukraine's successful integration into the global shipping. The main expected effects of the strategy's implementation include international establishment, investment attractiveness, trade balance improvement, modernisation, and socio-economic benefits.

The practical significance of the research outcome is that it may enable to enhance the educational process, optimise operations, costs and ensure more advanced and informed decisions in shipping companies and other maritime transport enterprises through better management, planning and forecasting efficiency, as well as to improve government policies for maritime development of Ukraine.

Keywords: shipping, maritime transport, asymmetries in international seaborne trade, shipping companies, fleet, seaborne trade, dry bulk trade, container transportation, tanker sector, freight market, freight rates, shipping finance, market capitalisation, decarbonisation, sea transport services.

LIST OF THE CANDIDATE'S PUBLICATIONS ON THE SUBJECT OF THE PhD RESEARCH

**Publications that present the major scientific
findings and outcomes of the PhD research**

1) Papers in scientific publications included in the List of Scientific Professional Publications of Ukraine

1. Yakubovskiy, S. and Zaidman, G. (2024) 'Dynamics and structure of world seaborne trade in 2009-2023: impact of COVID-19 pandemic and Ukrainian war', *Aktual'ni Problemi Mizhnarodnih Vidnosin* [Actual Problems of International Relations], 1(158), pp. 70–84. doi: <https://doi.org/10.17721/apmv.2024.158.1.70-84>
The candidate's personal contribution includes empirical analysing the dynamics, trends and structural changes in international seaborne trade, and suggesting an enhancement of the analytical toolkit for evaluating sectoral proportions in shipping. The co-author contributed by performing academic supervision and validation of the findings.
2. Zaidman, G. (2025a) 'Evoliutsiia svitovoi sudnoplavnoi haluzi v umovakh asymetrii mizhnarodnoi torhivli ta dekarbonizatsii' ['Evolution of the global shipping industry under asymmetries in international seaborne trade and decarbonisation'], *Galic'kij Ekonomichnij Visnik* [Galician Economic Journal], 97(6), pp. 17–28. doi: https://doi.org/10.33108/galicianvisnyk_tntu2025.06.017 [in Ukrainian].
3. Zaidman, G. and Yakubovskiy, S. (2021a) 'Ekonomika morskoho transportu ta morska torhivlia v suchasnykh doslidzhenniakh uchenykh iz postradianskykh

krain’ [‘Maritime economics and seaborne trade in current studies of scientists from post-Soviet states’], *Pričornomors'kì Ekonomìčnì Studii* [Black Sea Economic Studies], (63), pp. 11–19. doi: <https://doi.org/10.32843/bses.63-2> [in Ukrainian].

The candidate’s personal contribution includes a critical review and categorisation of the literature sources, and generalisation of observed trends. The co-author contributed by performing academic supervision and validation of the findings.

4. Zaidman, G. and Yakubovskiy, S. (2021b) ‘Peculiarities of current world scientific researches on maritime economics and specifically seaborne trade’, *Aktual'ni Problemi Rozvitku Ekonomiki Regionu* [The Actual Problems of Regional Economy Development], 1(17), pp. 8–22. doi: <https://doi.org/10.15330/apred.1.17.8-22>

The candidate’s personal contribution includes a critical review and categorisation of the literature sources, and generalisation of observed trends. The co-author contributed by performing academic supervision and validation of the findings.

5. Zaidman, G. and Yakubovskiy, S. (2025) ‘Modeling dynamics of oil tanker freight rates and market capitalization of oil tanker shipping companies’, *Včeni Zapiski* [Scientific-Research Works], (38(1)), pp. 301–315. doi: https://doi.org/10.33111/vz_kneu.38.25.01.24.166.172

The candidate’s personal contribution includes a correlation-regression analysis and evaluation of the dynamics of freight rates and shipping companies’ market capitalisation in the oil tanker sector. The co-author contributed by performing academic supervision and validation of the findings.

6. Zaidman, G., Yakubovskiy, S. and Romanenko, S. (2025) ‘Modeling dynamics of dry bulk freight rates and market capitalization of dry bulk shipping companies’, *Kiivs'kij Ekonomìčnij Naukovij Žurnal* [Kyiv Economic Scientific Journal], (8), pp. 52–59. doi: <https://doi.org/10.32782/2786-765X/2025-8-7>

The candidate's personal contribution includes a hypothesis formulation, correlation-regression analysis, and evaluation of the dynamics of freight rates and shipping companies' market capitalisation in the dry bulk sector. The first co-author, S. Yakubovskiy, contributed by performing academic supervision and validation of the findings. The second co-author, S. Romanenko, contributed by providing a methodological support.

2) Papers in scientific periodicals indexed in Web of Science Core Collection and/or Scopus databases

7. Zaidman, G. *et al.* (2021) 'Containership charter rates: analysis of unprecedented growth after COVID-19 pandemic outbreak', *Journal of Global Policy and Governance*, 10(2), pp. 21–38. doi: <https://doi.org/10.14666/2194-7759-10-2-002> [indexed in the Scopus database].

The candidate's personal contribution includes a hypothesis formulation, correlation-regression analysis, and evaluation of the dynamics of charter rates in the container sector. The first co-author, G. Dominese, contributed by providing a conceptual support. The second co-author, S. Yakubovskiy, contributed by performing academic supervision and validation of the findings. The third co-author, T. Rodionova, contributed by providing a methodological support.

Publications that substantiate the validation of the PhD research material

8. Zaidman, G. (2021a) 'Covid-19 pandemic's impact on shipping industry: quickly recovered dry sector and stagnating tanker fleet', *Sotsialno-ekonomichnyi ta politychnyi rozvytok v umovakh yevropeiskoi intehtratsii, zbirnyk naukovykh prats mizhnarodnoi naukovo-praktychnoi konferentsii* [Socio-economic and political

- development in the context of European integration, collection of scientific reports of the international scientific and practical conference]. Odesa, June 2021. Odesa: Odesa I. I. Mechnikov National University, pp. 64–65.
9. Zaidman, G. (2021b) ‘Dry bulk carriers and containerships move the post-Covid shipping industry’, *Materialy Mizhnarodnoi naukovo-praktychnoi internet-konferentsii “Tendentsii ta perspektyvy rozvytku nauky i osvity v umovakh hlobalizatsii”*, *zbirnyk naukovykh prats* [Proceedings of the international scientific and practical online conference “Trends and prospects for the development of science and education in the context of globalization”, collection of scientific papers], (77). Online, December 2021. Pereiaslav: Hryhorii Skovoroda University in Pereiaslav, pp. 77–80.
 10. Zaidman, G. (2022) ‘Shipping industry in 2022: new disruption after recovery’, *Sotsialno-ekonomichni ta politychni rozvytok krain u suchasnykh umovakh, zbirnyk naukovykh prats mizhnarodnoi naukovo-praktychnoi konferentsii* [Socio-economic and political development of countries in modern context, collection of scientific reports of the international scientific and practical conference]. Odesa, May 2022. Odesa: Odesa I. I. Mechnikov National University, pp. 61–62.
 11. Zaidman, G. (2025b) ‘Rol morskoho transportu v zovnishnii torhivli Ukrainy’ [‘The role of maritime transport in the foreign trade of Ukraine’], *Ekonomika sohodennia ta mizhnarodne spivrobitnytstvo, materialy Vseukrainskoi naukovo-praktychnoi konferentsii* [Modern economy and international cooperation, proceedings of the All-Ukrainian international scientific and practical conference]. Odesa, November 2025. Odesa: Odesa I. I. Mechnikov National University, pp. 151–155. doi: <https://doi.org/10.36059/978-966-397-558-0-38> [in Ukrainian].
 12. Zaidman, G. and Yakubovskiy, S. (2021c) ‘Shipping industry in bounce back after pandemic, with containership sector leading the way’, *Economic trends: new opportunities and threats, international scientific conference*. Le Mans, November

2021. Riga, Latvia: Baltija Publishing, pp. 9–12. doi: <https://doi.org/10.30525/978-9934-26-158-9-3>

The candidate's personal contribution includes an analysis of the COVID-19's impact on global shipping and post-pandemic development of the industry. The co-author contributed by performing academic supervision.

13. Zaidman, G. and Yakubovskiy, S. (2023) 'World seaborne trade in 2023: new recovery after disruption', *Tvorchyi vnesok profesora Antona Filipenka u navchalno-naukovyi protses ekonomichnykh spetsialnostei vyshchykh navchalnykh zakladiv Ukrainy, materialy naukovooho sympoziumu* [Professor Anton Filipenko's scholarly contribution to the educational and research development of economic disciplines in higher education institutions of Ukraine: proceedings of the academic symposium]. Kyiv, December 2023. Kyiv: Educational and Scientific Institute of International Relations of Taras Shevchenko National University of Kyiv, pp. 57–58.

The candidate's personal contribution includes an identification of contemporary trends in the development of international seaborne trade. The co-author contributed by performing academic supervision.

14. Zaidman, G. and Yakubovskiy, S. (2024a) 'Influence of Covid-19 shock and Ukrainian war on international seaborne trade', *Actual problems of international relations, collected papers*, (159/2). Kyiv, May 2024. Kyiv: Educational and Scientific Institute of International Relations of Taras Shevchenko National University of Kyiv, pp. 7–9.

The candidate's personal contribution includes an evaluation of response of global maritime trade on the COVID-19 pandemic and the war in Ukraine. The co-author contributed by performing academic supervision.

15. Zaidman, G. and Yakubovskiy, S. (2024b) 'Shipping industry after Ukrainian war outbreak: quantitative and qualitative changes', *Sotsialno-ekonomichnyi ta*

politychnyi rozvytok krain v umovakh hlobalnoi nestabilnosti, materialy druhoi mizhnarodnoi naukovo-praktychnoi konferentsii [Socio-economic and political development of countries under conditions of global instability, proceedings of the second international scientific and practical conference]. Odesa, May 2024. Odesa: Odesa I. I. Mechnikov National University, pp. 30–31.

The candidate's personal contribution includes an analysis of high-level transformations in dry bulk and tanker international seaborne trade caused by the war in Ukraine. The co-author contributed by performing academic supervision.

АНОТАЦІЯ

Зайдман Г. Б. Розвиток світової судноплавної галузі в умовах асиметрії міжнародної морської торгівлі. – Кваліфікаційна наукова праця на правах рукопису.

Дисертація на здобуття наукового ступеня доктора філософії з галузі знань 29 «Міжнародні відносини» за спеціальністю 292 «Міжнародні економічні відносини». – Одеський національний університет імені І. І. Мечникова, Одеса, 2026.

Дисертація присвячена комплексному дослідженню розвитку світової судноплавної галузі в умовах асиметрії міжнародної морської торгівлі.

У вступі визначено актуальність теми дисертаційної роботи та її зв'язок з науковими програмами, сформульовано мету та завдання дослідження. Згідно з метою та завданнями, визначено об'єкт та предмет дисертаційної роботи та описано методи дослідження, які застосовувалися. Основні положення, які відображають наукову новизну дисертації, також наведені у вступі разом із практичним значенням отриманих результатів та підтвердженням їхньої апробації.

У розділі 1 дисертаційної роботи розглянуто сучасні теоретичні та методологічні засади міжнародної морської торгівлі. У зв'язку з цим було визначено роль міжнародної торгівлі та морського транспорту в системі міжнародних економічних відносин, досліджено генезис міжнародної морської торгівлі та її асиметрії, циклічності судноплавних ринків та фінансування судноплавства з акцентом на чотири основні судноплавні ринки, які забезпечують функціонування галузі, короткий судноплавний цикл, що складається з чотирьох фаз, та історичні етапи розвитку фінансування судноплавства. Останній аспект підкреслює незмінну роль капіталу в судноплавній галузі та розкриває

трансформацію взаємовідносин між судноплавними компаніями та фінансовими інституціями впродовж 20-го століття.

На основі аналізу та узагальнення існуючих підходів до дослідження походження, причин та наслідків асиметрії міжнародної морської торгівлі у дисертаційній роботі запропоновано визначати асиметрію міжнародної морської торгівлі як економічне явище, яке спостерігається на глобальному, регіональному, національному рівнях та рівні компаній у формі географічних, секторальних та продуктових диспропорцій у морських торговельних потоках, в основі яких лежить комбінація економічних, геополітичних, історичних, культурних, технологічних, екологічних, соціальних, інституційно-регуляторних, техніко-операційних факторів, що зумовлює нерівномірний розподіл товарів, які перевозяться морем, між продавцями та споживачами.

Загалом було встановлено, що існуючу літературу в галузі морської економіки можна класифікувати за чотирма основними категоріями. На додаток до книг та наукових публікацій, дослідження в судноплавній галузі також спираються на галузеві огляди та аналітичні ринкові звіти щодо послуг морського транспорту. Ключові напрямки економічних досліджень у сфері судноплавства включають оцінку тенденцій та динаміки основних судноплавних економічних параметрів, аналіз впливу зовнішніх подій на судноплавство, оцінку впливу енергетичного переходу на політики та стратегії у судноплавстві та на економічні результати морських перевезень, а також розробку інвестиційних стратегій оновлення флоту.

Систематизація існуючих теоретичних та методологічних підходів до вивчення судноплавних економічних індикаторів дозволила удосконалити методологічний апарат та розробити економіко-математичні моделі, які було використано в цій дисертації для дослідження фрахтових індексів у секторах суховантажної торгівлі та перевезень нафти на нафтопродуктів, чартерних ставок

у сегменті контейнерних перевезень, а також показників ринкової капіталізації судноплавних компаній, що здійснюють діяльність у балкерному та танкерному секторах, з урахуванням впливу обраних економічних показників, що охоплюють економічний контекст ширшого спектру, зокрема індикаторів реального сектору економіки, товарних та глобальних фінансових ринків.

У розділі 2 дисертаційної роботи представлено комплексний емпіричний аналіз міжнародної морської торгівлі, показників фрахтових та фондових ринків. Загалом виявлено позитивні тенденції у розвитку міжнародної морської торгівлі з тимчасовими уповільненнями, викликаними критичними подіями для світової економіки, зокрема фінансовою кризою, пандемією коронавірусу та війною в Україні. Подібні тенденції стосуються і розвитку світового флоту. Було визначено три основні сегменти вантажної судноплавної галузі: сектор перевезень навалювальних вантажів, сектор перевезень наливних вантажів та сектор перевезень контейнерів. Результати дослідження продемонстрували наявність секторальної, географічної та продуктової асиметрії міжнародної морської торгівлі. На основі аналізу даних у роботі запропоновано удосконалений аналітичний інструментарій оцінки питомої ваги ключових судноплавних сегментів, який спирається на частки кожного сегмента в одному з показників, які продемонстрували однакову надійність, а саме сумарній вантажопідйомності світового флоту, обсязі світової морської торгівлі в тоннах та обсязі світової морської торгівлі в тонно-милях.

Завдяки застосуванню методів економіко-математичного моделювання у дисертації проведено оцінку динаміки ключових судноплавних економічних індикаторів, що сприяло більш глибокому розумінню їхніх основних детермінант. Було виявлено, що у сегменті суховантажних перевезень на фрахтові ставки впливає світова вартість капіталу. Щодо фрахтових індексів нафтових танкерів, зафіксовано позитивний вплив інфляції, яка тісно корелює з відсотковими

ставками і тому дозволяє частково узагальнити результати моделювання для обох секторів, та негативний вплив цін на нафту та обсягів світового виробництва нафти. Останнє спостереження потребує комплексного обґрунтування з огляду на ширші економічні прояви, які можуть формувати рівновагу попиту та пропозиції через такі канали, як освоєння альтернативних джерел видобутку нафти або зміни у ринковій поведінці продавців, спрямовані на утримання обсягів попиту. У сегменті контейнерних перевезень було підтверджено залежність чартерних ставок від цін на судна, індустріального зростання в Китаї та США, цін на сталь, а також ринкової капіталізації однієї з лідируючих компаній сектору. Зі свого боку, показники промислового виробництва в країнах Азії та перевалки контейнерів портами азійських країн, що розвиваються, на відміну від показників розвинених економік США та Європи, продемонстрували статистичну залежність від контейнерних чартерних ставок. Цей результат дослідження ілюструє один із проявів асиметрії у міжнародній морській торгівлі.

Крім того, економетричне моделювання індикаторів ринкової капіталізації лідируючих судноплавних компаній у балкерному та танкерному секторах виявило переважно індивідуалізовану поведінку акцій компаній, обмежуючи можливість повністю узагальнити результати. У сегменті перевезень навалювальних вантажів подібну поведінку проявили компанії найбільшої вартості, показавши залежність від фондового індексу Standard and Poor's (S&P) 500 та цін на алюміній. У сегменті перевезень наливних вантажів показники ринкової капіталізації танкерних компаній зі схожими характеристиками продемонстрували залежність від подібних факторів, зокрема на компанії, що експлуатують відносно великі флоти за розміром, впливають відсоткові ставки, на компанії з меншими флотами – фрахтові ставки, на компанії з більш тривалою біржовою історією – індекс S&P 500. Географічне походження компаній не виявилось визначальним фактором. Відповідно до результатів

моделювання і через лімітовану можливість уніфікувати поведінкові моделі акцій судноплавних компаній, концептуальні засади управління інвестиційним портфелем було удосконалено, а інвесторам рекомендовано застосовувати індивідуалізований підхід та виконувати оцінювання кожної компанії окремо під час планування додавання акцій судноплавних компаній у свої інвестиційні портфелі.

Розділ 3 дисертаційної роботи присвячений стратегічному погляду на міжнародну морську торгівлю в контексті світової економіки з особливим акцентом на вплив екологічних норм, які постійно розвиваються, на судноплавні економічні показники. Ключові сценарії прогнозують стабільне зростання світової економіки та міжнародної морської торгівлі. Незважаючи на збільшення обсягів та ймовірні структурні трансформації торгівлі та флоту, очікується, що асиметричні характеристики обох зберігатимуться. Цю асиметрію разом із декарбонізаційними вимогами та фінансовими рамками слід враховувати під час формулювання та реалізації судноплавних стратегій. Згідно з прогнозами, в рамках декарбонізаційного тренду очікується посилення регулювань, зниження рівня доступності капіталу та середньострокове зростання судноплавних ринків із довгостроковою стабілізацією стосовно суден та компаній, що відповідають вимогам. Водночас в дослідженні представлено альтернативні сценарії декарбонізації, які відхиляються від поточного тренду. Запропоновано класифікацію альтернативних сценаріїв декарбонізації за домінуючою політикою у світовій економіці, в яких рівні жорсткості контролю за виконанням екологічних вимог відрізняються, справляючи прямий економічний вплив на світові судноплавні ринки. Крім того, в дисертації розроблено та запропоновано розширення періодизації розвитку фінансування судноплавства з шести до восьми етапів шляхом введення фаз лістингу та декарбонізації, які відображають сучасні тенденції фінансування судноплавства.

Окрему увагу в дисертації приділено ролі України у світовому суднопластві. На підставі аналізу статистичних даних в роботі охарактеризовано поточний стан зовнішньоекономічної діяльності України та морської економіки України шляхом категоризації виявлених характеристик як переваг або недоліків. В результаті у дисертації запропоновано морську стратегію конкурентних переваг України, яка ґрунтується на наявних сильних сторонах та містить рекомендації щодо механізмів успішної інтеграції України у глобальне суднопластво. До ключових очікуваних результатів реалізації цієї стратегії віднесено становлення України на рівні міжнародної транспортної системи, інвестиційну привабливість, покращення торгового балансу, модернізацію та соціально-економічні вигоди.

Практичне значення результатів дисертації полягає в тому, що вони можуть дозволити удосконалити освітній процес, оптимізувати операційну діяльність, витрати і забезпечити ухвалення більш просунутих та обґрунтованих рішень у судноплавних компаніях та інших підприємствах морського транспорту завдяки підвищеній ефективності управління, планування та прогнозування, а також покращити державну політику морського розвитку України.

Ключові слова: суднопластво, морський транспорт, асиметрія міжнародної морської торгівлі, судноплавні компанії, флот, морська торгівля, суховантажна торгівля, контейнерні перевезення, танкерний сектор, фрахтовий ринок, фрахтові ставки, фінансування суднопластва, ринкова капіталізація, декарбонізація, послуги морського транспорту.

СПИСОК ОПУБЛІКОВАНИХ ПРАЦЬ ЗДОБУВАЧА ЗА ТЕМОЮ ДИСЕРТАЦІЇ

Праці, в яких опубліковані основні наукові результати дисертації

1) Статті у наукових виданнях, включених до переліку наукових фахових видань України

1. Зайдман Г. Б., Якубовський С. О. Економіка морського транспорту та морська торгівля в сучасних дослідженнях учених із пострадянських країн. *Причорноморські економічні студії*. 2021. Вип. 63. С. 11–19. DOI: <https://doi.org/10.32843/bses.63-2>
Особистий внесок здобувача включає критичний огляд і категоризацію джерел літератури та узагальнення спостережуваних тенденцій. Особистий внесок співавтора полягає у науковому керівництві та рецензуванні результатів.
2. Зайдман Г. Еволюція світової судноплавної галузі в умовах асиметрії міжнародної торгівлі та декарбонізації. *Галицький економічний вісник*. 2025. № 6(97). С. 17–28. DOI: https://doi.org/10.33108/galicianvisnyk_tntu2025.06.017
3. Yakubovskiy S., Zaidman G. Dynamics and structure of world seaborne trade in 2009-2023: impact of COVID-19 pandemic and Ukrainian war. *Актуальні проблеми міжнародних відносин*. 2024. Том 1, № 158. С. 70–84. DOI: <https://doi.org/10.17721/apmv.2024.158.1.70-84>
Особистий внесок здобувача включає емпіричний аналіз динаміки, тенденцій і структурних змін у міжнародній морській торгівлі та запропоноване удосконалення аналітичного інструментарію оцінки секторальних

пропорцій у судноплавстві. Особистий внесок співавтора полягає у науковому керівництві та рецензуванні результатів.

4. Zaidman G. B., Yakubovskiy S. O. Peculiarities of current world scientific researches on maritime economics and specifically seaborne trade. *Актуальні проблеми розвитку економіки регіону*. 2021. Том 1, № 17. С. 8–22. DOI: <https://doi.org/10.15330/apred.1.17.8-22>

Особистий внесок здобувача включає критичний огляд і категоризацію джерел літератури та узагальнення спостережуваних тенденцій. Особистий внесок співавтора полягає у науковому керівництві та рецензуванні результатів.

5. Zaidman G., Yakubovskiy S. Modeling dynamics of oil tanker freight rates and market capitalization of oil tanker shipping companies. *Збірник наукових праць «Вчені записки»*. 2025. № 38(1). С. 301–315. DOI: https://doi.org/10.33111/vz_kneu.38.25.01.24.166.172

Особистий внесок здобувача включає кореляційно-регресійний аналіз та оцінку динаміки ставок фрахту та ринкової капіталізації судноплавних компаній у секторі перевезень наливних вантажів. Особистий внесок співавтора полягає у науковому керівництві та рецензуванні результатів.

6. Zaidman G., Yakubovskiy S., Romanenko S. Modeling dynamics of dry bulk freight rates and market capitalization of dry bulk shipping companies. *Київський економічний науковий журнал*. 2025. №. 8. С. 52–59. DOI: <https://doi.org/10.32782/2786-765X/2025-8-7>

Особистий внесок здобувача включає формулювання гіпотези, кореляційно-регресійний аналіз та оцінку динаміки ставок фрахту та ринкової капіталізації судноплавних компаній у секторі перевезень навалювальних вантажів. Особистий внесок співавтора С. Якубовського полягає у

науковому керівництві та рецензуванні результатів. Особистий внесок співавтора С. Романенко полягає у методологічному супроводі.

2) Статті у періодичних наукових виданнях, проіндексованих у базах даних Web of Science Core Collection та/або Scopus

7. Containership charter rates: analysis of unprecedented growth after COVID-19 pandemic outbreak / G. Zaidman, G. Dominese, S. Yakubovskiy, T. Rodionova. *Journal of Global Policy and Governance*. 2021. Vol. 10, no. 2. P. 21–38. DOI: <https://doi.org/10.14666/2194-7759-10-2-002> (проіндексовано у базах даних Scopus)

Особистий внесок здобувача включає формулювання гіпотези, кореляційно-регресійний аналіз та оцінку динаміки чартерних ставок у секторі контейнерних перевезень. Особистий внесок співавтора G. Dominese полягає у концептуальному супроводі. Особистий внесок співавтора С. Якубовського полягає у науковому керівництві та рецензуванні результатів. Особистий внесок співавтора Т. Родіонової полягає у методологічному супроводі.

Праці, які засвідчують апробацію матеріалів дисертації

8. Зайдман Г. Роль морського транспорту в зовнішній торгівлі України. *Економіка сьогодення та міжнародне співробітництво* : матеріали Всеукр. наук.-практ. конф., 7 листопада 2025 р. Одеса : Одес. нац. ун-т ім. І. І. Мечникова, 2021. С. 151–155. DOI: <https://doi.org/10.36059/978-966-397-558-0-38>
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наук. праць, 15 травня 2024 р. Вип. 159 (спецвипуск). Ч.1. Київ : Київський національний університет імені Тараса Шевченка. Навчально-науковий інститут міжнародних відносин, 2024. С. 7–9.

Особистий внесок здобувача включає оцінку реакції глобальної морської торгівлі на пандемію коронавірусу та війну в Україні. Особистий внесок співавтора полягає у науковому керівництві.

10. Zaidman G. and Yakubovskiy S. Shipping industry after Ukrainian war outbreak: quantitative and qualitative changes. *Соціально-економічний та політичний розвиток країн в умовах глобальної нестабільності* : матеріали другої міжнар. наук.-практ. конф., 31 травня 2024 р. Одеса : Одес. нац. ун-т ім. І. І. Мечникова, 2024. С. 30–31.

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11. Zaidman G. and Yakubovskiy S. Shipping industry in bounce back after pandemic, with containership sector leading the way. *Economic trends: new opportunities and threats, international scientific conference*, 19–20 November 2021. Le Mans. Riga : Baltija Publishing, 2021. Pp. 9–12. DOI: <https://doi.org/10.30525/978-9934-26-158-9-3>

Особистий внесок здобувача включає аналіз впливу пандемії коронавірусу на світове судноплавство та розвитку галузі після пандемії. Особистий внесок співавтора полягає у науковому керівництві.

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15. Zaidman G. Shipping industry in 2022: new disruption after recovery. *Соціально-економічний та політичний розвиток країн у сучасних умовах* : зб. наук. праць міжнар. наук.-практ. конф. Одеса : Одес. нац. ун-т ім. І. І. Мечникова, 2022. С. 61–62.

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LIST OF ABBREVIATIONS

AI	Artificial Intelligence
ARCH	Autoregressive Conditional Heteroscedasticity
BCTI	Baltic Clean Tanker Index
BDI	Baltic Dry Index
BDTI	Baltic Dirty Tanker Index
BVAR	Bayesian Vector Autoregression
CO ₂	Carbon dioxide
COVID-19	Corona Virus Disease 2019
CRSL	Clarksons Research Services Limited
EMDEs	Emerging Market and Developing Economies
EPU	Economic Policy Uncertainty
FDI	Foreign Direct Investment
GARCH	Generalised Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GPR	Geopolitical Risk
IMF	International Monetary Fund
IMO	International Maritime Organization
INSW	International Seaways
IPO	Initial Public Offering
KG	Kommanditgesellschaft (Limited Partnership in German)
KS	Kommandittselskap (Limited Partnership in Norwegian)
LIBOR	London Inter-Bank Offered Rate
LNG	Liquefied Natural Gas

LPG	Liquefied Petroleum Gas
MCAP	Market Capitalisation
N/A	Not available
NAT	Nordic American Tankers
NBU	National Bank of Ukraine
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
OOCL	Orient Overseas Container Line
OPEX	Operating Expenditure
S&P 500	Standard and Poor's 500
SVAR	Structural VAR
TEU	Twenty-Foot Equivalent Unit
TS	Transport Services
ULCC	Ultra Large Crude Carrier
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
USPA	Ukrainian Sea Ports Authority
VAR	Vector Autoregression
VECM	Vector Error Correction Model
VLCC	Very Large Crude Carrier
2SLS	Two-Stage Least Squares

INTRODUCTION

Relevance of the PhD research topic. The relevance of the research topic is evidenced by the integral role of the global shipping industry in international economic relations. Given that a major part of goods traded globally is moved by sea with seaborne trade steadily growing in absolute terms, maritime transport remains a key contributor towards global and national security. At the same time, maritime transport currently undergoes a transition and stands at a crucial point under impacts of geoeconomic instability, geopolitical uncertainty, increasing asymmetries in international seaborne trade, and evolving maritime regulatory requirements. Studying determinants of the global shipping markets under the mentioned conditions gains particular relevance for ensuring enhanced flexibility of the industry and improved resilience of global economic development, as well as for adaptation and modification of actionable shipping strategies.

The development of the shipping industry has been analysed in numerous studies by both Ukrainian and foreign scientists. Seaborne trade on a global level, its asymmetries and ongoing transformation have been examined by O. Balan, D. Batzilis, D. Cerdeiro, A. Komaromi, O. Kotlubay, I. Lomachynska, K. Louca, O. Lypynska, K. Melas, N. Michail, I. Poznanska, O. Shkurenko, A. Stakhov and others. Investigations of trends, dynamics and determinants of the shipping freight markets have been reported by H. Alekseievskaya, D. Glen, L. Kilian, J. Kwon, B. Martin, N. Nomikos, S. Papadimitrou, S. Park, T. Pelagidis, Yu. Pichuhina, Y. Smirlis, V. Tsioumas, S. Yakubovskiy and others. Various aspects of shipping finance and shipping stock performance have been in the focus of the studies by A. Alizadeh, W. Drobetz, C. Grammenos, M. Kavussanos, O. Kopylova, S. Marcoulis, A. Merikas, M. Stopford, D. Tsouknidis, V. Zhykharieva and others.

Regardless of the volume and significance of the pertinent literature on the topic of this PhD research, heightened asymmetries in the world economy and enhanced shipping regulations create new challenges and stipulate a need for further comprehensive examination of the trends in the development of international shipping with regard to its disproportional dynamics on a global scale, as well as for holistic investigation of the cargo shipping freight markets' sensitivity to real economy, commodity and financial markets. Moreover, the relationship between shipping freight markets and shipping finance requires further studying. These requirements justify the choice of the topic of the PhD research whose outcome contributes to a deeper understanding of the role of the global shipping industry in an uncertain international economic landscape, and improved formation and development of shipping strategies capable of overcoming the emerging challenges.

Link of the PhD research to R&D projects. This PhD study was conducted within the research programmes of the Department of World Economy and International Economic Relations of Odesa I. I. Mechnikov National University when implementing the research topic “Financial Policy as a Factor of Socio-Economic Development of Countries” (state registration No. 0121U113869), wherein the author comprehensively investigated the condition and dynamics of development of the global shipping industry and examined the impact of asymmetries in modern international seaborne trade on global maritime transport.

Research aim and objectives. This PhD research aims at comprehensively studying development of the global shipping industry under asymmetries in international seaborne trade, as well as at developing recommendations concerning a maritime competitive advantage strategy for Ukraine.

Accordingly, the following objectives have been set and achieved:

- To examine the essence of asymmetries in international seaborne trade and refine their definition, and to trace the genesis of shipping markets' cyclicity and shipping finance;
- To systematise literature in shipping economics, identify the core focus areas of existing research and determinants of the development of cargo shipping markets based on existing research;
- To analyse methodological approaches in maritime economics and develop econometric models for assessing the relationship between the selected shipping indicators in the main sectors and variables reflecting wider economic dynamics;
- To examine dynamics, structure and asymmetries in modern international seaborne trade and global fleet;
- To identify determinants, commonalities and differences in the development of freight rates in the dry bulk and oil tanker sectors, charter rates in the container sector, and dry and liquid bulk shipping companies' market capitalisation indicators;
- To generalise current trends defining the formation of shipping strategies under asymmetric dynamics of international seaborne trade and decarbonisation;
- To suggest an extension of periodisation of shipping finance; and
- To perform a comprehensive analysis of the role of Ukraine in international trade of goods carried by sea and maritime transport services, and develop a maritime competitive advantage strategy for Ukraine under existing transformations and disproportions in shipping.

The research object is the dynamics of global shipping under the effects of asymmetries in international seaborne trade that contribute to disproportionate characteristics of shipping sectors.

The research subject is the combination of economic indicators, parameters, mechanisms and channels through which asymmetric international seaborne trade

shapes the shipping industry on a global scale, including its influence on cargo shipping freight and stock markets development.

Research methods. In order to achieve the set objectives, a combination of general scientific and specialised research methods have been employed:

- Induction and deduction – for the research of theoretical foundations and methodological approaches to studying maritime economics; for the generalisation of empirical data and formulation of findings;
- Analysis, synthesis and systems approach – for studying the global shipping industry and international seaborne trade in their sectoral decomposition; for the development of the grounds for extending the periodisation of shipping finance;
- Historical-logical method – for studying the genesis of international seaborne trade and its asymmetries, shipping, shipping markets and shipping finance;
- Systematisation and generalisation – for the generalisation of existing theories and concepts adopted in studying the phenomena of shipping, asymmetries in international seaborne trade, shipping market's cyclicity and shipping finance; for the generalisation of current trends defining the formation of shipping strategies;
- Semantic and morphological analysis – for refining the conceptual and categorical apparatus concerning the essence of asymmetries in international seaborne trade;
- Statistical analysis – for the evaluation of dynamics, structure, current trends and asymmetries in the shipping industry; for identifying the role of Ukraine in international trade of goods carried by sea and maritime transport services;
- Econometric modelling and correlation-regression analysis – for the evaluation of the dynamics of freight rates and shipping companies' market capitalisation in different shipping sectors under the impact of selected indicators, with the use of the following software: Microsoft Excel, IBM SPSS Statistics, EViews;

- Analogy and comparative analysis – for the identification of trends, commonalities and differences in development of shipping sectors, freight rates in different shipping sectors, dynamics in market capitalisation indicators of shipping companies in different shipping sectors; for the elaboration of alternative decarbonisation scenarios; for the formulation of some provisions of Ukraine's maritime competitive advantage strategy; and
- Visual-graphical methods – for visual presentation of data, the research provisions and findings.

The theoretical and methodological base of this PhD thesis includes the foundational theories of international economic relations, international trade, and maritime transport, scientific publications and conference proceedings, studies of the leading Ukrainian and foreign scholars that examine international cargo shipping and determinants of cargo shipping markets, and analytical reviews and reports by international organisations. In respect of **the information base** of this PhD study, statistical data are retrieved from the following open- and closed-access sources, including but not limited to the United Nations Conference on Trade and Development (UNCTAD), the International Monetary Fund (IMF), Clarksons Research, Federal Reserve Bank of St. Louis, Trading Economics, Macrotrends LLC, CompaniesMarketcap.com, the National Bank of Ukraine (NBU), the State Statistics Service of Ukraine, the State Customs Service of Ukraine, Centre for Transport Strategies. **The legislative base** of the PhD thesis includes the core regulatory framework in shipping adopted globally and in Ukraine.

The scientific novelty of the PhD research findings is that the scientific problem of identifying determinants and trends that shape the development of the global shipping industry under the existing asymmetries in international seaborne trade has been successfully resolved. The key contributions of the study which justify its scientific novelty comprise of:

those which have enhanced the existing methods and techniques, including:

- Methodological apparatus for econometric modelling in shipping economics, the distinguishing feature of which is an assessment of the influence of key economic variables capturing general trends in the real economy and commodity markets, shipping markets and international trade development, global financial markets, including capital and equity markets, and macroeconomic price dynamics on the selected shipping indicators, which enabled identification of factors driving the dynamics of freight rates in the bulk sector, charter rates in the container sector, and the market capitalisation of shipping companies operating in the bulk sector;

- Analytical toolkit for evaluating sectoral proportions in shipping which, unlike others, draws on the share of each segment in either of the following parameters, all of which proved equally reliable: cumulative global fleet deadweight capacity, global seaborne trade volumes in tonnes and global seaborne trade volumes in tonne-miles;

- Conceptual principles of the investment portfolio management and risk hedging whose distinctive characteristics lie in the adoption of individualised, company-based assessment approach when contemplating the inclusion of shipping stocks into investment portfolio; and

those which have further developed the following:

- Conceptual and categorical apparatus regarding the essence of asymmetries in international seaborne trade and global shipping industry through refining the definition of “asymmetries in international seaborne trade” as an economic phenomenon observed at the global, regional, national and company levels in the form of geographical, sectoral and product disproportions in maritime trade flows due to a combination of underlying economic, geopolitical, historical, cultural, technological, environmental, social, institutional and regulatory, as well as technical and operational factors, predetermining uneven distribution of goods transported by sea among both producers and consumers;

- Approach to an assessment of drivers that define modern shipping strategies, determine ongoing changes in global shipping, and impact the economic results of maritime transportation through a comprehensive analysis of a combination of factors induced by decarbonisation, emerging financial frameworks, and asymmetries in international trade;
- The existing periodisation of shipping finance history that has been extended from six to eight phases; the extended classification highlights current trends and recent systemic changes in shipping finance – namely, public listings of shipping companies and focus on vessels' environmental compliance;
- Conceptual principles of the development of maritime economy of Ukraine and strengthening Ukraine's position in the global shipping industry through suggestion of a maritime competitive advantage strategy for Ukraine in the context of modern international seaborne trade that factors in the effects of core international elements and distinctive features of Ukraine's foreign economic activity and maritime sector, as well as enables Ukraine to integrate into the global maritime transport market.

Practical significance of the research findings. The PhD study findings proved both theoretical and practical significance with the potential for further implementation in research and practice. In particular, they can serve as a basis for the development and implementation of academic courses in higher educational institutions, enhancement of the educational process, optimised operations, costs and more advanced and informed decisions in shipping companies and other maritime transport enterprises through better management, planning and forecasting efficiency, improvement of state policies concerned with development of maritime economy of Ukraine.

The PhD study findings have been already included into the activity of the following Ukrainian maritime transport enterprises: Inter Trans Logistics (certificate dated 11 February 2026), TULLY LOGISTICS, LLC (certificate dated 18 February 2026). Furthermore, the PhD research findings have been incorporated into the activity

of several international shipping companies, including V.Ships UK Group Ltd (certificate dated 15 January 2026), Warden Chartering s. r. o. (certificate dated 27 January 2026) and BPG Shipping DMCC (certificate dated 5 February 2026).

The PhD study findings have been integrated into the educational process at Odesa I. I. Mechnikov National University, particularly at the Faculty of International Relations, Political Science and Sociology, within the following courses: “Workshop on World Economy Research”, “World Economy” and “Theory of International Economic Relations” (certificate dated 15 April 2026). In addition, the PhD research findings have been integrated into the educational process at Odesa National Maritime University within the courses “Economics of Maritime Transport” and “Economics of Shipping Companies” (certificate dated 16 April 2026).

Personal contribution of the author. The personal contribution of the author is noticeable in comprehensive investigation of development of the global shipping industry under asymmetries in international seaborne trade. The scientific provisions, findings, conclusions and recommendations presented for the defence of this PhD thesis are personal scientific achievements of the author. From among the provisions presented in co-authored publications, only those belonging to the author personally have been included in this PhD thesis.

Validation of the research findings. The key findings of the research were presented and discussed at the meetings of the Department of World Economy and International Economic Relations of Odesa I. I. Mechnikov National University during the period of 2021–2026. The findings were also presented and accepted at several All-Ukrainian and international scientific and practical conferences, including “Socio-economic and political development in the context of European integration” (Odesa, June 2021), “Economic trends: new opportunities and threats” (Le Mans, November 2021), “Trends and prospects for the development of science and education in the context of globalization” (Pereiaslav, December 2021), “Socio-economic and political

development of countries in modern context” (Odesa, May 2022), “Financial aspects of global economy development: challenges and prospects” (Kyiv, May 2024), “Socio-economic and political development of countries under conditions of global instability” (Odesa, May 2024), and “Modern economy and international cooperation” (Odesa, November 2025), as well as at the academic symposium “Professor Anton Filipenko’s scholarly contribution to the educational and research development of economic disciplines in higher education institutions of Ukraine” (Kyiv, December 2023).

Publications. The major conclusions and scientific findings of the PhD research have been reported in 15 scientific papers, including six articles in scientific professional publications of Ukraine, one article in a scientific periodical indexed in the Scopus database, and eight publications that prove the validation of the PhD research material.

Structure and volume of the thesis. This PhD thesis consists of an introduction, three chapters, followed by conclusions, a list of references and appendices. This PhD thesis is a 285-page long study, including 180 pages of the main text. The text is supplemented by 23 tables, 31 figures and 21 formulae. A list of references comprises 289 sources on 39 pages. Appendices run to 39 pages and include 26 tables and one figure.

CHAPTER 1

CONTEMPORARY THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF INTERNATIONAL SEABORNE TRADE

1.1. The genesis of international seaborne trade and its asymmetries, shipping markets' cyclicity and shipping finance

International economic relations encompass various forms of collaboration between countries, including capital movement, labour migration, different monetary relations, scientific and technical cooperation, economic integration. Among all the forms of international economic relations, international trade is one of the most important (IMF, 2024; Kushnir and Zayats, 2023, pp. 13–14; Schenk, 2021, pp. 1–5). Countries engage in trade for three primary reasons, and all of them stem from the asymmetry in their capabilities, particularly in production costs, natural resources, and temporary local surpluses or shortages. While the latter falls within the category of uneven resources distribution, it particularly holds relevance in the context of shipping (Stopford, 2009, pp. 394–395).

The theory of international trade has considerably evolved over the last centuries. In the 17th and 18th centuries, the mercantilist approach held dominant positions and declared that the wealth of a country increased if it exported more and imported less. That doctrine promoted protectionism as a means to accumulate and retain gold reserves. The mercantilist principles appeared to underlie modern trade theory; however, the industrial revolution transformed global trade market (Kushnir and Zayats, 2023, pp. 43–44; Stopford, 2009, p. 395).

Adam Smith and David Ricardo advocated for trade liberalisation. The renowned classics made an assumption of capital and labour immobility and explored how production factors were transferred through trade when countries exchanged labour-

and capital-intensive products. In 1776, Smith introduced the theory of absolute advantage and the division of labour, which emphasised that countries should ideally specialise in producing those goods where they have an absolute advantage. International specialisation enhances productivity and allows countries to produce higher volumes and export the surplus production, so that such a surplus can be exchanged for other goods, which the respective country is not capable of producing (Kushnir and Zayats, 2023, pp. 45–47; Schenk, 2021, p. 1; McConnel, Brue and Flynn, 2009, pp. 96–99).

In 1817, David Ricardo advanced Smith's ideas and came up with the theory of comparative advantage. Ricardo's theory posits that even without an absolute advantage countries can benefit from trade via specialisation in their most competitive industries, thereby activating their comparative advantage. This approach leads to an optimisation of how production factors are used globally and ultimately increases the global wealth compared to a “no trade” scenario (Kushnir and Zayats, 2023, pp. 47–49; Schenk, 2021, p. 1; McConnel, Brue and Flynn, 2009, pp. 96–99).

In the 1920s, Eli Heckscher and Bertil Ohlin expanded on classical trade theories and developed the Heckscher-Ohlin model, which is also known as the factor endowment theory. The model justifies the trade activity through the unequal, asymmetric distribution of production factors across the globe. In this context, countries tend to export goods which are produced internally by the use of their surplus factors and, subsequently, import goods whose production requires scarce resources. The factor endowment theory, having been updated by Paul Samuelson in 1948, evolved into the Heckscher-Ohlin-Samuelson model. However, in 1953, Wassily Leontief challenged its practical relevance using the U.S. economy as a case study. His findings did not reject the theory, rather they showcased its limitations and highlighted the need to consider more sophisticated approaches which would incorporate the global

development, including new technologies and complexities in trade structure (Kushnir and Zayats, 2023, pp. 49–52; Stopford, 2009, pp. 400–401).

In contrast to country-based classical theories, contemporary international trade theories focus predominantly on companies. The most well-known alternative theories are the product lifecycle, similarity of countries, national competitive advantages, technological gap, and economies of scale (Kushnir and Zayats, 2023, pp. 54–61; Schenk, 2021, p. 4).

At present, trade plays a crucial role in the balance of payments (IMF, 2024; Schenk, 2021, p. 1) and fundamentally relies on international transport. Transport relations are sometimes defined as a distinct form of international economic relations (Kushnir and Zayats, 2023, p. 13). Within the global transport network, shipping is seen as a primary method of transporting different commodities over long distances (Mukherjee and Brownrigg, 2013, p. 15). Due to its relatively low cost and ability to assist in exploring and entering new markets, as early as more than two centuries ago, Adam Smith recognised seaborne trade as one of the core drivers of overall economic growth (Kavussanos and Marcoulis, 2005, pp. 107–108).

According to the available data, over 80% of annual international trade has been carried by maritime transport for the past decade (UNCTAD, 2023; Clarksons Research Services Limited (CRSL), 2015). This underscores the central role of shipping in the world economy and international economic relations (IMF, 2024). In essence, shipping connects countries and helps them to satisfy their diverse needs in goods. For countries' wealth and economic prosperity, sea transport is more essential than air or road transport (Park, Seo and Ha, 2019). For global trade, shipping remains indispensable, providing a safe, cost-effective and, which is especially relevant today, environmentally friendly means of transporting commodities (Mukherjee and Brownrigg, 2013, pp. 14–15). Maritime transport supports all other industries by enabling the delivery of raw

materials to production centres and the shipments of finished products to end consumers located elsewhere (Stopford, 2009, p. 403).

Traditionally, the global shipping industry comprises cargo, leisure and offshore sectors. However, when the discussion is concerned with serving global trade flows, shipping is exclusively viewed as the cargo sector, because both leisure vessels facilitating passenger transportation and offshore vessels mainly supporting resource extraction and ocean research projects are not directly related to trade flows; therefore, they fall outside the scope of this thesis which is primarily focused on shipping in the context of international trade.

Asymmetry is one of the distinctive features of the world economy and international economic relations. Due to historically disproportionate access to resources and varying economic development of countries and regions, asymmetries are equally inherent to both international trade and transport markets. And since the reasons behind disparity in economic development cannot be eliminated, neither can asymmetries; therefore, an assessment and effective management of asymmetries has become of paramount importance. In accordance with one of the definitions, asymmetry in the transport services markets is associated with changes in relations between providers and consumers of transport services, as well as with difference in approaches to how these relations are regulated within individual national economies. The latter can be exemplified by market economy and protectionism. Thus, asymmetries have an institutional foundation which directly or indirectly impacts on the optimal work of maritime transport, be it economically viable transportation route, transport type, or a combination of both (Kotlubay *et al.*, 2018, p. 10–11, 14, 27, 40–41, 112).

Poznanska (2019) has noted that asymmetry is a broad and multifaceted term which can be defined as both one of the elements of the transport market system and the environment in which this system is immersed. As per the classification by

Shkurenko (2025), the following groups of factors cause disproportions in trade flows within the global shipping industry: economic, geopolitical, technological, environmental, social, and institutional and regulatory. Uneven development of global markets, macroeconomic instability, shifts in production and consumption centres, international competition, disparity in economic growth, changing structure and dynamics of foreign direct investment (FDI), and trade imbalances fall under economic factors. Geopolitical instability includes military conflicts, political tensions, sanctions and tariffs. Historical and cultural contexts also remain impactful. Scientific and technological progress, including port automation, digitalisation, artificial intelligence (AI) adoption, which vary between countries, has a direct operational impact and predetermines asymmetries in seaborne trade. Environmental factors become increasingly important due to transport decarbonisation, green transition, implementation of alternative fuels and other emission-reduction initiatives. Social challenges include workforce shortage and immobility. Differences in national customs, safety and tax regimes, along with local logistics regulations, are known as institutional and regulatory factors which are equally significant for studying global trade disproportions at the current stage. Poznanska (2019) has also distinguished vessel's standard dimensions as a group of technical and operational factors.

Within the global shipping industry, asymmetries are observed at different levels and in various manifestations. Poznanska (2019) classified geographical, sectoral and product forms of asymmetry in the context of maritime transport. The impact of product asymmetry spreads to a lesser extent compared to other forms, as it affects merely the complementary product markets. Geographical asymmetry means uneven saturation of trade flows across the globe. Sectoral asymmetry can be defined as a varied impact on economic growth of different sectors of maritime transport. At the international level, both seaborne trade and freight market are subject to sectoral asymmetry, which is cascaded down to the regional, national and company levels (Stakhov, 2023).

Taken together, asymmetries in international seaborne trade are observed at the global, regional, national and company levels in the form of geographical, sectoral and product disproportions in maritime trade flows due to a combination of underlying economic, geopolitical, historical, cultural, technological, environmental, social, institutional and regulatory, as well as technical and operational factors, predetermining uneven distribution of goods transported by sea among both producers and consumers. These asymmetries presently shape the context of the global shipping industry.

According to Stopford (2009, pp. 177–179), four interconnected markets provide sea transport services, with each market specialising in a different type of commodity. The freight market handles sea transport services, in other words, trades vessels' space. The other three markets are considered supportive. The sale and purchase (S&P) and newbuilding markets handle the trade of second-hand vessels and the construction of new ships respectively. The demolition market arranges for the disposal of ships for scrap. All four markets operate on a completely international scale (Cullinane, 2005, p. 2).

All four markets are closely interrelated, which is evidenced by the existing literature. Three of them are especially connected, as significant volatility transmission is registered across freight rates, new vessel prices, and second-hand asset prices. It is worth noting that the freight market demonstrates the highest level of volatility (Dai, Hu and Zhang, 2015; Cullinane, 2005, p. 5).

Shipowners representing the supply side and shippers representing the demand side determine the freight market equilibrium by negotiating freight rates. The equilibrium depends on the availability of both vessels and cargoes in the market. This process of negotiations and conclusion of deals aligns demand and supply functions (Stopford, 2009, pp. 160–161). Given that instantaneous availability of vessels and cargoes is unequal in different regions, this is considered as one of the forms of asymmetry observed in shipping.

Fundamentally, freight rates represent transportation costs. Freight rates are a monetary amount earned by shipowners for providing maritime transportation services – in other words, the price of maritime transportation services (Alizadeh and Nomikos, 2009, p. 1). Many scholars emphasise the pivotal role of freight rates in the entire global shipping industry. In the existing literature, freight rates are often referred to as “the representative variable in the shipping market” (Park, Kim and Kwon, 2023) and “the main variable of interest” for all market players, including shipowners, shippers, charterers, shipping companies, and investors (Michail and Melas, 2020a).

The global freight market is a complex system of asymmetric nature, which can be divided into several submarkets based on various classification criteria (Nikolaieva and Bereza, 2018). Shipping professionals typically distinguish freight markets based on specific shipping sectors. Numerous freight indicators represent the state of each segment of the freight market. These indicators include spot rates, time charter rates and various other indices. Existing research has revealed that freight rates within one segment of the shipping market tend to move in the same direction. Therefore, it is a common practice to use one type of freight rate as a proxy for analysis of a segment (Alizadeh and Nomikos, 2009, pp. 44–55).

The Baltic Exchange, headquartered in London, is the leading authority in freight market information. Freight indices produced daily by the Baltic Exchange are widely recognised by the industry as reliable indicators. These indices compile data from various vessel trade routes within a specific segment and provide an assessment of freight market trends. They are also utilised for derivatives trading. In the dry bulk sector, the industry relies on the Baltic Dry Index (BDI), an indicator which combines several dry bulk sub-indices depending on vessel size. In the tanker sector, the Baltic Clean Tanker Index (BCTI) and the Baltic Dirty Tanker Index (BDTI) represent the markets for clean and dirty oil products, respectively. Additionally, the Baltic LNG (liquefied natural gas) and LPG (liquefied petroleum gas) Tanker Indices represent the

LNG and LPG freight markets, while the Freightos Baltic Index (FBX) provides information about the container transportation (Baltic Exchange, 2023; Alizadeh and Nomikos, 2009, pp. 107–124; Stopford, 2009, pp. 195–196; Baltic Exchange, n.d).

For all market participants, freight rates are equally important. In addition to the fact that freight rates represent the cost of physical delivery of goods, they also compose a part of the final product price which is ultimately passed on to end consumers (Angelopoulos, Sahoo and Visvikis, 2020). As freight rates fluctuate unevenly, so does their portion of the final product's cost. This illustrates the wider impact of freight market asymmetry on global and regional economic growth.

The relationship between shipping and various commodity markets is established in existing scientific research. At different stages and based on various macroeconomic conditions, either shipping or commodities may either transmit shock or appear at the receiving end (Adewuyi *et al.*, 2023). Numerous studies confirm that freight rates are influenced by commodity prices (Shi *et al.*, 2022; Melas and Michail, 2021; Michail and Melas, 2021b; Angelopoulos, Sahoo and Visvikis, 2020; Michail and Melas, 2020a; Tsioumas and Papadimitriou, 2018; Yang *et al.*, 2015; Sun *et al.*, 2014; Shi, Yang and Li, 2013). Conversely, a range of studies demonstrate that commodity prices are affected by freight rates (Tiwari *et al.*, 2024; Angelopoulos, Sahoo and Visvikis, 2020; Tsioumas and Papadimitriou, 2018).

Nevertheless, the prices of the commodities transported are not the sole determinants of freight rates (Melas and Michail, 2021). Once institutional investors started to trade commodity futures, which is referred to as “the financialisation of commodities”, it resulted in an increasing volatility of prices of commodities (Basak and Pavlova, 2016). This enhanced the role of market sentiment in forming the prices of individual commodities (Melas and Michail, 2024).

The intrinsic uncertain and asymmetric nature of the freight market leads to extreme freight rate volatility. For shipping companies, this has always been a challenge

which deteriorates cash flows (Alizadeh and Nomikos, 2009, pp. 65, 107). Economic theory identifies economic cycles which differ in duration and magnitude, although consist of similar stages (McConnell, Brue and Flynn, 2009, p. 521), and shipping cycles are no exception. Apart from long-term and specific seasonal cycles in shipping, the literature defines short shipping cycles. The short cycles regulate supply and demand in the shipping market by removing imbalances and ensuring the fleet adapts to structural changes in international maritime trade (Stopford, 2009, p. 101). These imbalances between development of trade and fleet in various regions, sectors and globally represent another form of asymmetry.

In brief, highly fluctuating demand and supply interact within the shipping cycle. Supply takes time to adjust and align with the demand, as vessels are not constructed instantaneously but require considerable time till full deployment (Stopford, 2009, p. 168). Nobel laureates J. Tinbergen and T. C. Koopmans are known as the first researchers who explained cargo shipping market cycles and the underlying connection between freight and asset markets (Goulielmos, 2019; Jiang, 2010; Cullinane, 2005, p. 4). Since then, the balance between fleet supply and trade demand has always attracted global scientific society, including Ukrainian scholars (Bychkovskyi, 2011).

The demand for sea transport services is defined as the amount of shipping capacity shippers are willing to purchase at a given freight rate level (Lun, Lai and Cheng, 2010, pp. 17–18). The key determinants of shipping demand include global economic growth and the commodity market condition, which essentially reflects the intersection of supply and demand curves in the transported product market. Additional factors include sporadic economic and political shocks, transportation costs, and the average haul. The latter is understood as the average distance which a vessel travels from the port of departure to the port of arrival (Stopford, 2009, pp. 136–149).

The supply of sea transport is determined as the available tonnage in the market for cargo transportation. Several parties contribute to the formation of the supply curve

for shipping services, including shipowners, charterers, financial institutions, and regulatory authorities (Lun, Lai and Cheng, 2010, p. 22). The key factors of the shipping supply are the size of the world fleet and its productivity, which is, in turn, affected by time spent in port, time spent at sea while loaded, vessel speed, and capacity utilisation. The other determinants of the supply function include the effectiveness of shipyards in building new vessels, vessel scrapping volumes, and freight income (Stopford, 2009, pp. 150–160).

Although originating in the mid-18th century, the concept of cycles became widely recognised in the shipping industry by the 19th century. Nowadays, it is commonly acknowledged that the current business model in global shipping is dictated by cycles. However, ongoing discussions happen about its sustainability for the future or whether the transport system requires a full-scale modification (Stopford, 2017).

According to Stopford (2009, pp. 96–98) and as illustrated in Figure 1.1, a short shipping cycle contains four stages: a trough (stage 1), a recovery (stage 2), a peak (stage 3) and a collapse (stage 4). Cycles are asymmetric, as the duration of each varies typically from 4 and 7 years.

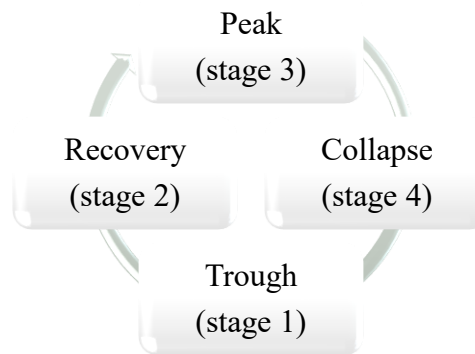


Fig. 1.1. Short shipping cycle

Source: Compiled by the author based on Stopford (2009, pp. 96–98)

In shipping, cycles are traditionally measured from trough to trough. The stages are considered “episodic”, with no fixed and predictable duration for each. The core characteristic of a trough is oversupply when, due to reduced demand, decreased freight

rates hardly cover low-efficient vessel operating expenditure (OPEX). For shipping companies, this leads to negative cash flow and other implications of financial pressure. During the recovery phase, the balance between demand and supply shows improvement, freight rates rise along with vessel prices while lay-ups decline. The peak stage signifies an increase in earnings, high freight rates, easy credit access, and surge in new orders. Second-hand vessels can be priced higher than newbuilds; all existing vessels are put at trade and operate at full speed. During the collapse stage, freight rates and vessel prices plunge substantially and overcapacity leads to fleet idling or slowing operations (Stopford, 2009, pp. 96–98). Table 1.1 provides a concise summary of the development of four shipping markets at each stage of the short shipping cycle.

Table 1.1

Dynamics of four shipping markets across cycle stages

Cycle stage	Shipping capacity: supply (S) vs demand (D)	Freight rates	Prices of second-hand vessels	Prices of newbuilding vessels (and orderbook)	Scrap prices and demolition activity	Bank lending
Trough (upturn)	Huge surplus of vessels, more vessels than cargoes ($S \gg D$)	Low (at OPEX level)	Low (at scrap price)	Low	High	Limited
Recovery (expansion)	More balanced ($S > D$)	Increase (above OPEX)	Increase	Increase	Decrease	Tight
Peak (peaking)	Balance ($D = S$) or shortage of vessels ($D > S$)	High (2+ times OPEX)	High (prices of modern vessels are higher than newbuilding ones)	High	Low	Widely available
Collapse (slowdown)	Surplus of vessels ($S > D$)	Decrease	Decrease	Decrease	Increase	Stricter

Source: Compiled by the author based on Stopford (2009, pp. 96–98)

For shipowners, freight rates are particularly crucial, being the primary source of income and profitability for their companies. Shipowners may typically generate

revenue in two ways – through asset play or chartering operations (Melas and Michail, 2024). The core assets of shipping companies are vessels. Shipping companies which own vessels are less prone to collapse (Haider, Ou and Pettit, 2019). Nonetheless, “asset play”, that is buying and selling vessels based on price fluctuations (Stopford, 2009, p. 274), is considered an unreliable income source (Duru, 2013) due to the inherently asymmetric and cyclical nature of the shipping market (Zhykharieva, 2010). Consequently, shipping companies can secure stable income only through chartering operations, where vessels are chartered to charterers under long-term agreements or one-trip contracts (Melas and Michail, 2024).

The foundational principle of finance identifies two primary sources of company capital: internal (equity) and external (debt) (Berk and DeMarzo, 2017, pp. 73, 521). The shipping industry is no different from this principle (Stopford, 2009, pp. 277–278). Within the category of debt, shipowners have several financing options available, including bank loans, public offerings, bonds and private placements (Alizadeh and Nomikos, 2009, p. 42). Given that a significant proportion of a shipping company’s resources are tied up in vessels (Stopford, 2009, p. 269), which is risky in itself, a selection of the appropriate financing instruments is crucial for the success of the business (Merikas, Gounopoulos and Nounis, 2009).

Balancing between the available options has always presented a challenge for shipping companies. This challenge attracted considerable attention from economists, including Ukrainian scholars, who have recently developed a long-term fleet renewal model based on discounted free cash flow (Bazaluk *et al.*, 2022). Later, Zhykharieva *et al.* (2025) have developed a model to assess profitability and financial risk of investment into fleet expansion. The proposed approach takes into account freight rates fluctuations, company’s operational expenses, and financing terms.

Shipping is known to be a highly capital-intensive industry of the world economy (Kavussanos and Marcoulis, 2005, p. 109). And shipowners continuously require

access to substantial resources, which typically entails obstacles (Zhykharieva *et al.*, 2023, p. 175). For a long time, shipping, as a rather conservative industry, preferred traditional financing methods to global capital market and explored the latter later than other industries (Haider, Ou and Pettit, 2019).

Stopford (2002) has divided the history of shipping finance in the 20th century into five phases. Importantly, while the financial landscape in the maritime industry changed and developed, its evolution was influenced by the freight market. Freight market has been playing a dominant role in establishing and evolving the relationship between shipowners and bankers, as it reflects how global fleet changes in response to the growth of international trade.

1) During the first phase of shipping finance in the 1950s, shipowners adopted a traditional financing approach – private sources accounted for over 80% of shipowners' capital (Haider, Ou and Pettit, 2019; Stopford, 2002). This enabled owners of the companies, typically families, to maintain close control over their self-contained businesses. Such management style allowed them to avoid leakage of internal information and prevent dilution of the ownership structure. Moreover, the volatile nature of shipping cash flows made shipping an unattractive investment platform for investors from other sectors (Merikas, Gounopoulos and Nounis, 2009).

2) The expansion of the European and Japanese economies in the 1960s transformed shipping finance. There was a growing need in quick access to financial resources to expand fleets in response to the rapidly increasing demand for seaborne transportation and to capitalise on rising freight rates. As a result, the role of bankers became more prominent, and they started to offer charter-back credits. Companies whose vessels employment was fixed and guaranteed for a period of time were considered as reliable partners by lenders (Stopford, 2009, pp. 272–273; Kavussanos and Marcoulis, 2005, p. 109; Stopford, 2002).

3) During the third phase called a “bubble”, shipowners gradually changed their chartering priorities from time-chartering to spot market, which emerged to become more profitable. Bankers adapted to that and no longer required long-term charter agreements to back credits, as the vessel herself was deemed sufficient collateral. Such a shift enabled shipowners to obtain funds without complications (Stopford, 2017).

4) The “bubble” burst in the 1970s due to the oil crisis and the surge in oil prices. The fourth phase was characterised by distress and imbalance between fleet supply and demand for capacity. This imbalance resulted in a sharp decline in freight levels. Many shipping companies defaulted, leaving bankers with unpaid loans in the 1980s. Consequently, shipping became highly unattractive to financial institutions until the fifth phase of the shipping finance history known as “convalescence” (Stopford, 2002).

5) As the freight market gradually recovered in the 1990s, bankers resumed activities in shipping finance, predominantly by adopting an option of syndicated debt (Stopford, 2009, pp. 275–276). Along with rising freight rates, the fifth phase was marked by an increase in shipping investment via limited partnership companies, particularly German KG (Kommanditgesellschaft, in German) and Norwegian KS (Kommandittselskap, in Norwegian), which gained momentum as they satisfied investors’ appetite for high returns and offered them beneficial tonnage tax and amortisation schemes (Zhykharieva, 2010).

6) Zhykharieva *et al.* (2023, p. 177) have expanded this shipping finance history periodisation and noted that the major economic and shipping boom of the 2000s marked the sixth phase of the global shipping finance. This phase is notable by increased lending activity in the sector, particularly in shipbuilding. Having neglected the cyclical nature of shipping, banks, especially those with lack of expertise in shipping finance, relied merely on current (lucrative) shipping market conditions.

Throughout the 2000s, the shipping industry started adopting new financial instruments. Capital markets continued to integrate and globalise, bank financing

diminished, and capital resources in major shipping companies became depleted, while the need to renew aging fleets remained (Merikas, Gounopoulos and Nounis, 2009). As a result, a huge volume of loans was issued during the peak stage of the freight market. Eventually, the global financial crisis of 2008 drastically changed the financial landscape. The collapse of several financial institutions froze global capital markets, reducing bank financing available for shipping industry and pushing shipping companies towards finding alternative financial solutions (Haider, Ou and Pettit, 2019).

Table 1.2 summarises the key characteristics of the phases of shipping finance and illustrates the close connection between the financial and freight markets. It can be deduced that fluctuations in the global freight market were a fundamental driver of the evolution in ship finance observed between the mid-20th century and the 2000s.

Table 1.2

Historical phases of shipping finance

Phase	Name	Period	Key characteristics	Freight market context
Phase 1	Cash	1950s	Traditional financing through private shipowners' sources	Establishment after the war
Phase 2	Charter-back	Mid-1950s – early 1970s	Revolution in shipping finance Banks start to offer charter-back credits	Generally increasing freight rates
Phase 3	Bubble	1970s	Banks consider vessels sufficient collateral and no longer require charter agreements to back credits	Peak freight rates
Phase 4	Distress	1980s	Due to the oil crisis, the default of many shipping companies left bankers with unpaid loans	Low freight rates prevail
Phase 5	Convalescence	1990s	Banks reengage in shipping finance Syndicated debt German KG and Norwegian KS companies	Predominantly increasing freight rates
Phase 6	Boom	2000s	Increased unsecured lending, new financial instruments Global financial crisis	Peak freight rates

Source: Compiled by the author based on Zhykharieva *et al.* (2023, p. 175–178) and Stopford (2002)

Recently, the traditional economic and operational practices in shipping have started being increasingly determined by the environmental agenda, wherein decarbonisation emerged as a core concept (Ma, Zhe, and Xiao, 2026). After the replacement of steam engines by the mid-20th century, diesel engines became the primary propulsion source for vessels. In order to operate, diesel engines consume fossil fuels. These fuels, when combusted, discharge toxic gases, such as sulphur and nitrogen oxides, carbon dioxide (CO₂), and particulate matter, many of which contribute to greenhouse gas (GHG) emissions, driving global warming, and to broader air pollution (Hein, 2022). The mitigation of GHG emissions is a key objective of the current sustainability transition in the global shipping industry. The development of alternative fuels is one of the means to achieve it.

The existing literature categorises energy sources into nuclear, fossil, and renewable. Nuclear energy is released from the nuclei of atoms and used to generate electricity, as well as for heating purposes. Coal, oil and gas are typical fossil fuels. The non-renewable nature is the key characteristic of fossil fuels, along with their high carbon-intensity, especially of coal and oil (UN, n.d.).

Natural and petroleum gases, although fall within the fossil fuels group, are considered more environmentally sustainable and regarded as “a middle ground solution” on the decarbonisation pathway (Michail and Melas, 2022). However, there is no strong agreement among scholars regarding future gas trade volumes. Some research project a downturn in the U.S. LNG exports due to reduced flows to Europe and an increase in demand from Asian markets for gas originating from Russia and the Middle East (Lin and Brooks, 2021). Others forecast continued development of the USA–EU gas trade, suggesting a more optimistic outlook for transatlantic LNG flows (Karachalios, 2021).

To achieve shipping decarbonisation, the overriding solution lies in the adoption of naturally renewable fuels, which are commonly referred to as clean or green for

being environmentally friendly (DNV, 2022). These clean options are broadly divided into biofuels, electrofuels and blue fuels. Biofuels include wood, ethanol, methanol, biogas and biodiesel. Biofuels are obtained from biomass, such as agricultural waste, algae, and forestry residue (ResourceWise, 2023). Electrofuels are produced from wind, solar, or hydro energy (Brynolf *et al.*, 2018). Blue fuels, although generated from fossil energy sources, differ from conventional fuels as during their production, CO₂ is captured and stored (DNV, 2022).

Research is ongoing with regard to decarbonisation in shipping. In particular, application of alternative fuels in maritime transport receives considerable attention from scholars (Ma, Zhe, and Xiao, 2026; Ampah *et al.*, 2021). It is evident that the development and scalability of alternative fuels within the shipping industry will largely define the progress and course of overall maritime decarbonisation.

1.2. Determinants of the development of cargo shipping markets: a review of theoretical and empirical research

From among the foundational literature in the field of shipping economics, there are several key works that essentially formed the basis for understanding and studying maritime transport economics and international seaborne trade. *Maritime economics* by M. Stopford (Stopford, 2009) is referred to as “a shipping management bible” (Lirn, 2011) for its fundamental nature and practical usefulness for both students, scholars and industry practitioners. The book starts with the evolution of the global shipping industry from its development to the contemporary state and explains the fundamental principles of modern shipping. In addition, the book covers a wide range of topics, such as interactions of different shipping markets, the economic essentials of shipping

companies' operations, current seaborne trade and transport systems. It also discusses the forecasting techniques applicable in shipping.

Shipping derivatives and risk management (Alizadeh and Nomikos, 2009) is another seminal work from both theoretical and practical standpoints. Although the authors provide a less comprehensive introduction to shipping history compared to M. Stopford, the book targets a more advanced audience in respect of a discussion of sophisticated statistical tools for monitoring and management of various shipping risks. These risks include financial and credits risks, as well as bunker and vessel price fluctuations. The book also examines trading and hedging strategies, as well as freight derivatives, such as freight options and futures.

Shipping and logistics management by Y. H. V. Lun, K.-H. Lai and T. C. E. Cheng (Lun, Lai and Cheng, 2010) offers a comprehensive overview of the shipping and logistics industries as parts of the global supply chain. The book explores various business strategies applicable to shipping, and determinants of international trade and freight markets. It is important that the book provides examples of how correlation and regression analysis is applied to model the fleet size in specific market segments and to evaluate shipping firms' performance. While the presented models are relatively simplistic, they are still highly valuable for educational purposes to demonstrate the link between theoretical discussions and empirical analysis.

Shipping economics (Cullinane, 2005) is concerned with modelling in the dry and liquid bulk sectors. In the book, independent research papers are compiled, hence each chapter is a self-contained study. Theoretical and practical aspects of regression modelling of key shipping indicators, such as trade demand, fleet supply, freight rates, and prices of new and second-hand vessels, are discussed. One of the chapters is an in-depth study of shipping stocks performance, which makes K. Cullinane's work particularly noteworthy. Published in 2005, during the early stage of shipping public listings growth, the book initiated detailed research of stocks performance.

Farthing on international shipping by P. Mukherjee and M. Brownrigg (Mukherjee and Brownrigg, 2013) primarily focuses on maritime policy and law, highlighting the highly regulated nature of the shipping system. From an economic viewpoint, the book provides a structured and concise overview of each segment of international shipping.

Economics of shipping and service activities: global trends and transformation by V. Zhykharieva and others (Zhykharieva *et al.*, 2023) stands out as a remarkable contribution from among shipping textbooks published in Ukraine. This monograph meets the highest global standards in terms of content and relevance. It covers a range of relevant theoretical and practical aspects, including but not limited to the theory of cyclicity and pricing mechanisms across different shipping sectors, touching the topic of asymmetries; the link between market development and cash flows; the portfolio of freight strategies employed by shipping companies under various circumstances; the directions for sustainable industry development, and the emerging trends in fleet renewal financing.

This PhD study extensively refers to all the foundational books described above. However, they do not exhaust the entire range of literature sources available within the field. In addition to thorough scientific research published in the form of books and articles (the latter are discussed later in this section), shipping-specific reports provide an invaluable source of information. The most widely recognised report is the *Review of Maritime Transport*, which is issued by the United Nations Conference on Trade and Development, generally known as UNCTAD, on an annual basis (UNCTAD, 2025; UNCTAD, 2024; UNCTAD, 2023; UNCTAD, 2022). These annual reports contain a detailed overview of international seaborne trade and sea transport services. It is crucially important to note that the numerical data underlying the quantitative analysis provided in these reviews are normally gathered by the well-known shipping services companies, mainly shipbrokers, that provide advisory services and perform maritime

research. The dependence on these companies is a distinguishing feature of the maritime industry in comparison with the other forms of international economic relations.

The leading maritime research companies are Clarksons (Clarkson PLC, 2025), Fearnleys AS (Fearnleys AS, 2024), Simpson Spence Young (SSY) (Simpson Spence Young, 2025), BRS Shipbrokers (BRS Shipbrokers, 2025b) and Drewry Shipping Consultants (Drewry Shipping Consultants Limited, 2025). These companies produce market intelligence reports and data analytics, which are highly demanded by all industry players. The role of these reports is crucial in assisting all market participants to take more informed tactical and strategic decisions and ultimately enhance and optimise operational efficiency (Zaidman and Yakubovskiy, 2021b). Figure 1.2 summarises the main categories of literature in maritime economics.

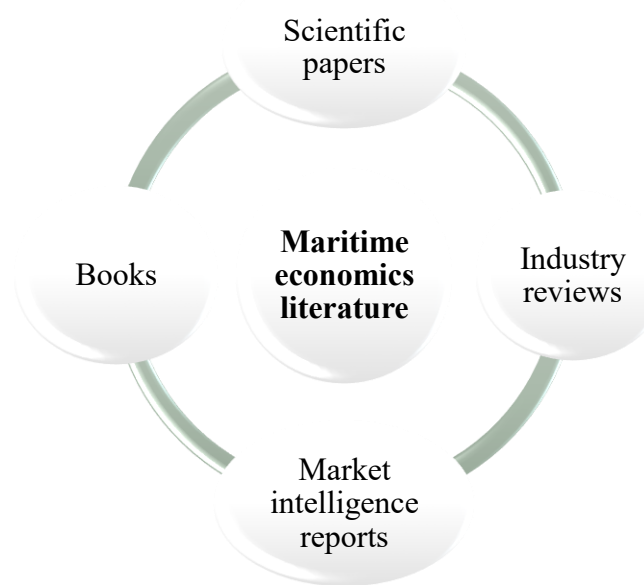


Fig. 1.2. Main categories of literature sources in maritime economics

Source: Compiled by the author

As discussed in Section 1.1, Stopford's short shipping cycle highlights the close connection between the four shipping markets and their respective indicators. However, the relationship between the shipping markets and global economic conditions is more

complex and is hence continuously examined. The freight market in itself is cyclical but irregular, asymmetric and unsystematic – these peculiarities make it impossible to use cycles only to forecast freight market conjuncture (Lun, Lai and Cheng, 2010, p. 30; Zhykharieva, 2010). Understanding the mechanisms of interaction between various “external” macroeconomic indicators and “internal” shipping economic indicators, demand for shipping services, supply of vessel capacity, and freight rates from among the latter, is a prerequisite for analysis which attempts to predict development of shipping markets (Park *et al.*, 2024).

The ability to forecast market trends with accuracy presents one of the major challenges for the shipping industry and its participants. Therefore, enhancing forecasting capability is the primary objective of a significant portion of the existing global research in the field. To this end, the studies attempt to develop maritime policies, propose both operational, freight and investment strategies applicable to shipping, and support decision-making in vessel chartering, ship purchasing and selling, budget and resource planning and distribution.

Maritime transport research is generally divided into two major parts: shipping and ports (Yan *et al.*, 2021; Cullinane, 2005, p. 1). Within the shipping area, studies can be classified in several ways, such as by sector, method or market. When classified by sector, cargo shipping papers can be grouped into four main categories based on the type of cargo transported. These are: general research on global seaborne trade, papers on the dry bulk trade, studies on the tanker sector and papers on the liner shipping. According to the method-based classification, studies can be grouped by research techniques. Most studies employ analytical calculation methods, which include econometric techniques, correlation-regression and time series analysis, while specific models can vary. According to the market-based categorisation, four groups corresponding to the four shipping markets can be distinguished.

A dual approach is adopted in this study. Papers on seaborne trade in general are discussed first. Thereafter, the papers are classified by the type of market, with a focus on the freight market. Within each market, the sector-based classification is applied.

In a noteworthy study on contemporary shipping, Michail (2020) examined how international seaborne trade volumes responded to changes in global gross domestic product (GDP) and oil prices. The findings revealed that the demand for all types of transported commodities positively reacted to GDP shocks, reaffirming the derived-demand nature of shipping (Alizadeh and Nomikos, 2009, p. 45; Stopford, 2009, p. 387; Zannetos, 1959). It was also validated that GDP could be used as an indicator of international trade. Conversely, oil prices had a negative impact on seaborne trade volumes. Taking into account existing disproportions in the world economy, the author classified countries into three groups based on their income level and found out that high- and middle-income countries accounted for the largest portion of changes driven by macroeconomic shocks. This underscores the more significant role of wealthier countries in the world economy compared to poorer ones.

Later, Michail, Melas and Batzilis (2021) identified a reverse relationship when examining the containership segment. Their findings demonstrated that international container seaborne trade volumes, both in the current year and in the previous one, positively influenced global GDP, which suggested that containership trade could perform as a reliable determinant of global economic growth. However, these conclusions can be questioned, given that containerised trade represents only a portion of total global seaborne trade volumes and mainly consists of finished goods. Since such goods are already factored in the calculation of GDP of producing countries, container trade is more likely to depend on GDP rather than determine it.

While forecasting trade activity is an important area of research, nowcasting seaborne trade data is another field which has been actively addressed by scholars recently, particularly in a series of the IMF publications (Cerdeiro and

Komaromi, 2020; Cerdeiro *et al.*, 2020; Arslankap, Marini and Tumbarello, 2019). Official trade data reports are typically published with 3–4 months delay while the industry clearly requires quicker access to such data for the sake of taking more informed decisions. The above-mentioned studies developed a methodological approach which used AIS-based data for economic purposes. The AIS stands for the Automatic Identification System. It was introduced in 2004 with the aim of improving international navigation safety. This system mandates commercial vessels to frequently transmit radio signals specifying their course. By utilising data on vessels' port calls and respective changes in draughts after loading and discharging, those studies developed techniques for evaluating seaborne cargo flows in real-time. The methodology has been tested under extreme conditions at early stages of COVID-19. The outcomes of the nowcasting have been successfully verified through official reports released thereafter, demonstrating a strong correlation with official trade data.

The next group of studies examined the shipbuilding market. A study by Nomikos and Tsouknidis (2022) suggests that global seaborne trade volumes do not impact shipping companies' decisions and overall policies in respect of investments in new vessel orders whereas world fleet size shocks do. The study considers shipowners in the dry bulk and crude oil tanker segments only. Alternatively, Park, Kwon and Kim (2021) have identified global trade, as well as industrial production and freight rates, as key factors driving new shipbuilding agreements across all shipping sectors.

Focusing on new orders of container vessels, Michail and Melas (2023) similarly have confirmed that the macroeconomic environment, including global trade volumes, positively influences investment volumes in new vessels. However, during the periods of less expected shocks, for example, when a freight rate increase is not justified by economic growth, shipowners tend to delay their investment decisions for up to a year. The authors refer to this phase as a period of “inaction”, during which companies just observe the market to evaluate the nature of the sudden shock.

This observation is aligned with an earlier paper. According to the research conducted by Michail and Melas (2021a), “while intentional herding has a large effect on the orders of the newbuilding vessels, the impact is very short-lived. On the contrary, unintentional herding, related to common environmental factors, has a smoother but more time persistent effect on the newbuilding vessels”.

The Ukrainian scholars Lomachynska, Yakubovskiy and Alekseievskaya (2025) have highlighted that shipbuilding volumes are an impactful factor for the seaborne trade trends. Their study suggests actions to reduce the global dependence on the Chinese shipbuilding, currently accounting for more than a half of global shipbuilding, through closer engagement of shipping companies with the South Korean and Japanese yards. Furthermore, Yakubovskiy, Lomachynska and Shmagina (2026) have indicated that differences between main shipbuilding nations in shipbuilding volumes and technological focus affect the formation of contemporary business models in the sector. The authors note that it is access levels to the modern smart and green tonnage that determine investment strategies and competitive positioning of shipping companies.

The next noteworthy group of studies examines the freight market. As discussed in Section 1.1, freight rates play a central role in the shipping industry and always attract significant attention from the leading scientific community. As a result, the body of research on the subject permanently grows. Most of the studies performed globally have attempted to identify determinants of freight rates in various sectors in order to improve understanding and ability to predict future trends.

A review of the pertinent literature reveals that the following variables have been identified as influential for freight rates in different sectors: oil prices are mentioned in 11 studies (Lim, 2022; Shi *et al.*, 2022; Jacks and Stuermer, 2021; Angelopoulos, Sahoo and Visvikis, 2020; Michail and Melas, 2020a; Chen *et al.*, 2019; Bereza, 2017; Yang *et al.*, 2015; Sun *et al.*, 2014; Shi, Yang and Li, 2013; Dikos *et al.*, 2006); global trade volumes as a demand function for sea transport services – in six studies (Michail and

Melas, 2023; Park, Kim and Kwon, 2023; Nomikos and Tsouknidis, 2022; Park, Kwon and Kim, 2021; Michail and Melas, 2020b; Michail and Melas, 2020a); economic uncertainty – in six studies (Melas, Michail and Louca, 2025; Wang *et al.*, 2025; Park *et al.*, 2024; Gu and Liu, 2022; Drobetz *et al.*, 2020; Fei *et al.*, 2020); commodity prices – in five studies (Lim, 2022; Melas and Michail, 2021; Michail and Melas, 2021b; Angelopoulos, Sahoo and Visvikis, 2020; Tsioumas and Papadimitriou, 2018); industrial growth and GDP – in four studies (Gu and Liu, 2022; Lim, 2022; Jacks and Stuermer, 2021; Park, Kwon and Kim, 2021); geopolitical risk – in four studies (Wang *et al.*, 2025; Yilmazkuday, 2025; Monge, Rojo and Gil-Alana, 2023; Drobetz *et al.*, 2020); global fleet size – in two studies (Park, Kim and Kwon, 2023; Jacks and Stuermer, 2021); and oil demand – in one study (Siddiqui and Basu, 2021).

The above-mentioned studies have been analysed in greater detail in subsequent paragraphs. The inverted pyramid in Figure 1.3 generalises the review of the literature against the key determinants of freight rates. Factors are ranked from the most to the least frequently referenced.

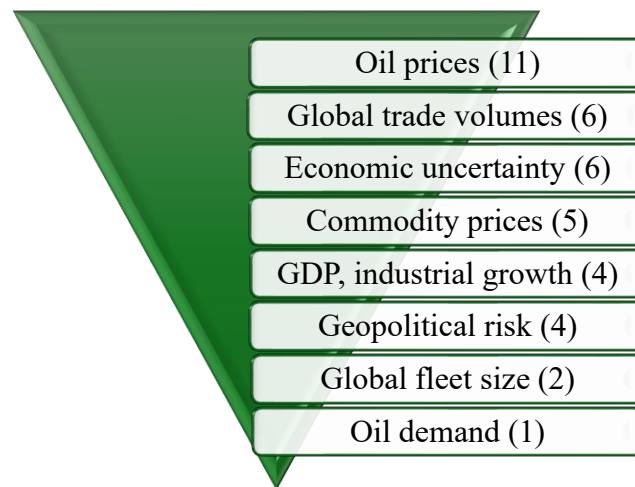


Fig. 1.3. Key factors impacting freight rates

Note: The numbers in brackets represent the quantity of the studies reviewed which reference the respective factor.

Source: Compiled by the author

It is worth noting that a series of seminal studies by Michail and Melas laid the foundation for contemporary research in maritime economics, since a lot of the existing papers rely on their findings. Based on an earlier referenced paper (Michail, 2020), Michail and Melas (2020a; 2020b) proved the importance of seaborne trade volumes for forecasting freight rates. As scholars point out, freight rates in the dry bulk and dirty tanker sectors are strongly affected by seaborne trade volumes when the economy is under normal circumstances. However, this relationship does not hold for clean tanker freight rates, as this type of tanker vessels is more versatile in terms of cargo, being capable of transporting both clean and dirty oil products. During extreme conditions in the economy, for instance, the COVID-19 pandemic, the scientists observed different patterns. In the dry bulk sector, the trade volumes still significantly influenced the freight rates. However, in the tanker sector, the observation was opposite – crude oil (dirty tanker) freight rates demonstrated a low dependence on seaborne trade, while clean tanker rates showed a strong correlation with trade volumes. This kind of individualised behaviour exhibited by different segments also supports the concept of sectoral asymmetry intrinsic to the global freight market.

In addition, under normal economic conditions, oil prices have been documented to positively impact dry bulk freight rates. In the tanker sector, the relationship is more complex: the initial short-term negative impact of oil prices on tanker freight rates has transitioned to a positive effect over time. This phenomenon can be explained by the specifics of crude oil tankers which are able to operate as floating storage units when required. Where oil prices decline, it can be profitable to purchase “cheap” oil and store it on board crude oil tankers until prices recover. Under this scenario, a portion of the global tanker fleet becomes fixed and immobilised for a given period. Consequently, this causes a reduction in supply of tankers which are available for transportation of “non-speculative” cargo. Apparently, freight rates increase. A similar situation was observed in 2020 after the pandemic outbreak. This explains the finding that the crude

oil freight market is less dependent on the overall trade demand when the world economy is under shock. It can be concluded that freight rates in both the dry bulk and wet bulk sectors are influenced by international seaborne trade volumes, which are, in turn, driven by global GDP. However, the magnitude of this influence is asymmetric and varies depending on the stage of economic cycle and additional external factors acting upon the world economy (Zaidman and Yakubovskiy, 2021b; Zaidman, 2021a).

After the COVID-19 pandemic, the popularity of exploring the exogenous effects in the shipping industry has increased. Park *et al.* (2024) considered several economic crises which had occurred over the last 25 years and examined how freight market responded to different macroeconomic shocks – from the Asian financial crisis of 1997–1999 to the COVID-19 pandemic in 2020. In line with expectations, the study found that freight rates and global economic uncertainty indicators tended to move in the opposite direction. Different factors were influential for the freight rates during different crisis periods. During the COVID-19 pandemic, freight rates notably declined but quickly recovered due to the unique nature of the COVID-19 disruption. Compared to traditional crises which usually originate in the financial sector and spill over to the real sector of economy, the COVID-19 crisis was accompanied by a global freeze in economic activity, it was shorter and less severe. A meaningful finding of the study was that oil prices demonstrated a positive effect on freight rates during all crises.

Freight rates were also examined in the two studies referenced earlier in the discussion regarding shipbuilding market. In particular, Park, Kwon and Kim (2021) found a positive correlation between maritime transport revenue and such variables as international trade, industrial production and freight rates themselves. In contrast, Nomikos and Tsouknidis (2022) attempted to separate the demand and supply shocks and investigated how they individually impacted the freight market. As a result, the study revealed that freight rates in the dry bulk and crude oil sectors followed a trend similar to that one of seaborne trade volumes. Supply shocks appeared to demonstrate

lower significance for the modelling. In essence, both studies reaffirmed the shipping cycles and associated interrelation of key variables.

Angelopoulos, Sahoo and Visvikis (2020) have highlighted that oil prices drive other commodity markets (mainly dry bulk) and the freight market. In their study, asymmetries in shipping are emphasised through showing the difference between the dry bulk and tanker freight markets. Dry bulk freight rates tend to follow the trend of dry bulk commodity prices, while tanker freight rates move in the opposite direction to wet bulk commodity prices. The scientists explain this highlighting that dry bulk cargoes are perishable and require relatively quick delivery and consumption, while oil can be stored on board for longer periods, as exemplified earlier. Despite bi-directional depending on the sector, the relationship between commodity prices and freight rates has been established.

During the COVID-19 pandemic, speculative bubbles in the dry bulk and tanker freight indices were observed. According to the research, the BDTI bubble was caused by changes in oil prices and availability of tankers due to demand for floating storage capacity. The BCTI bubble was triggered by supply chain disruptions, fluctuations in price of oil and changes in the demand for oil products. In contrast, the BDI was “the most explosive and showed four bubbles (...) caused by strong demand for raw materials and uncertainty restrictions” (Khan, Khurshid and Koseoglu, 2023).

Meng *et al.* (2023) examined the information spillovers between the carbon finance market and the shipping market; they identified the dominant influence of the carbon finance market in the long term. The asymmetry in seaborne trade was also reflected in their findings, as the dry bulk segment demonstrated a higher dependence on the carbon finance market than the tanker sector. This can be explained by earlier adoption of stringent environmental regulations by the tanker sector.

The next subset of the freight market research focuses on the dry bulk sector. Kilian (2009) and Kilian and Zhou (2018) carried out foundational studies in which

attempts were taken to consider the dry bulk sector of shipping as an indicator of the global economy. Similarly to a series of the IMF publications referred to earlier, the scholars mentioned the challenge associated with a delayed release of official data on trade activity and emphasised the importance of real-time modelling. To this end, the scientists suggested a new indicator of the global economy based on dry bulk freight rates. The proposed indicator factored in fluctuations in both the global demand dynamics and oil prices. Due to the global nature of shipping, there was no need to adopt such a measure to exchange rates. In both studies, it was demonstrated that the global economy depended on demand more than on supply shocks. Therefore, dry bulk freight rates, which represent the cost of transportation of raw materials used in construction, manufacturing, energy generation and other industries, can be reckoned as a credible proxy of the world economy.

On the basis of earlier studies, Michail and Melas examined the effects of prices of various commodities on the dry bulk freight rates. Their first study was focused only on grains that demonstrates its limitation as iron ore and coal, which are key dry bulk commodities transported by larger vessel classes, were excluded from analysis (Michail and Melas, 2021b). The second paper covered a wider range of commodities and examined energy, metallic and agricultural ones (Melas and Michail, 2021).

In line with the concept of shipping as a demand-derived system, the above mentioned studies have confirmed the positive but non-linear lead-lag relationship between prices of commodities and freight rates, which appear more pronounced during the negative growth periods. Structural features of such a relationship vary across vessel classes. For instance, agricultural commodities exhibit a strong connection with Handysize and Supramax freight indices, since these vessel classes are mainly used to transport grains. Similarly, iron ore and coal prices predominantly influence larger vessels – namely, Panamax and Capesize classes – which are mostly employed to carry ores and coal. Notably, coal prices significantly influence all vessel

classes. This supports the interrelationship between all dry bulk subsegments, as changes in one freight index usually cause changes in the others. Unlike in other studies, the effect of oil prices on the freight market has not been specified. This suggests a lack of consensus in the literature regarding the nature of impact of oil prices on freight rates.

Tsioumas and Papadimitriou (2018) conducted a similar analysis and drew conclusions consistent with the findings reported by Michail and Melas, confirming the lagged nature of relationship between commodity prices and freight rates in the dry bulk market. Unexpectedly, wheat prices were established as a core determinant of the Panamax freight index despite the fact that grain transportation constituted only 20% of Panamax overall trade volumes (Alizadeh and Nomikos, 2009, p. 33). In general, the study is meaningful, although it does not offer significant new insights as opposed to Lim (2022). The latter examined solely the iron ore trade, in particular spot freight rates for transportation of iron ore to China from four production centres spread across Australia, South Africa and Brazil. Such selection is understandable given China's dominant role in the global iron ore market – according to the data, China absorbs over 74% of global iron ore imports (CRSL, 2023a). Lim found out that iron ore spot rates were positively affected by industrial growth, bunker fuel oil prices, the BDI, and voyage distance. In addition, the study also revealed a negative relationship between iron ore prices and spot rates *ceteris paribus*. While this represents a rare case of an inverse relationship between the price of a commodity and freight rates, it may be partly attributed to the study's limitation, as only selected trade routes were considered.

Another study with a particular focus on the Chinese economy was performed by Gu and Liu (2022). In line with the existing knowledge, the study indicated that dry bulk freight rates were positively impacted by China's manufacturing activity, while economic policy uncertainty (EPU) had a minor effect. This can be explained by the cross-industrial nature of the EPU index, which may lack shipping specifics.

In contrast, Drobetz *et al.* (2020) drew a different conclusion regarding EPU. Their research established a negative effect of the EPU indices for the US, China and Brazil on freight rates. Similarly, in a more recent study, Melas, Michail and Louca (2025) confirmed EPU's significant negative impact on the BDI and overall economic activity. The impact of trade uncertainty, another type of uncertainty considered by the paper, was identified as less significant, although still negative. The above findings are entirely aligned with economic fundamentals and trade theories. Additionally, Drobetz *et al.* (2020) noted a positive effect of the global geopolitical risk (GPR) index on the freight market. And although the study was published in 2020, its findings remained relevant during the outbreak of the Ukrainian war, when the GPR index spiked along with freight rates.

Following the global energy crisis triggered by the Ukrainian war in 2022, the GPR index gained higher scientific attention. Geopolitical risks, along with climate ones, represent non-traditional risk forms; they were examined in financial risk management research (Jiao *et al.*, 2023). A few studies that attempted to investigate the relationship between GPR and oil prices reached inconsistent conclusions. Some research has identified a negative relationship between GPR and oil prices (Zhang *et al.*, 2022), whereas other studies have revealed both positive and negative effects (Jiao *et al.*, 2023; Zhang *et al.*, 2023). It is argued that most geopolitical events tend to drive oil prices upwards due to supply disruptions or substandard volume of speculative activity, especially if such events affect oil-producing regions. However, terror threats or a decline in global demand may result in reduced oil prices. Although these studies have not directly explored international seaborne trade, they are referenced to illustrate how contemporary research in other economic fields incorporates different GPR factors.

An attempt to consider a GPR indicator in shipping research was made by Monge, Rojo and Gil-Alana (2023), who analysed the impact of GPR on the BDI and

oil prices during the period from 1985 to 2021. GPR demonstrated a minimal neutral to negative, short-term impact on oil prices and a positive long-term effect on freight rates. Although the findings are noteworthy, the limitation of the study, namely a lack of shipping context, should be noted. As discussed earlier, the BDI is commonly recognised as a barometer of the world's economic growth (Zhang *et al.*, 2019; Kilian and Zhou, 2018; Ruan *et al.*, 2016; Kilian, 2009). Based on this generally accepted view, the study by Monge, Rojo and Gil-Alana (2023) focused more on the general macroeconomic environment rather than on shipping intricacies.

Nonetheless, it can be inferred that GPR is an increasingly relevant factor for consideration in view of global instability, although its impact on shipping markets requires further investigation, especially in the bulk and container sectors, which Wang *et al.* (2025) aimed to address. Their study revealed inconsistent influence of external shocks on different subsegments: climate factors affected the container and tanker markets; energy shocks were meaningful for the container and dry bulk sectors; economic events mainly impacted the dry and tanker subsegments, while geopolitical changes had the strongest effect on the tanker sector. In respect of the gas sector, more clarity exists, as Michail and Melas (2022) recorded a significant positive influence of GPR on LPG and LNG freight rates. This also highlights the asymmetric nature of international seaborne trade.

Furthermore, Yilmazkuday (2025) decomposed geopolitical events into three categories (risks, threats and acts) and examined the response of shipping costs on each of those categories. Both dry bulk and containership indices positively reacted on GRP and geopolitical threats, while geopolitical acts caused a reduction in shipping indices.

Overall, a research by Lomachynska, Yakubovskiy and Alekseevska (2025) highlighted seven phases of structural transformation in international seaborne trade in the 21st century and concluded that each of the identified stages had been predetermined by one or more economic and/or political event, including but not

limited to China's accession to the World Trade Organization (WTO), trade wars and military conflicts.

Regarding the main dry bulk freight index, the BDI, it is worth mentioning that several attempts have been made in scientific literature to develop alternative indicators, such as the Dry Bulk Economic Climate Index (DBECI) and the Expanded Dry Bulk Economic Climate Index (DBECI-E). Those efforts were intended to improve the ability to predict freight market trends by addressing perceived limitations of the BDI. One approach added several economic variables into the index's composition to factor in demand fluctuations more precisely (Tsioumas, Smirlis and Papadimitrou 2021; Tsioumas *et al.*, 2017). Another approach allowed for a higher influence and weight of smaller vessel classes (Handysize, Supramax, Panamax), given the perception that the Capesize component typically dominated the BDI (Ko, 2011). While those attempts should be acknowledged, the consensus reached across the industry on using the BDI as a primary index remained unchanged. In essence, the objective of those studies was to show the highest possible correlation with the BDI, in other words, to repeat the BDI trends accurately.

Park, Kim and Kwon (2023) have documented a short-term strong positive impact of dry bulk trade volumes on dry bulk freight rates, which diminishes in the long run. In contrast, the global dry bulk tonnage negatively affects dry bulk freight rates. In simple terms, this is consistent with the inherent cyclicity of the shipping market and the demand-supply model which drives it. However, the authors have observed that during periods of market overheating, when freight rates surpass equilibrium level, rates can no longer be explained by a conventional demand-supply mechanism but rather a specific demand for sea transport space.

Jacks and Stuermer (2021), having considered a longer time series dataset (140 years from 1880 to 2020), drew the same conclusion. GDP and fuel prices were found to positively influence dry bulk freight rates, while the global dry bulk fleet had a

negative impact. It was also emphasised by the authors that the significance of demand shocks increased with time, while the role of supply factors diminished, which was consistent with the findings of Nomikos and Tsouknidis (2022). According to the analysis, demand shocks account for approximately 50% of the fluctuations in dry bulk freight rates, while 22% of changes are explained by supply factors. Although these findings do not contradict the established maritime economics theory, they do not introduce new insights but rather confirm the existing understanding.

Among the studies performed by Ukrainian scholars, a paper by Sotnichenko (2017) is worth mentioning for the attempt to identify the determinants of the dry bulk freight market. The study established that the price of newly built dry bulk carriers was the most influential factor. Other factors which demonstrated statistical significance were seaborne trade volumes, size of the global dry bulk fleet, number of new and scrapped vessels, and second-hand vessel prices. As a result, the study has suggested that these variables can explain 99% of the variation in freight rates, which is almost ideal coefficient of determination. However, it has not offered a solid forecasting model but rather reconfirmed the existence of shipping cycles and the ability to ascertain the stage of the cycle by assessing indicators of three out of four shipping markets.

Two studies focus on the Capesize subsegment of the dry bulk market, which is the largest one in the dry sector in terms of trade volumes, fleet size in deadweight tonnes, and its contribution to the BDI. These characteristics of the Capesize subsegment further emphasise the seaborne trade asymmetry which is observed even within one sector. Pelagidis and Panagiotopoulos (2019) found that the introduction of Capesize forward freight agreements initially increased the volatility of the freight market, but helped to stabilise it over time. Pelagidis and Karaoulanis (2021) emphasised the self-dependence of the Capesize freight rates by highlighting a strong positive correlation of the present rates with the lagged values. This means that the Capesize market is determined by momentum, as current freight rates are affected by

the most recent ones. As a result, increase in recent rates can drive current rates higher, and vice versa. On the one hand, this observation helps to enhance the ability to predict market movements. On the other hand, it does not sufficiently explain the turning points, necessitating further analysis to detect the extremums. Interestingly, although Capesize vessels are all relatively similar in size, larger and smaller tonnage within the subsegment still react differently to changes in freight rates dynamics.

The next subset of freight market studies captures upon the second-largest sector of the shipping industry – the liquid bulk or tanker sector. The studies in this group exhibit similarity, as they mainly explore the connection between the energy market and tanker freight market, in other words, how oil prices impact tanker freight rates. It is noteworthy that there is no consensus in the existing literature on this subject. Some studies, including Ukrainian ones, have reported a negative influence of oil prices on tanker rates (Angelopoulos, Sahoo and Visvikis, 2020; Bereza, 2017). In parallel, several studies have found that tanker freight indices co-move with oil prices (Melas, 2026; Shi *et al.*, 2022; Chen *et al.*, 2019; Yang *et al.*, 2015; Shi, Yang and Li, 2013). Moreover, in the latter category, no consensus regarding which types of shocks determine these co-movements has been reached.

In particular, one study has stated that crude oil supply shocks are considerably more influential than non-supply shocks (Shi, Yang and Li, 2013). In contrast, another paper has suggested that non-supply oil shocks significantly impact freight rates during both peaks and troughs in conjunction with tanker-specific factors during peaks and oil supply factors during troughs (Shi *et al.*, 2022). Furthermore, even oil grade is proved to matter, as crude oil Brent price has a greater effect on fluctuations in freight rates than the WTI grade (Yang *et al.*, 2015). From a shipping perspective, the core gap in this series of studies is a lack of attention to the regionalisation of oil trade. Regional markets and the respective route indices, although widely aligned, can follow different trends depending on local factors.

In contrast to the research mentioned above, Sun *et al.* (2014) did not document a consistent relationship between oil prices and freight rates, particularly the BDTI. The study identified distinct characteristics of such a relationship, with correlations reaching very high levels (close to 1.00) in the medium- and long-term but varying in opposite directions. Another study attempted to quantify the duration of cycles in the Aframax tanker market, dividing them into short-term (3.45 years), medium-to-long-term (7.11–8.97 years) and long-term cycles (11.96 years) (Chen *et al.*, 2019).

Apart from oil prices, other factors also deserved attention in the research of the tanker freight market. Siddiqui and Basu (2021) deduced that oil demand demonstrated an even stronger connection with freight rates than oil prices. The study classified such a relationship as complex and non-linear, since the correlation gradually strengthened from an initially low or even negative to a strong positive with time. The influence of oil demand became more pronounced upon the introduction of time lags, which suggested that fluctuations in oil demand impacted freight rates with a delay.

The contribution of the study by Fei *et al.* (2020) is a different approach to examining the effect of external shocks on the tanker freight market. Similarly to studies which analysed the impact of GPR on dry bulk freight rates, the scholars did not find a consistent relationship between critical events and tanker freight rates. For example, financial crises and international competition tended to depress the BDTI, as opposed to environmental awareness and crude oil agreements which stimulated the index. However, the study's limitations necessitated further elaboration on this topic, since such events as natural disasters and local conflicts were not considered.

Studies of the container freight market form a different subset. As the container segment is smaller in terms of trade volumes and fleet compared to the bulk one, it is hence less popular as a research area. From among the Ukrainian studies, Bereza (2017) pointed out the significance of container transportation volumes and second-hand containership prices as determinants of containership freight rates, reinforcing the

concept of shipping market cyclicalities and interconnectedness of variables across the different shipping markets. A recent study by Shkurenko *et al.* (2024) is particularly significant for examination of feeder shipping services, where smaller containership tonnage is employed for short-sea transportation. Presently, a feeder transportation system is a crucial part of both the container shipping and the entire global logistics system; however, it remains an underexplored area in the literature. By analysing examples from the Asia-Pacific region, Europe, and especially Ukraine, the study highlighted the interconnection between the feeder transportation and globalisation processes. It has demonstrated a channel by which this type of transportation service connects regional ports with major global hubs and larger port complexes that ultimately facilitates international trade.

In addition, Saeed *et al.* (2023) has mentioned another topic which is underexplored in the literature, that is the impact of external events on container freight rates. Their study employed the Prophet method on shipping datasets. The technique was developed by the Facebook's Core Data Science team. Incorporating unstructured data reflecting the external shocks in the economy (for example, COVID-19 pandemic) into the study improved the forecasting accuracy of containership rates.

A common limitation of existing studies on the freight market across all sectors is the reliance on the *ceteris paribus* assumption (from Latin – “other things equal”), while in practice freight rates are influenced by different demand and supply shocks which vary in duration, magnitude and direction of impact. In order to overcome this, studies use empirical proxies to represent the shocks. Proxies are often interrelated, thus compromising the *ceteris paribus* condition (Nomikos and Tsouknidis, 2022).

A study by Michail and Melas (2023) is worth mentioning separately. It reveals that it is macroeconomic conditions rather than fuel costs that primarily drive containership freight rates, which is aligned with the general theory and earlier referenced papers. What sets the study apart is the use of the Wilshire 5000 index as a

proxy for the condition of the world economy. This index is an equity indicator which factors in actively traded U.S.-based stocks (Wilshire OpCo UK Limited, 2024).

In the existing shipping research, a limited range of studies have examined how equity market indicators impact shipping economic indicators; Melas, Michail and Louca (2025), Michail and Melas (2023), Michail and Melas (2022), Michail and Melas (2020b) are among them. The latter study identified that the equity market was a channel through which the lagged effects of COVID-19 influenced freight rates. It also revealed a connection between crude oil freight rates and the Standard and Poor's 500 (S&P 500) index. S&P 500 is a key equity index which represents the stock performance of the 500 leading U.S.-listed companies (S&P Global, 2024). A notable finding of that paper was the nature of the relationship revealed: while the impact of the S&P 500 index on crude oil freight rates was negative, it shifted to positive with a one-day lag. In parallel, Melas, Michail and Louca (2025) identified a positive effect of European and American equity markets on the freight market.

In theory, since shipping is a demand-derived industry, a higher demand for cargo transportation should lead to an increase in transportation costs (freight rates), *ceteris paribus*. As long as the equity market is considered to serve as barometer of global macroeconomic state, growing stock prices are intuitively expected to signify a positive economic outlook, *ceteris paribus*, which should be favourable for seaborne trade and, consequently, increase freight rates (Melas and Michail, 2024; Michail, Melas and Louca, 2023). However, beyond a few papers outlined earlier, the existing research, which includes stock market indicators as independent variables in the analysis to assess their direct impact on freight rates, remains thin.

Nonetheless, it is widely accepted in the literature and in the industry that indicators reflecting the state of the world economy are regularly used to evaluate the freight market and assess risks for shipping companies. The latter clearly influences their stock market performance (Michail and Melas, 2019). And although the research

in this area is also limited, contemporary studies have started examining the stock performance of shipping companies as a dependent variable and factors influencing variations in their stock returns. Importantly, earlier studies did not classify shipping companies as an independent group of entities and traditionally analysed shipping stocks in conjunction with stocks of companies from other sectors (Nathan, 2002). As noted by Kavussanos and Marcoulis (2005, pp. 110–112), traditional approach to stock analysis claims that price of any stock, regardless of the sector, is a function of global economic conditions, market conditions, specific industrial factors and inter-company financial fundamentals.

Grammenos and Arkoulis (2002) are known to pioneer research of how macroeconomic conditions impact the stock returns of shipping companies. Their findings suggested that exchange rates positively influenced shipping stocks, while laid-up tonnage and oil prices demonstrated a negative effect. Inflation and industrial production did not show statistical significance and were irrelevant to forecasting. The study also noted that the observed effects were consistent across countries. This has underscored the global nature of the shipping industry which is independent of country-specific factors. Although some of the findings can be contested, this study's primary contribution is the commencement of research of shipping stocks.

Shipping companies started to actively engage into public listings in the 2000s, which triggered a rising interest of researchers in shipping stocks. It became evident that the relationship between macroeconomic variables and stock returns in shipping required more complex explanation than basic economic theory. According to Kavussanos and Marcoulis (2005, p. 130), their initial research findings were rather counterintuitive, for example, positive impact of oil prices and negative influence of industrial production on shipping stocks were recorded.

An influential contribution to literature was made by Merikas, Gounopoulos and Nounis (2009). The scientists highlighted the maturity of shipping as an industry, where

both investors and underwriters possessed strong knowledge of the market and performed equally competently. The study explained that underpricing was understood as a phenomenon where newly issued stocks were priced below their market value at the time of listing, which typically enabled a significant immediate benefit for investors. The level of shipping stocks' underpricing (17.69%) over the period under examination was lower compared to other sectors. Furthermore, shipping initial public offerings (IPOs) exhibited relatively slight underperformance, while IPOs in other industries tended to considerably underperform in the long run. Such an observation again confirmed both stability and attractiveness of the industry to investors in the short and long term.

In addition, the study indicated that stock performance in shipping correlated with the company's age, reputation of underwriter and level of stock market exchange. For example, younger companies or those listed on major exchanges in New York or London experienced higher underpricing. In the long run, shipping stock returns showed a positive correlation with the duration of the company's operating history and a surprisingly negative correlation with the underwriter's reputation.

The study by Syriopoulos and Roumpis (2009) also incorporated equity indicators into analysis, although produced rather intuitive findings, confirming that stock market returns (and their associated volatility) were primarily explained by variations in freight rates.

El-Masry, Olugbode and Pointon (2010) examined the performance of almost 150 shipping stocks over the period from 1997 to 2005 and partially validated the findings of Grammenos and Arkoulis (2002); however, some of them were challenged. The study found that exchange rates had a greater effect on shipping stock returns than interest rates and oil prices. Contrary to theoretical expectations, shipping companies turned out to benefit from a stronger U.S. dollar. Moreover, the authors demonstrated that shipping companies generally tended to adopt effective hedging strategies.

Drobetz, Schilling and Tegtmeier (2010) revealed that shipping stocks were more sensitive to exchange rate changes than to interest rates or oil prices; they also confirmed that shipping companies gained positive returns when dollar strengthened. In line with theoretical expectations, interest rates negatively impacted shipping stocks, while industrial production had a positive effect. Due to a unique and multifactor risk profile of shipping stocks, which are characterised by irregularity and unpredictability, the study revealed that shipping stocks should be classified as a separate investment asset group, forecasting of which was challenging. That underscored the need for the development of more advanced techniques to account for shipping-specific nuances. With respect to limitations, the study employed a relatively simplistic modelling technique with limited explanatory power.

An attempt to perform a shipping-specific analysis was undertaken by Lin, Chang and Hsiao (2019). Focusing on the dry bulk sector, the authors assessed long-term volatility spillover effects between the three markets – shipping equity, commodities and currency. The freight market appeared to influence those three markets in the short run during extreme events of global disruptions (for example, the subprime crisis in 2008 or the Chinese stock market collapse in 2015–2016), although no long-term effect of the freight market on these three markets was recorded.

Turning to another finding, the study confirmed the China's high predictive power in the financial sector, including prices of shipping stocks. China consistently absorbs a significant portion of global dry bulk imports, and the BDI appears to be highly dependent on the Chinese economy and local events. As to the limitations of the study, it employed an adjusted Dow Jones Global Shipping (DJGS) index as a proxy for the shipping equity market. This rather unique approach differentiates this study from the others which usually use broader indicators, such as the S&P 500 and the Wilshire 5000 indices. The composition of the adjusted Dow Jones Global Shipping index is biased towards Asian market, as it includes the market value of just 11 dry bulk

shipping companies, eight of which are traded on Asian exchanges and the other three – in the USA.

Michail and Melas (2019) focused on the tanker sector and recommended a customised trading strategy for those investors who dealt with shipping stocks but lacked shipping expertise. According to the study, the proposed strategy outperformed the standard buy-and-hold approach by 50%. While the specifics of the strategy fall out of scope of this research, a meaningful finding of that study lies in revealing the role of freight rates in the suggested strategy: an increase in freight rates led to a more than threefold spike in the value of the portfolio of shipping stocks under examination, again confirming a direct positive relationship between stock and freight markets.

Kamal, Chowdhury and Hosain (2021) concentrated on COVID-19-related events and considered how shipping stocks reacted to them. All associated events were split into either optimistic or pessimistic group. As a result, stocks of 77% of companies reacted according to expectations by increasing during positive events and decreasing during negative ones. Overall, 18% of companies responded negatively to all events. The study cannot be called ground-breaking, although it contributes notably to the research on the topic of shipping stocks.

To examine the impact of commodity prices on stock market returns in the dry bulk sector, Melas and Michail (2024) used an advanced modelling technique to address potential multicollinearity. Their findings are partially aligned with theory and partially diverging from it. For instance, in contrast to Grammenos and Arkoulis (2002), oil prices were found to positively affect stock returns. Additionally, mineral prices demonstrated a strong positive influence. No impact of grain prices or the Wilshire 5000 index on stock returns was recorded. The explanation for this lies in the asymmetry in dry bulk seaborne trade, especially in higher global trade volumes of ores and coal (CRSL, 2023a) and the larger vessel classes used for their transportation compared to agricultural commodities (Alizadeh and Nomikos, 2009, p. 33). These

findings support and enhance those reported by the authors in their earlier studies (Melas and Michail, 2021; Michail and Melas, 2021b) and establish a clear chain of effects: dry cargo prices positively influence freight rates and stock returns, while the stocks are potentially affected (a) directly, (b) through freight rates, or (c) through a combination of both. Finally, the absence of correlation between shipping stocks and general stock market indices suggests that investors may consider acquiring shipping stocks as an effective instrument for hedging purposes.

Touching the topic of stocks, Zhykharieva (2025) developed an advanced approach to evaluation of shipping companies' business value through two-stage calculations based on market capitalisation and on multipliers of the company's value and equity. While only containership companies were used in the study to illustrate this approach, it can be further expanded to other segments.

Figure 1.4 summarises the literature review in respect of key factors whose influence on shipping stocks is documented.

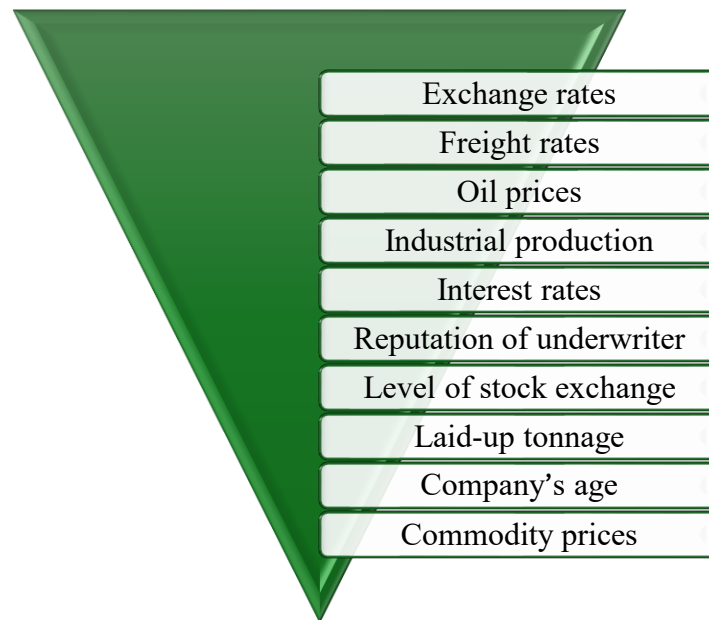


Fig. 1.4. Key factors impacting shipping stocks

Source: Compiled by the author

To conclude the review of the existing literature on the subject, it is worth noting that research by Ukrainian scholars differs from studies conducted by foreign researchers, particularly those from the EU, USA and Asian countries. A significant portion of the studies by Ukrainian scholars are concerned with examining systemic issues, which impact the development of Ukrainian maritime sector, and producing recommendations for its revival and integration into the wider external economic strategy of Ukraine (Zaidman and Yakubovskiy, 2021a).

According to the literature reviewed, the complete integration of Ukraine into the global shipping industry is hindered by unfavourable conditions, including the absence of national fleet, complex customs procedures in place, inefficient tax system, absence of market-based mechanisms for managing the maritime sector, and an outdated regulatory framework not aligned with the EU and international legislation (Minakova and Poznanska, 2019). To a certain extent, these issues demonstrate maritime asymmetry at the national level. Scholars mention the importance of registering more vessels under the Ukrainian flag to address asymmetries, increase budget revenues, and ensure decent working conditions for Ukrainian seafarers (Poznanska and Lypynska, 2018). Solutions suggested by Ukrainian scholars include various mechanisms to revive national shipping through adoption of a more flexible government policy (Nikolaieva, 2009) and international tax practices for shipping operations (Poznanska and Lypynska, 2018; Zhykharieva, 2010).

The war in Ukraine has clearly introduced new challenges and identified gaps in the regulatory framework, in particular in respect of freight payments. Ukrainian companies have been facing difficulties submitting freight and associated payments to shipowners as these types of transactions are not included in the list of critical payments defined by the government. Such inability to make payments has also resulted in a loss of tax revenues for Ukraine (Shkurenko, Korniiiko and Popov, 2023). Regarding legal aspects of transportation under war, Lypynska and Kotlubai (2025) revealed gaps in the

Rotterdam Rules, which required the development of additional protocols to ensure practical applicability to war circumstances, and suggested a mechanism to align national rules for maritime transportation with international standards.

A series of dissertations have proposed strategies for the comprehensive development of Ukraine's maritime transport sector. For instance, Vinnikov (2006) developed a maritime transport policy as a methodological base for the organisational and economic mechanism of Ukraine's establishment as a maritime nation. Kotlubay (2004) proposed methods for modelling organisational structures of shipping companies and economic systems by optimising external cargo shipments using fleets chartered by Ukrainian companies and improving freight rate calculations for long-term contracts. All those studies aimed to implement the global shipping standards in various aspects in Ukraine.

As regards research focused on shipping companies, Ukrainian scientists have also been exploring the best management practices adopted globally. The need to develop innovative measures and align business strategies with unstable and changing macroeconomic conditions and global requirements related to the fleet optimisation has been highlighted as a recommendation for Ukrainian enterprises (Balan, Lypynska and Stakhov, 2023; Poznanska, Husarina and Yudin, 2023). Prymachova *et al.* (2023) have strategically considered concepts of integration within the shipping industry. Zhykharieva's (2010) dissertation stands out for thorough examination of shipping companies' investment planning fundamentals, such as risk management techniques, methodological principles for investment decisions, and freight market volatility.

Numerous studies have considered opportunities to optimise sea ports in Ukraine (Baryshnikova and Lototskyi, 2024; Shkurenko, Budnyk and Perepichko, 2022; Mihai *et al.*, 2021; Mihai, 2020; Logutova and Poltoratskiy, 2018; Naumova, 2015), but this is beyond the scope of this research.

Several Ukrainian studies have analysed global seaborne trade condition. Some of these studies (Savchenko, Panasiuk and Levchenko, 2022; Logutova and Poltoratskiy, 2018) are based on reports published by international organisations, including but not limited to the UNCTAD reviews referred to earlier. Such studies show the trends within the shipping industry and retrospectively describe data.

The freight market is frequently explored in Ukrainian research, although limited attempts have been made to model and forecast the freight market dynamics compared to international studies. Some papers have mainly confirmed that freight rates are impacted by intuitive factors in line with the theory, reflecting the inherent cyclicity of shipping (Bereza, 2017; Sotnichenko, 2017). The practical applicability of such studies for market participants is rather limited. In contrast, scholars from the EU, the USA and Asia constantly try to develop and advance various methodologies in order to improve accuracy in nowcasting of global seaborne trade volumes and predicting freight market fluctuations. This also includes investigation of spillover and substitution effects in shipping, which have been rarely studied by Ukrainian scientists yet (Zaidman and Yakubovskiy, 2021a).

Recent trends demonstrate closer alignment of Ukrainian maritime studies with global research topics. For instance, the dissertation by Poznanska (2019) and the thesis by Stakhov (2023) focus on asymmetries in the global seaborne trade market and propose models to address the observed disproportions and minimise impact of asymmetric deviations. Both works provide a foundation for optimising Ukraine's maritime enterprises in view of asymmetric nature of shipping environment, as well as uncertain nature of global macroeconomy.

The modern research is also concerned with analysing recent trends in international seaborne trade and its adaptation to new challenges under the pressure of various shocks in the world economy. Studies focus on geographical and regional shifts in seaborne trade, underscore its increasing sectoral and regional asymmetric deviations

(Lomachynska, Yakubovskiy and Alekseevska, 2025; Pichuhina, Alekseevska and Kocharian, 2024; Balan, Lypynska and Stakhov, 2022), and also address transformations in the global fleet under global digitalisation, particularly widening mismatch between countries of vessels' ownership and flags of registration (Yakubovskiy, Pichuhina and Korol, 2025).

Balan, Lypynska and Shepel (2022) addressed the complexity of planning in shipping under uncertainties in modern seaborne trade. Alekseevska, Yakubovskiy and Pichuhina (2025) examined the dependence of the global inflation on maritime transport cost, particularly the impact of freight rates on global import prices, and suggest adopting an integrated maritime transport policy. Exploring contemporary freight policies, Shkurenko (2026) has outlined the trends that currently determine global chartering practices, with a particular focus on digitalisation and environmental orientation.

1.3. Methodological approaches to studying shipping economic indicators

Methodology is a set of methods which makes it possible to achieve research objectives (Medvid, Danko and Koblianska, 2020, p. 128). The literature review has identified a wide range of methods employed in maritime economics in general and particularly for studying the factors that influence shipping markets. Methodological approaches vary depending on the available datasets, research periods, principles, and ultimate research objectives.

According to the literature review presented in Section 1.2, the most effective approach to shipping research involves the use of general scientific theoretical and empirical methods, coupled with specialised discipline-specific and international trade-specific techniques. General scientific methods include induction, deduction, analysis,

synthesis, systematisation, generalisation, modelling, abstraction, formalisation, comparison, and visual-graphical methods. From among discipline-specific methods in shipping economics research, the most commonly applied are computational-analytical tools, particularly statistical analysis and econometric methods, including correlation and regression techniques (Koretska *et al.*, 2023; Zaidman and Yakubovskiy, 2021b; Medvid, Danko and Koblianska, 2020, pp. 129–133, 136–137; Barrow, 2017, pp. 263–348). This is aligned with general trends in economic research, where a significant part of studies employ statistical methods to improve understanding, planning and forecasting economic and macroeconomic indicators. These methods are used to both analyse macroeconomic processes and forecast the overall economic development based on historical data (Koretska *et al.*, 2023).

Cullinane (2005, p. 2) has noted that, within the transportation segment, the market modelling in shipping economic research is more advanced compared to other transport modes. However, compared to other forms of international economic relations, shipping economists started to implement statistical methodologies later and at a slower pace. As Goulielmos (2019) pointed out, modelling tools evolved from initially verbal logical scientific instruments to physical, geometrical and ultimately algebraic models. It is J. Tinbergen and T. C. Koopmans in the 1930s and Z. S. Zannetos in the 1960s who pioneered maritime economics research and laid the foundation for its development in the next decades. It should be acknowledged that the applied methodologies were based on the econometric tools available at that time and some of the produced findings are subject to critique nowadays. Nonetheless, the contribution of the mentioned scholars cannot be underestimated in terms of the introduction of a data-driven research approach into maritime economics (Goulielmos, 2019; Glen and Martin, 2005, pp. 20–28; Zannetos, 1959).

With the progress of econometrics, methodologies employed in maritime economics also evolved (Goulielmos, 2019; Glen and Martin, 2005, pp. 19–20).

Tinbergen and Koopmans explored the freight rate dynamics through the prism of interplay between supply and demand. For instance, Tinbergen developed a two-equation model. Supply was assumed to depend on the fleet size, costs (proxied by fuel prices), and freight rates (Equation 1.1). Thereafter, Equation 1.2 was produced under the assumption that supply equals demand at the equilibrium point.

$$S = K^a P^{-b} F^g, \quad (1.1)$$

$$F = e_1 D - e_2 K + e_3 P, \quad (1.2)$$

where S represents a supply function; K is the existing tonnage; P denotes the cost of fuel; F is the freight rate; D is a demand function; $e_1 = 1/g$, $e_2 = a/g$, and $e_3 = b/g$.

According to this model, freight rates are calculated as a function of demand for vessel space less existing tonnage, plus fuel costs (Goulielmos, 2019; Glen and Martin, 2005, pp. 19–20).

Koopmans' model presented in Equation 1.3 was aligned with Tinbergen's model, it was just applied to the tanker sector only. Compared to earlier models, Koopman's contribution lies in addressing the static nature of previous models and introducing a concept of market expectations. Koopmans demonstrated that sentiment about future market conditions influenced investment decisions, which, in turn, had an effect on freight rates. The scientist suggested factoring in the time taken to build a vessel as such a delay in supply's response clearly disrupted equilibrium at a given moment (Goulielmos, 2019).

$$D = K(F/P)^g \quad (1.3)$$

Despite a wide recognition, these models have been criticised for their relative simplicity and limitations, even regardless of Koopmans' decision to include market expectations as a parameter. One of the critical remarks is related to the omission of time lags in the analysis. Furthermore, vessels scrapping and lay-ups, vessel speeds, travel distances and others meaningful considerations were basically oversimplified or

their direct influence was neglected. This is why these models are presently called “static” as they reflect a snapshot of existing market conditions while not capturing their dynamic movements. Moreover, it is noted that other methodological gaps of the first models included insufficient testing arrangements and goodness-of-fit measurements, omission of error terms, and limited data availability, which are all mandatory components of present models (Goulielmos, 2019).

Later Zannetos challenged traditional research approaches. The scientist advanced a previous concept of market expectations, which, due to cyclicity, exhibited non-linear, asymmetric impact on the behaviour of charterers and shipowners. Zannetos deduced that investment in newbuildings was not driven by freight rates only. Furthermore, Zannetos emphasised the importance of the term structure of freight rates: longer charter durations tended to bring freight rates closer to equilibrium. Such an observation stimulated further research which considered both spot and time-charter rates separately. Still, Zannetos questioned the quantitative credibility of own models (Goulielmos, 2019; Glen and Martin, 2005, pp. 24–26; Zannetos, 1959).

The 1990s are widely regarded as a turning point in maritime economics research. Building on earlier contributions of the mentioned scholars, M. Beenstock and A. Vergottis introduced a structural model (Equation 1.4) which addressed several earlier critical remarks:

$$D = K(F/\alpha P)^{1/(\alpha-1)}, \quad (1.4)$$

where α is a technology constant determining a vessel’s speed and fuel consumption.

The model by Beenstock and Vergottis, as previous ones, still explained the freight rate formation through the interaction of demand and supply functions but also allowed for rational expectations, dynamic nature of the market, and assumed market efficiency in itself. The scholars applied two-stage least squares (2SLS) and ordinary

least squares (OLS) regressions. It was the last prominent research in that scientific era. Later, methodologies started to change significantly due to the introduction of new modelling tools, increased access to data and advanced approaches to the statistical properties of data (Goulielmos, 2019; Glen and Martin, 2005, pp. 19–28).

Three major changes in the research approaches can be mentioned, as stated by Glen and Martin (2005, pp. 28–37). First, data-driven reduced-form autoregressive models and vector autoregressions (VAR) substituted for structural models which paid excessive attention to theoretical explanations of interplay between variables. Second, those data-driven models shifted focus to purely statistical connection between variables, sometimes without a strong theoretical foundation. Researchers started investigating data properties through stationary testing and analysis of long-term dependencies between variables, which essentially marked a phase when empirical research and associated findings superseded theoretical constructs. Third, greater variety, higher quality, increased frequency, and ease of access to time series data facilitated such a transition.

Regressions are broadly categorised into multiple linear, multivariate multiple linear, multinomial logistic and multivariate non-linear ones (Sun *et al.*, 2023). In particular, multiple linear regression models examine the relationship between a dependent (explained) variable and any number of independent (explanatory) variables. The standard form of a linear regression model is presented by Equation 1.5:

$$y = f(x_1, x_2, \dots, x_K) + \varepsilon = x_1 \beta_1 + x_2 \beta_2 + \dots + x_K \beta_K + \varepsilon, \quad (1.5)$$

where y represents a dependent variable, and $x_1, \dots, x_K$ denote independent variables (Greene, 2005, pp. 52–53).

Similarly to any other instrument, regressions typically rely on several assumptions and have certain limitations. The least squares method is the most popular approach to the estimation of regression model parameters. The OLS technique minimises the sum of squared residuals (the differences between observed and expected

values) and assumes that regressors do not correlate with the error term (meaning there is no endogeneity). Where endogeneity exists, the more advanced 2SLS method may be used for the estimation as it eliminates the issue by introducing estimators (instrumental variables) (Wooldridge, 2020, pp. 20–34; Barrow, 2017, pp. 278–283; Greene, 2012, pp. 51–147, 264–294). Based on the literature review, it has been established that in existing shipping research such types of regression as OLS and 2SLS were more often used to examine stock returns (Kamal, Chowdhury and Hosain, 2021; El-Masry, Olugbode and Pointon, 2010; Merikas, Gounopoulos and Nounis, 2009) rather than freight rates (Lim, 2022; Melas and Michail, 2021). The applicability of OLS methodology to studying stocks performance has been tested earlier in the research focused on the banking sector (Kasman, Vardar and Tunc, 2011). Kavussanos and Marcoulis (2005, p. 133) have also advocated for the use of multiple models to examine stock returns, as this approach enables researchers to draw practical conclusions which are especially valuable for investors.

Given the fact that a reduced-form autoregressive model does not factor in the relationship between multiple variables, a more complex vector autoregression (VAR) model has been developed. A VAR model can examine dynamic interactions between multiple variables (Greene, 2012, p. 546; Pfaff, 2008; Glen and Martin, 2005, pp. 28–37). According to Akkaya (2021), “all variables in the model are treated symmetrically with an equation for each variable explaining the development of the variable, depending on the lags of the variable in the model and the lags of all other variables. (...) It is not necessary to specify which variables are endogenous or exogenous. (...) Granger causality test developed by Granger is a test used to determine the direction of causality of the relationship in the presence of delayed relationship between two variables”. The generic form of a VAR is presented by Equation 1.6:

$$y_t = A_1 y_{t-1} + \dots + A_p y_{t-p} + u_t, \quad (1.6)$$

where A_i denotes coefficient matrices for $i = 1, \dots, p$, and u_t is the error component referred to as multivariate “white noise”, with a mean vector of 0 and a dispersion matrix (Wozniak, 2016; Pfaff, 2008).

The analysis has shown that today VAR-type models, having gained popularity in the scientific world since the introduction in 1980, are widely adopted across various research fields. Nonetheless, they have certain limitations which have been addressed by the introduction of VAR modifications. Several advanced types of VAR aim to incorporate economic theory into the analysis (Pfaff, 2008). A Bayesian vector autoregression (BVAR) improves standard VAR by using Bayesian inference, thereby making BVAR suitable for smaller datasets (Wozniak, 2016; Litterman, 1986). The vector error correction model (VECM) is another form of VAR which is used for non-stationary variables and allows for cointegration while treating variables as endogenous (Michail, 2020; Pfaff, 2008). Unlike standard VAR, which explains variables based on their past values, structural VAR (SVAR) and recursive SVAR “allow the explicit modelling of contemporaneous interdependence between the left-hand side variables” (Pfaff, 2008). Recursive SVAR also assumes that ordering of the variables predetermines the outcomes (Pfaff, 2008).

Within the scientific community, opinions are different on whether a VAR or a structural model is more efficient (Cullinane, 2005, p. 4). Some scholars claim that the traditional method (by Beenstock and Vergottis) offers a deeper insight into economic reality compared to purely data-driven approaches (Glen and Martin, 2005, p. 36). Still, modern maritime economics widely adopts VAR models and their modifications. For example, standard VAR is frequently employed in studies examining the freight market (Gu and Liu, 2022; Drobets *et al.*, 2020) and seaborne trade (Michail, Melas and Batzilis, 2021). Despite the expectation that a Bayesian VAR would be suitable for shipping-specific investigations, it has only been employed by a few studies (Melas,

Michail and Louca, 2025; Michail, Melas and Louca, 2023; Drobets *et al.*, 2020; Michail and Melas, 2020a).

In contrast, a VECM is used more actively, particularly by the prominent scholars Michail and Melas, who analyse different indicators such as freight rates, seaborne trade volumes, stock market returns, and newbuilding orders using a VECM framework (Michail and Melas, 2023; Monge, Rojo and Gil-Alana, 2023; Michail and Melas, 2021b; Michail, 2020; Michail and Melas, 2019; Tsioumas and Papadimitriou, 2018). Notably, once both VECM and BVAR were used in the same research with the aim to further verify the outcomes produced by VECM through BVAR framework (Michail and Melas, 2022).

Structural VAR is the most popular VAR modification used for studying freight rates, with almost equal breakdown between the use of standard SVAR (Yilmazkuday, 2025; Park *et al.*, 2024; Nomikos and Tsouknidis, 2022; Jacks and Stuermer, 2021; Shi, Yang and Li, 2013) and recursive VAR (Park, Kim and Kwon, 2023; Park, Kwon and Kim, 2021; Kilian, 2009). Autoregressive model (AR) is rarely used (Pelagidis and Karaoulanis, 2021).

In the 1980s, a model known as autoregressive conditional heteroscedasticity (ARCH) and its generalised modification (GARCH) were developed. These models attempt to address the limitation of traditional econometric assumptions of constant volatility. ARCH and GARCH models allow for heteroscedasticity (Greene, 2021, pp. 970–979; Wooldridge, 2012, pp. 417–418). Glen and Martin (2005, pp. 33) have noted that “the original model (ARCH) was developed to allow for the persistence of periods of greater and lesser volatility of the data. GARCH models generalised this approach, so that the modelling of the conditional variance can become as sophisticated as the modelling of the conditional mean of the data”. Such characteristics of these models ensure that regression equations remain robust even during periods of

significant volatility which is intrinsic to permanently fluctuating shipping markets. The basic form of this model includes the following Equations 1.7 and 1.8:

$$y_t = x_t' \beta + \varepsilon_t, \quad (1.7)$$

$$\varepsilon_t = u_t \sqrt{\alpha_0 + \alpha_1 \varepsilon_{t-1}^2}, \quad (1.8)$$

where u_t is a standard normal random variable (Greene, 2021, p. 971).

In modern shipping research, the GARCH model has been rarely employed as a single framework (Pelagidis and Panagiotopoulos, 2019). GARCH is normally combined with other techniques, such as VAR (Melas, 2026; Michail and Melas, 2020b; Lin, Chang and Hsiao, 2019; Yang *et al.*, 2015).

In addition to the methods described above, there are a few other methodologies worth mentioning, albeit they are used sporadically in maritime economics. They include threshold regression approach (Melas and Michail, 2021) and seemingly unrelated regression (Drobetz, Schilling and Tegtmeier, 2010); ensemble empirical mode decomposition models (Siddiqui and Basu, 2021; Sun *et al.*, 2014), rescaled range analysis (Fei *et al.*, 2020), wavelet analysis (Chen *et al.*, 2019), and mixed-frequency data sampling copula model (Shi *et al.*, 2022); generalised dynamic factor model (Angelopoulos, Sahoo and Visvikis, 2020) and principal component analysis (Melas and Michail, 2024).

Apparently, the construction of models is a common approach in modern research (Koretska *et al.*, 2023). Modelling plays a crucial role in forecasting, which is in high demand in the industry, as it provides the necessary tools to take more informed decisions at various stages (Goulielmos, 2019), optimise processes and reduce inefficiencies. The choice of a specific modelling technique depends on various factors (Zaidman and Yakubovskiy, 2021b). Moreover, for such an inherently high-risk industry as global shipping, modelling serves as a tool for quantitative risk assessment. This is particularly important since qualitative risk assessments proved less efficient in

shipping. Models primarily draw on freight rates fluctuations, since the profitability of all investment and other projects in shipping is in any case related to freight rates (Zhykharieva *et al.*, 2023, pp. 227–228).

Concurrently, the uncertain nature of freight rates underlies Stopford's (2009, pp. 697–701) scepticism about the accuracy of forecasting exercises in shipping. Under these circumstances, several recent studies have adopted a hybrid approach by combining classic econometric approaches with AI tools, in other words, various types of machine learning techniques. The initial outcomes demonstrated the ability of such hybrid models to predict the future values with a higher credibility than conventional models (Atsalaki *et al.*, 2025; Guo *et al.*, 2025; Wang *et al.*, 2025; Zhang *et al.*, 2019; Eslami *et al.*, 2017). Although such methods have not been widely accepted by the global scientific community yet, this is an area for further investigation. At present, these methods require a high level of technical development and complex computations.

It is also important to use econometric methods with caution, as experts constructively advise. Interpretation of the model outcomes should be done with alertness and special attention, going beyond the standard statistical parameters, such as R-squared, F-statistic and others. It is essential to delve deeper into the nature, structure and properties of the data, since statistics alone does not determine robustness. It is necessary to remember that significance does not imply causality. Not to be misled by inaccurate calculations which lead to incorrect results, it is essential to build reasonable hypotheses (Michail and Massouras, 2014; Black, 1982).

Based on the analysis of the existing methodologies within maritime economics research and the research objectives of this PhD research, the following multiple regression models have been developed. Equation 1.9 represents a modelling instrument designed to examine the relationship between freight indices in the dry bulk and oil tanker sectors and a set of key economic parameters that vary across both

segments for higher robustness and capture the general trends in the real economy and commodity markets, international trade development, global financial markets, including capital and equity markets, and macroeconomic price dynamics.

Equation 1.10 represents a modelling framework developed for studying the relationship between the market capitalisation (MCAP) of leading companies in the dry bulk and oil tanker sectors and core economic variables that vary across both segments and reflect the dynamics of the commodity, shipping freight, and global financial markets, including capital and stock markets, and macroeconomic price conditions.

$$Freight\ index_{sector} = \beta_0 + x_1 \beta_1 + \cdots + x_k \beta_k, \quad (1.9)$$

$$MCAP_{company} = \beta_0 + x_1 \beta_1 + \cdots + x_k \beta_k, \quad (1.10)$$

where $Freight\ index_{sector}$ denotes the relevant freight index of the sector; $X_1, \dots, X_k$ represent segment-specific economic explanatory variables that capture trends of broader economic conditions; β_0 is a constant; β_i represents the factor impact coefficient, and $MCAP_{company}$ denotes the market capitalisation indicator of the leading companies under examination.

Additionally, considering unique characteristics of the containership market, which started to gain scientific attention later than the bulk market (Cullinane, 2005, p. 15), coupled with the widespread adoption of the VAR framework in shipping research, the following VAR model (Equation 1.11) is chosen to analyse containership charter rates in terms of their relationship with the wider economic environment represented by indicators capturing the developments in the real economy and international trade, as well as general trends in shipping, commodity, and equity markets:

$$CC\ rate_t = \alpha + \sum_{i=1}^p \beta_i MI_{t-i} + \sum_{i=1}^p \gamma_i CC\ rate_{t-i} + \varepsilon_t, \quad (1.11)$$

where *CC rate* represents the containership charter rate, *MI* represents a set of selected macroeconomic and economic indicators, α is a constant term, β and γ are coefficients, and p represents the selected lag.

In combination with general scientific and statistical methods, the selected models form a robust methodological framework for the research of economic indicators in the global shipping industry. This framework enables an analysis of various aspects, including identification of the freight rate determinants and factors determining the dynamics of companies' market capitalisation across different shipping sectors. Regression analysis makes it possible to establish the influence of key economic factors, including commodity prices, interest rates, stock market indicators, macroeconomic, industrial and trade parameters, on freight markets, while vector autoregression captures dynamic interrelations between variables under examination. Moreover, testing mechanisms provide a critical review of the revealed relationships. Given the availability and characteristics of the data, the chosen methods are considered suitable to perform a comprehensive analysis of shipping economy and its connection to the broader economic environment. All methods together offer a scientific approach to the subject and allow of establishing emerging trends in the global shipping industry under asymmetries in international seaborne trade and producing relevant forecasts and recommendations.

Conclusions to Chapter 1

The following conclusions have been drawn from the theoretical analysis:

1. International trade is a key form of international economic relations, and shipping plays a crucial role in it. Four interconnected international markets facilitate the shipping industry: the freight market, the sale and purchase market, the newbuilding

market, the demolition market. Among these, the freight market is most exposed to volatility driven by high sensitivity to ever-changing elastic demand and supply responding with a lag, as vessels construction is a time-consuming process. This specifics determines the underlying mechanism of shipping cyclicalities. At the current stage, cyclicalities in shipping is measured against a benchmark of Stopford's short shipping cycle.

2. International seaborne trade is characterised by asymmetries which are suggested to be defined as an economic phenomenon observed at the global, regional, national and company levels in the form of geographical, sectoral and product disproportions in maritime trade flows due to a combination of underlying economic, geopolitical, historical, cultural, technological, environmental, social, institutional and regulatory, as well as technical and operational factors, predetermining uneven distribution of goods transported by sea among both producers and consumers.

3. The history of shipping finance in the 20th century is divided into six phases. Although each phase is characterised differently while the preferred financing options and the role of banks in shipping finance have changed over time, the key conclusion is that the freight market is always a significant factor which shapes the relationship between shipping companies and financial institutions.

4. The core focus areas of existing research in maritime economics include the following: evaluation of the dynamics and identification of trends in shipping economic parameters, with freight rates being paid most attention; examination of shipping markets' spillovers; analysis of the effects of external shocks and risks on the global shipping architecture; investigation and modelling of decarbonisation in maritime transport, and development of fleet renewal investment strategies. At a high level, the objective of most studies is to support strategic decision-making in shipping, improve planning activity and risk management, lessen inefficiencies, optimise resources, costs and operations, and forecast shipping market developments – in other

words, research aims at practical applicability. It has been also ascertained that stock market indicators, including shipping stocks, and their relationship with other shipping indicators remain less explored as compared to the major focus areas.

5. The key approaches and methodologies to studying maritime economics globally have been analysed. As far as research of the dynamics of main shipping economic variables is concerned, the employment of econometric methods is considered the most suitable for evaluation, modelling and forecasting purposes. The theoretical and methodological review has justified the choice of quantitative research methods used in this research and described in the next sections. In particular, multiple regression models have been developed to examine the relationship between freight indices in the dry bulk and oil tanker sectors and selected economic variables that capture the broader economic dynamics. A similar framework has been developed to evaluate the trends in market capitalisation of the leading companies in the dry bulk and oil tanker sectors. A VAR model has been developed to study containership charter rates.

The major findings and outcomes of the research described in Chapter 1 have been reported in the following author's publications: Zaidman and Yakubovskiy (2021a); Zaidman and Yakubovskiy (2021b); Zaidman (2025a).

CHAPTER 2

A COMPREHENSIVE EMPIRICAL ANALYSIS OF INTERNATIONAL SEABORNE TRADE, FREIGHT MARKET AND SHIPPING STOCK PERFORMANCE

2.1. Dynamics, structure and asymmetries in modern international seaborne trade

In maritime economics, two approaches are typically adopted to quantify the volume of seaborne trade either in tonnes or tonne-miles. To measure trade in tonne-miles, the total weight of transported goods (in tonnes) is multiplied by the distance the goods travelled on board vessels (in miles). In 2024, the total world seaborne trade amounted to 12,643 million tonnes and 66,378 billion tonne-miles. Both figures represent the all-time highs for the global seaborne trade (Clarksons Research, n.d.). As illustrated in Figure 2.1, total international seaborne trade, measured in both tonnes and tonne-miles, demonstrated the overall upward trend over the 2005–2024 period.

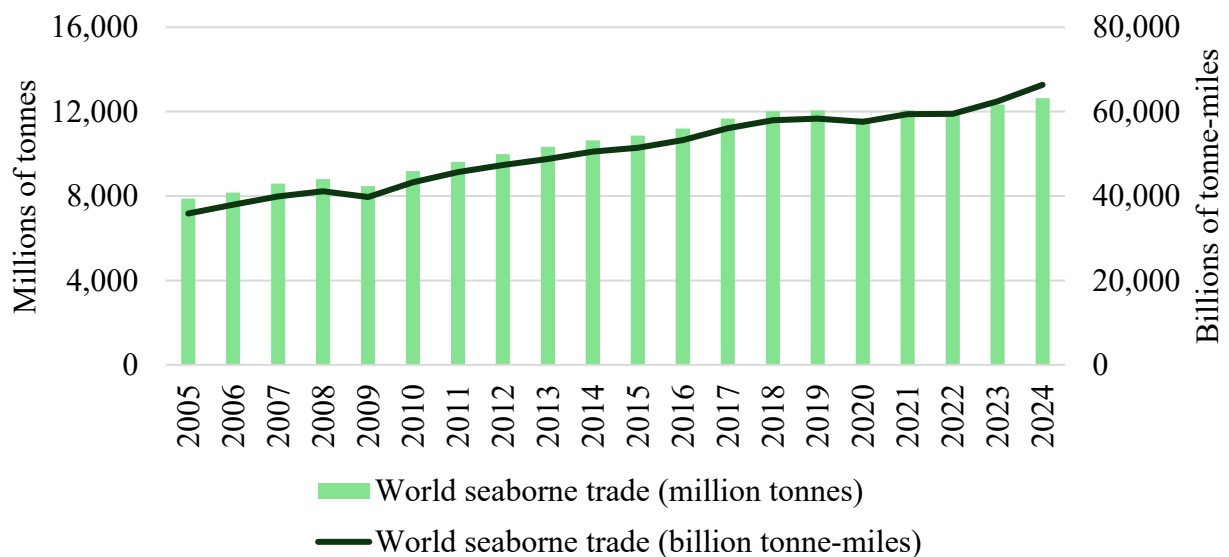


Fig. 2.1. Dynamics of world seaborne trade

Source: Compiled by the author based on data from Clarksons Research (n.d.)

Year-on-year declines of both measures were observed in 2009 and 2020. Additionally, in 2022, seaborne trade in tonnes dropped, while the volume in tonne-miles insignificantly increased by 0.1%. All declines are clearly linked to the extreme events – the global financial crisis in 2008–2009, COVID-19 pandemic outbreak in 2020 and the Ukrainian war in 2022. In 2023 and 2024, seaborne trade in tonne-miles increased at a higher pace than seaborne trade in tonnes. This can be primarily attributed to both the global economic growth and the need to reroute vessels due to several ongoing and emerging disruptions, particularly in the Black Sea, the Red Sea, and the Panama Canal, which impacted critical “maritime checkpoints” (UNCTAD, 2024).

Sectoral asymmetry is one of the forms of asymmetry in international seaborne trade; therefore, it is important to distinguish sectors within the global cargo shipping industry. The current literature suggests several ways how to do this (CRSL, 2015; Mukherjee and Brownrigg, 2013, pp. 19–26; Lun, Lai and Cheng, 2010, pp. 10–11; Alizadeh and Nomikos, 2009, pp. 25–26; Stopford, 2009, p. 62; Cullinane, 2005, p. 5). The most widely accepted classification divides the international seaborne trade into bulk trade (dry and liquid), liner trade (containerised) and specialised trade (CRSL, 2015; Stopford, 2009, p. 62). While they are the elements of one industry, each sector has specific characteristics and role (Mukherjee and Brownrigg, 2013, p. 19).



Fig. 2.2. World seaborne trade by sectors in 2024

Source: Compiled by the author based on data from Clarksons Research (n.d.)

As shown in Figure 2.2, the bulk sector constitutes the largest share of international seaborne trade. It handles homogenous cargo transported in large parcels. Depending on the type of cargo, bulk trade is further divided into dry bulk and liquid bulk, the latter is widely known as wet trade (CRSL, 2015; Stopford, 2009, p. 466).

Dry bulk trade amounts to almost half of the total volume of goods transported by international maritime transport and is facilitated by dry bulk carriers, which can be geared or gearless. There is no commonly accepted strict classification of dry bulk vessel classes. Geared dry bulk carriers (equipped with cranes) are generally up to 60,000 deadweight tonnes – Handysize, Handymax and Supramax classes. Deadweight tonnage of gearless dry bulk carriers is typically over 65,000, these include Panamax and Capesize classes (CRSL, 2015; Mukherjee and Brownrigg, 2013, p. 21; Alizadeh and Nomikos, 2009, pp. 30, 33; Stopford, 2009, pp. 591–592), as illustrated in Figure 2.3. The substitution effect is regularly observed in the dry bulk fleet. Based on vessels' availability within certain distance and time, it is a common practice for charterers in the dry bulk market to utilise smaller tonnage in lieu of larger units or vice versa (Melas and Michail, 2024).

Vessel type	Ship size (dwt)	Approximate speed (knots)
Handysize	20,000–35,000	12–16
Handymax	35,000–45,000	12–16
Supramax	45,000–55,000	12–15
Panamax	60,000–75,000	12–15
Capesize	80,000–300,000	12–14

Fig. 2.3. Vessel classes in the dry bulk sector

Source: Alizadeh and Nomikos (2009, p. 30)

Figure 2.4 shows that over the last 20 years, dry bulk seaborne trade grew significantly, except for 2009, 2020 and 2022, when volumes decreased similarly to the total seaborne trade. In 2009 and 2022, declines were recorded in both tonnes and tonne-miles, while in 2020 only in tonnes (Clarksons Research, n.d.). This suggests that

the drop in tonnage of dry bulk commodities transported in 2020 was offset by increased distance, probably due to lockdown measures. Importantly, the Ukrainian war (2022) appeared more impactful on dry bulk trade volumes than the COVID-19 pandemic (2020) (Yakubovskiy and Zaidman, 2024).

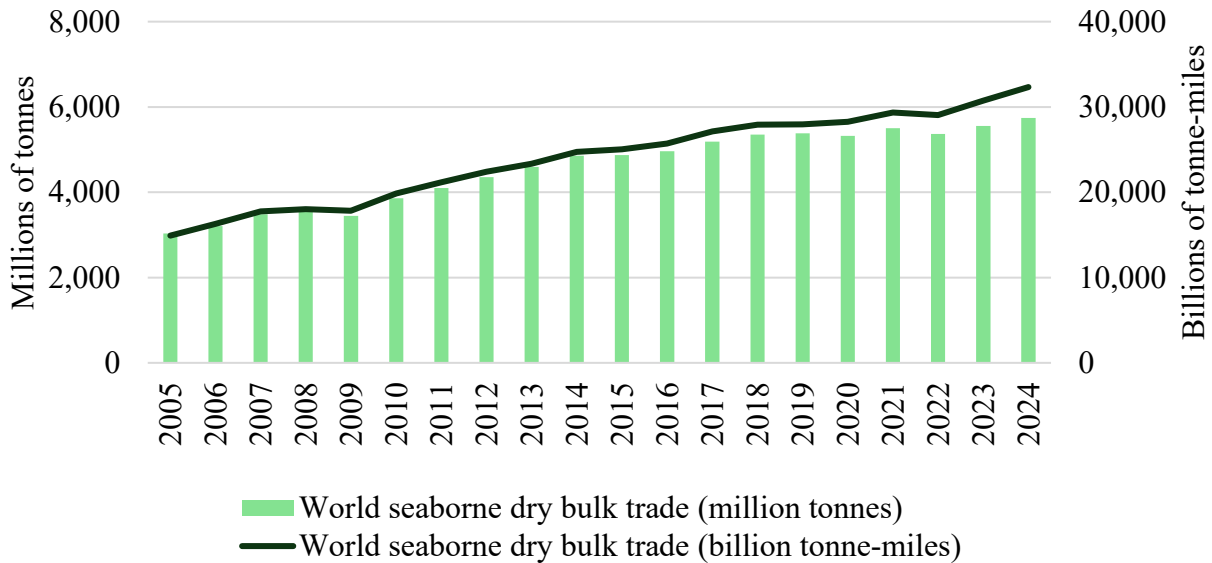


Fig. 2.4. Dynamics of world seaborne dry bulk trade

Source: Compiled by the author based on data from Clarksons Research (n.d.)

The decline in the dry bulk seaborne trade in 2022 was primarily attributed to the role of Ukraine in the agricultural sector, as Ukraine accounted for roughly 10% of global grain exports (UNCTAD, 2022; Zaidman, 2022). While the Black Sea Initiative enabled the partial resumption of grain seaborne exports from Ukraine, volume of grains moved by sea in 2022 remained substantially below pre-war levels. Major global grain importers were induced to turn to alternative sources, predominantly in the Americas, which increased the distances travelled by vessels (UNCTAD, 2024; UNCTAD, 2023; Zaidman and Yakubovskiy, 2024b).

Overall, the dry bulk trade immediately recovered after each decline. It reached an all-time high first in 2023 and surpassed it in 2024 – 5,743 in tonnes and 32,328 in tonne-miles (Clarksons Research, n.d.). Discussing the reasons for record volumes, UNCTAD (2024) mentions long-lasting disruption in the Red Sea, drought in the

Panama Canal, growing demand generated by China, and adverse weather conditions, which influenced major exporters.

Dry bulk commodities are typically classified into major and minor bulks. Three major dry bulks are iron ore, coal and grain. Bauxite and phosphates also used to be considered as major bulks (CRSL, 2015) but were later reclassified as minor bulks. Standard minor bulks include metals and ores; minerals such as cement, petcoke, salt and stone; sugar; agribulks such as soymeal, oilseed and rice; various fertilisers; and manufactured goods like steel and forest products (CRSL, 2023a; UNCTAD, 2022).

Iron ore and coal are the major industrial commodities; therefore, these trades have many common characteristics. Iron ore is a crucial component required for the production of steel, which is in turn a key material for construction, infrastructure, automotive industry, machinery, shipbuilding and railways (Stopford, 2009, p. 445). In 2024, approximately 1,600 million tonnes of iron ore were moved by sea. Iron ore trade is geographically asymmetric, as Asian region absorbs essentially the entire volume of iron ore seaborne trade: China accounts for 76% of global imports, Japan for 6% and South Korea for 4.5%. Exports primarily originate from Australia (57%) and Brazil (24%) (CRSL, 2023b; Clarksons Research, n.d.). Transportation of iron ore is normally handled by the largest dry bulk carriers – Capesize and Panamax classes (Alizadeh and Nomikos, 2009, p. 33).

Over 1,300 million tonnes of coal were transported by sea in 2024. Coal is also a vital bulk commodity, as it supports industrial growth globally. There are two types of coal: thermal (steam) coal is consumed by stations for power generation; coking coal is used for steel production together with iron ore (Stopford, 2009, p. 445). Coal trade is also characterised by geographical asymmetry, as Asian region again consumes a major part of global imports (82%). At the country level, China (31%), India (19%) and Japan (12%) are the leading importers, while Indonesia (41%) and Australia (27%) are the leading exporters (CRSL, 2023b; Clarksons Research, n.d.). Similarly to iron ore,

transportation of coal is mainly handled by the largest dry bulk carriers – Capesize and Panamax classes (Alizadeh and Nomikos, 2009, p. 33).

An important similarity of iron ore and coal trades lies in the type of contractual agreements used to fix and organise their transportation. Steel mills are the primary consumers of iron ore and coal. Traditionally, steel mills purchase large volumes of raw materials to ensure uninterrupted steel-making processes. These volumes exceed the limits of a single shipment, even if the largest dry bulk carrier is used, making the most typical chartering agreements, such as voyage contract (renting the vessel for one-off trip) or time-charter contract (renting the vessel for a certain period), unsuitable. In such scenario, a contract of affreightment is a preferred option, as under this agreement shipowners are obliged to arrange for multiple voyages and regularly deliver shipments. This kind of arrangement provides the opportunities for both: shipowners can optimise operations while charterers can be assured of frequent cargo deliveries in the long term (Alizadeh and Nomikos, p. 39; Stopford, 2009, pp. 183–184).

As regards seaborne grain trade, it is crucial for global security as it contributes and ensures global food security. Over 500 million tonnes of wheat, coarse and soybeans were transported by sea in 2024 (Clarksons Research, n.d.). Grain performs the two key functions: it is a staple food source and a key component for livestock farming (Stopford, 2009, pp. 445–446). In recent years, grain has been also increasingly used in biofuel production (Srivastava *et al.*, 2020). In seaborne grain trade, Asian countries similarly hold the leading positions, highlighting geographical asymmetry, although less pronounced. China consumes between 25% and 30% of global seaborne imports, followed by the EU, Egypt, Japan and Iran. Major exporting countries are Brazil (24%), the USA (23%) and Argentina (11.7%) (CRSL, 2023a). Grain can be transported by geared Handy-class dry bulk carriers and gearless Panamax vessels (Alizadeh and Nomikos, 2009, p. 33).

The volume of minor bulk trade exceeded 2,200 million tonnes in 2024 (Clarksons Research, n.d.). Minor bulk trade is diversified, as it includes over 20 types of commodities. Steel and forest products (manufactured goods) represent the largest share of minor bulk volumes. Being the major coal and iron ore importer, China exports the highest volume of steel products globally, primarily to the European markets which are the largest importers. China imports approximately a third of global forest products moved by sea, while the USA, Brazil and New Zealand are the major exporters. Vietnam and Turkey lead the cement exports consumed mainly by the USA and China. The primary destination of bauxite trade is China (over 80% of global imports), while the leading exporters are Guinea (more than 50%) and Australia (CRSL, 2023a).

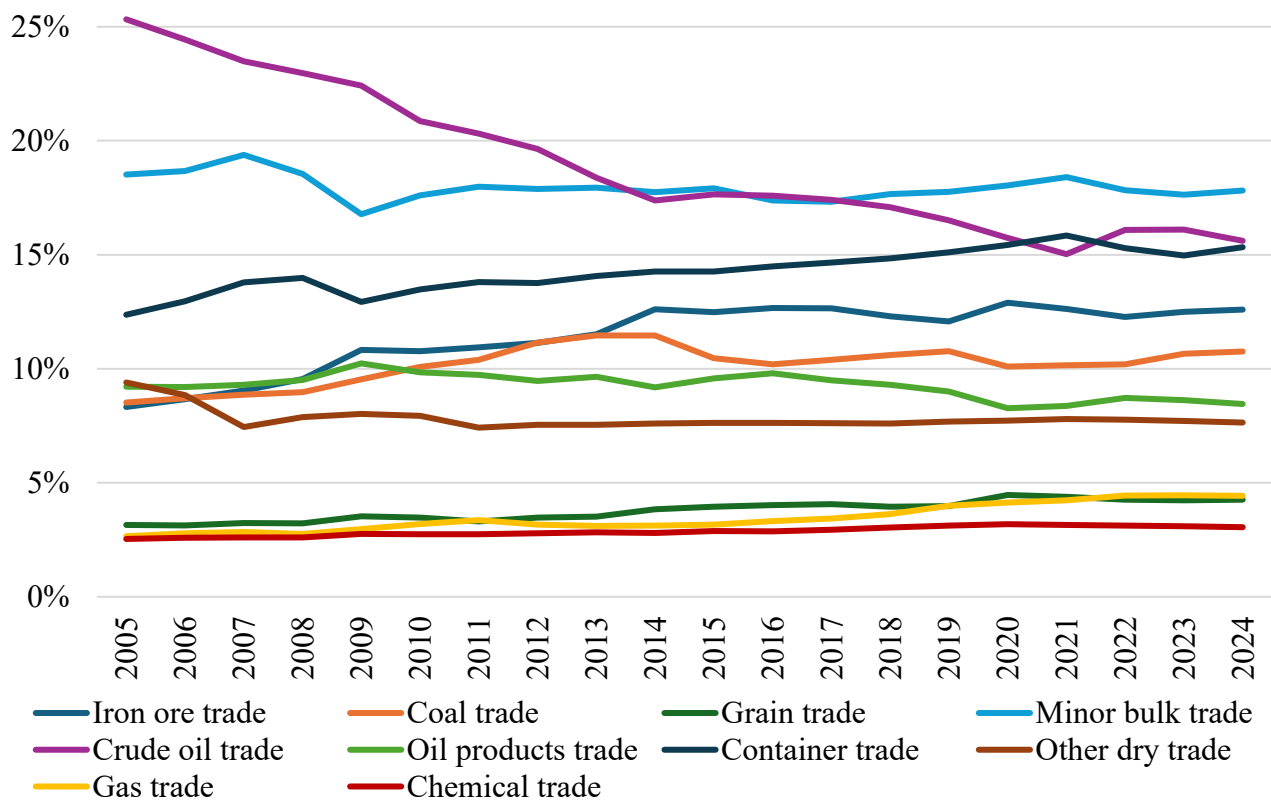


Fig. 2.5. Global seaborne trade volume by cargo type in %

Source: Calculated and compiled by the author based on data from Clarksons Research (n.d.)

As illustrated in Figure 2.5, the share of minor bulk trade in global seaborne trade marginally declined over the past 20 years. In contrast, the shares of grain, coal and

especially iron ore experienced noticeable growth. Figure 2.5 illustrates the product asymmetry in international seaborne trade.

Liquid bulk trade includes crude oil and oil products and accounts for nearly one-quarter of global seaborne trade in tonnes (Clarksons Research, n.d.). Wet bulk trade facilitates two important industrial processes: the transportation of crude oil as a raw material from places of extraction to oil refineries and the movement of processed oil products from plants to end consumers (Stopford, 2009, pp. 432–434). Trade patterns in this sector asymmetrically concentrate around the areas where oil is produced and refined (Mukherjee and Brownrigg, 2013, p. 20).

As shown in Figure 2.6, over the period of 2005–2024, oil seaborne trade demonstrated less stability compared to dry bulk trade (Clarksons Research, n.d.).

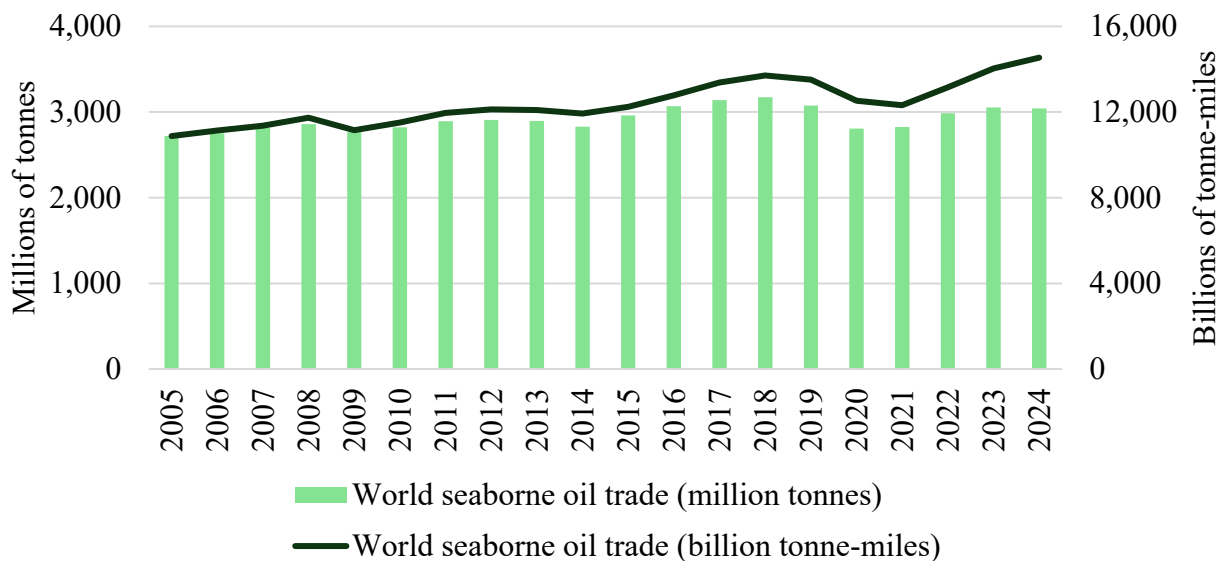


Fig. 2.6. Dynamics of world seaborne oil trade

Source: Compiled by the author based on data from Clarksons Research (n.d.)

The decline in 2009 can be explained by the global financial crisis, which impacted all types of trade. Later, oil trade both in tonnes and tonne-miles dropped in 2013 and 2014. Further declines were observed in 2019, 2020 and 2021 (the latter in tonne-miles only) after the oil market collapse and a twofold decrease in oil prices (Federal Reserve Bank of St. Louis, n.d.).

In the next years seaborne oil trade steadily recovered. In 2024, total seaborne oil trade reached an all-time high in tonne-miles (15,540 billion) due to simultaneous disruptions in both canals which caused vessels rerouting. However, oil trade measured in tonnes did not increase in 2024. Moreover, it decreased year-on-year and amounted to 3,043 tonnes, nearly 130 million tonnes below the all-time high recorded in 2018 (UNCTAD, 2024; Clarksons Research, n.d.).

The distinctive feature of the oil market lies in an opportunity to use oil and product tankers as oil storage units. It normally happens when oil prices are low, for instance, during the oil crisis in the 1990s (Stopford, 2009, p. 148) and later during the coronavirus pandemic (Michail and Melas, 2020b). This aspect helps to explain the declines in seaborne oil trade in 2019 and 2020. Yet, it does not entirely explain the decrease in oil trade tonne-mileage in 2021. This observation presupposes more complex considerations. According to basic mathematics, the reduction of tonne-mileage can be explained by the fact that oil and oil products stored on tankers earlier, when oil prices plummeted, were finally located rather close to the end consumers, and the vessels did not need to cover long distances to reach cargo buyers. From a geopolitical perspective, this may be attributed to the easing of the U.S. sanctions on Iran during nuclear negotiations (Bard, n.d.); therefore, Iranian oil could travel shorter distances to reach consumers in Europe and China (Yakubovskiy and Zaidman, 2024).

Regarding the recovery of seaborne oil trade post-COVID, IMF (2025b) and UNCTAD (2024; 2023) highlight that the spike in oil trade distances in 2023–2024 was primarily driven by disruptions caused by the war in Ukraine. Europe started to engage with alternative energy suppliers other than Russia. In contrast, Russian producers found new markets to export oil products, mainly in the East – China and India (Peachey, 2024). This redistribution of global oil trade effectively increased the tonne-mileage. Excluding oil products, crude oil alone experienced substantial increases in tonne-miles: 7.4% in 2022 and 6.6% in 2023 – the highest growth rates of seaborne

crude oil trade ever (Clarksons Research, n.d.), recorded regardless of crude oil oversupply observed in Europe and Asia in the middle of 2024 (Su, 2024).

According to the recent data, seaborne crude oil trade reached nearly 2,000 million tonnes in 2024. Europe, including the UK, China and India are historically the leading importers of crude oil transported by sea. The Middle East Gulf region is clearly a dominant exporter (almost 50%), followed by the Americas and West Africa (CRSL, 2023b). In order to transport crude oil, the following classes of tanker vessels are used: Panamax, Aframax, Suezmax, and Very Large Crude Carriers and Ultra Large Crude Carriers (VLCC-ULCC), whose capacity ranges from 50,000 to over 300,000 deadweight tonnes, as per Figure 2.7 (CRSL, 2015; Alizadeh and Nomikos, pp. 34–36; Stopford, 2009, pp. 596–599).

Vessel type	Ship size (dwt)	Approximate speed (knots)
Handysize	20,000–45,000	14–16
Panamax	50,000–70,000	14–16
Aframax	70,000–120,000	13–15
Suezmax	130,000–160,000	12–14
VLCC-ULCC	160,000–500,000	12–14

Fig. 2.7. Vessel classes in the wet bulk sector

Source: Alizadeh and Nomikos (2009, p. 30)

Oil products can be clean or dirty. Clean oil products include light distillates from crude oil processing: naphtha, gasoline, heating oil, jet fuel and kerosene (Alizadeh and Nomikos, 2009, p. 115). These are sometimes referred to as “easy” chemicals (CRSL, 2015). In order to transport clean products, vessels should be equipped with coated (clean) tanks (Alizadeh and Nomikos, 2009, p. 115). Dirty oil products are residual oils and lower distillates. To maintain fluidity due to their high viscosity, dirty products require steam-heating during transportation (Stopford, 2009, p. 442).

Seaborne oil products trade exceeded 1,000 million tonnes in 2024. Europe, the Persian Gulf, and the Americas are the leading global exporters, while Asia and again

the Americas are the leading importers. Southeast Asia alone absorbed around 20% of global seaborne oil products imports (CRSL, 2023b). Oil products trade is asymmetrically regionalised, with rather self-contained markets in Europe, the Far East and U.S. coasts. Depending on the distance and parcel size, the following tanker vessel classes can be employed for oil products transportation: Handysize, Panamax and occasionally Aframax (Alizadeh and Nomikos, 2009, p. 35).

As illustrated in Figure 2.5, the share of oil products in global seaborne trade volumes decreased minorly over the examined period while the share of crude oil declined significantly from 25.3% in 2005 to 15.6% in 2024 (Clarksons Research, n.d.).

In the bulk sector, there is no pre-defined sailing schedule, and cargo is transported in large parcels which are sufficient to fill the entire ship – vessels “ply for hire like taxis” (Mukherjee and Brownrigg, 2013, p. 21). In contrast, liner sector handles fixed-route transportation of relatively small units of cargo which cannot fill the entire ship (Stopford, 2009, p. 512). Due to its scheduled nature, liner shipping services are referred to as “the trains of international seaborne trade” (Mukherjee and Brownrigg, 2013, p. 21).

To transport liner cargo, geared and gearless cellular containerships, as well as multi-purpose, general cargo vessels and Ro-Ro ships are employed (CRSL, 2015; Stopford, 2009, pp. 537–538). Containerisation of trade, which started in the second half of the 20th century, reshaped international trade (not only seaborne), making the container segment the fastest-growing in shipping over decades. At present, container vessels carry a wide range of different commodities, including but not limited to industrial machines, cars, spare parts, electronics, clothing, textiles, consumer goods, steel, scrap, wood and food products. Goods transported by containerships are consumed by both industries and households (Stopford, 2009, pp. 517, 526).

In 2024, world seaborne container trade exceeded 1,900 million tonnes, which constituted 15% of the overall seaborne trade volume in tonnes. In tonne-miles,

container transportation amounted to 10,057. Both indicators for 2024 are all-time high. Notably, world seaborne container trade in tonne-miles experienced a remarkable year-on-year increase of 16.5% in 2024 – the highest growth rate observed in the 21st century, as seen in Figure 2.8 (Clarksons Research, n.d.). The disruptions in the Red Sea and the Suez Canal, where plying vessels were attacked, forced shipping companies to reroute vessels around the Cape of Good Hope (Kamali *et al.*, 2024; UNCTAD, 2024). This had a major impact on distances covered by container vessels, as approximately a quarter of the global seaborne container transportation transits through the Suez Canal annually. As to the Panama Canal, the restrictions were less impactful on liner segment than on the dry bulk trade, as containers can be transported through alternative landbridge routes (UNCTAD, 2024).

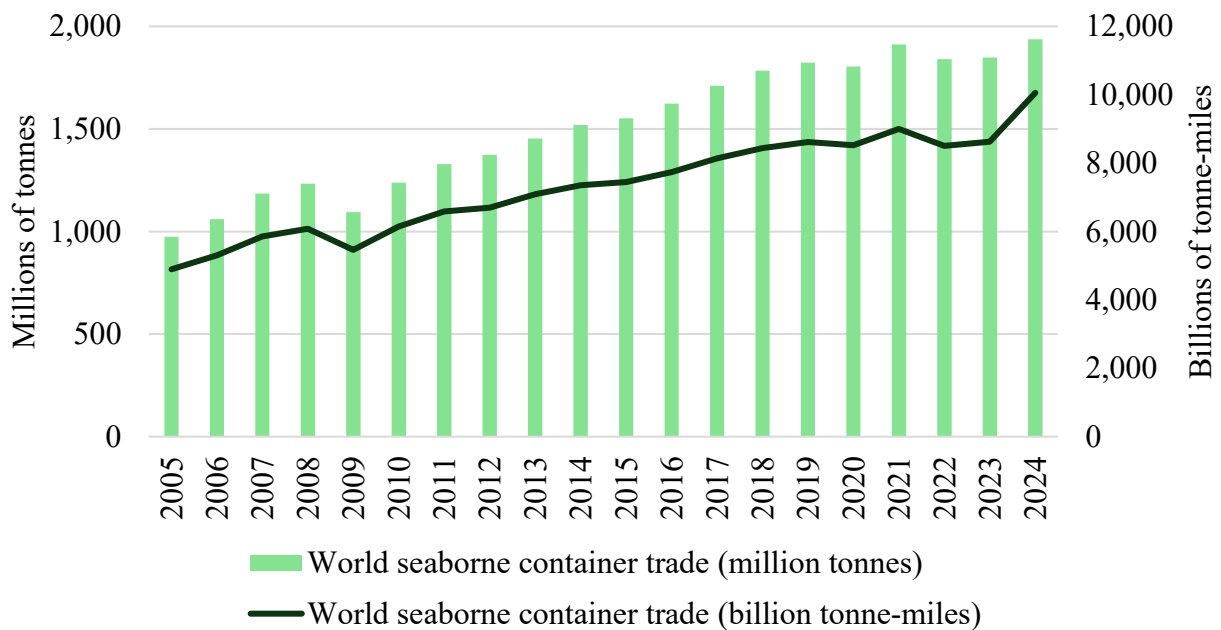


Fig. 2.8. Dynamics of world seaborne container trade

Source: Compiled by the author based on data from Clarksons Research (n.d.)

From 2005 to 2024, seaborne container trade followed the same trend as total seaborne trade and dry bulk seaborne trade. Containership trade declined in 2009, 2020 and 2022, due to earlier mentioned reasons which affected the entire global economy, container transportation not differing. After decline in 2020, container transportation

strongly recovered in 2021. This period is known for an unprecedented spike in containership charter rates (Zaidman *et al.*, 2021; Clarksons Research, n.d.) which can be partially attributed to the increased popularity of electronic commerce due to global lockdowns (UNCTAD, 2022).

Compared to the other types of seaborne trade which are mainly measured in tonnes and in tonne-miles, seaborne container trade is also measured in twenty-foot equivalent units (TEUs) (Alizadeh and Nomikos, 2009, p. 29). In the last six years, nearly 200 million TEU were handled annually by the world containership fleet, and almost 50% of this volume were transported in intraregional trade (CRSL, 2023b). This underscores the high level of regionalisation and asymmetry in container transportation. The intra-Asian trade accounts for the majority of intraregional container flows, as China and East Asian countries dominate in global manufacturing (UNCTAD, 2023), thereby lead global seaborne container exports. North America consumes the highest portion of container imports (CRSL, 2023b). According to UNCTAD (2024), containership trade growth rates are expected to surpass those of total seaborne trade in the next years.

Finally, the specialised cargo trade employs vessels especially designed for particular types of cargo, for example, chemicals, gases, and other dry cargo, including refrigerated goods and unitised cargo (motor vehicles and trucks) (CRSL, 2015; Stopford, 2009, pp. 469–470). The transport market for the latest is rather closely connected with containership transportation (Zaidman and Yakubovskiy, 2021c). Other dry cargo seaborne trade volumes exceeded 900 million tonnes in 2022 (CRSL, 2023b).

The chemical trade comprises vegetable and lubricant oils, organic and inorganic chemicals, asphalt, biodiesel, molasses and ethanol. In 2022, global seaborne chemical trade exceeded 350 million tonnes. The dominant importers were China (organics), India (vegetable oils) and the USA (inorganics), while the leading exporters were the

USA (organics and inorganics), Saudi Arabia (organics), Indonesia and Malaysia (vegetable oils) (CRSL, 2023b).

The gas trade is divided into LNG and LPG. LPG trade includes butane, propane, ethylene, ammonia, and other petrochemical gases (CRSL, 2015). Nearly 400 million tonnes of LNG and over 100 million tonnes of LPG were carried by sea in 2022. LNG flows were primarily directed to Japan and China, while LPG flows were directed to China, Europe, India and Japan. LNG exports originated mainly from Qatar, Australia and the USA, while LPG exports – from the USA and the Middle East (CRSL, 2023b).

While seaborne trade is measured in tonnes and tonne-miles, the global cargo fleet is also quantified in two ways in maritime economics: either in vessels numbers or in deadweight tonnes. As of the end of 2024, the world cargo fleet consisted of 68,497 vessels with the total cargo carrying capacity of 2,336 million deadweight tonnes (Clarksons Research, n.d.).

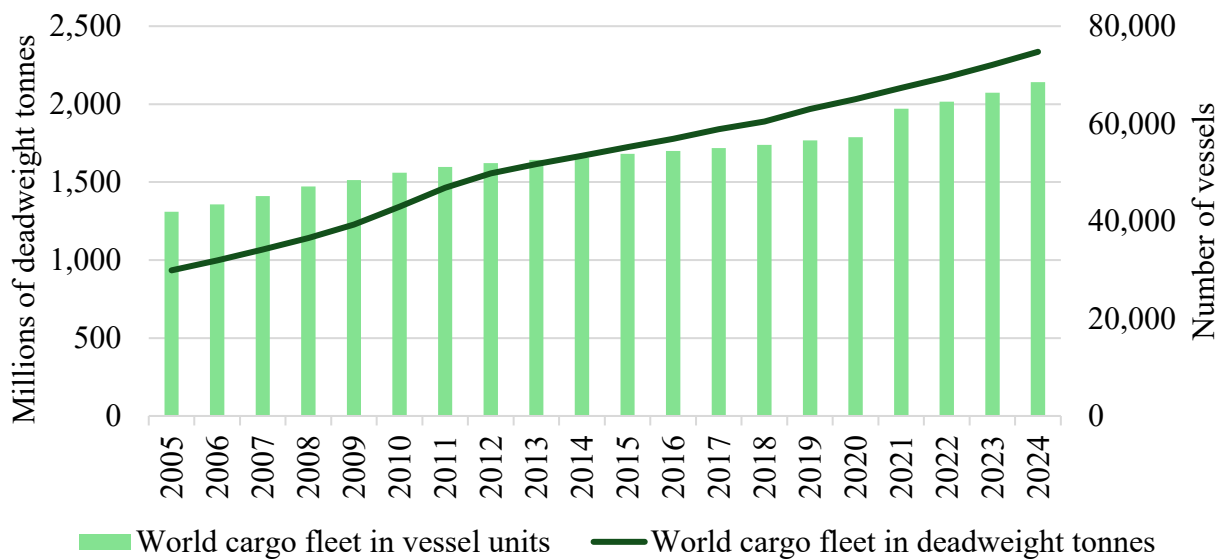


Fig. 2.9. Dynamics of world cargo fleet

Source: Compiled by the author based on data from Clarksons Research (n.d.)

According to Figure 2.9, the global fleet continuously expanded. In deadweight tonnes, the world cargo fleet more than doubled over the period of 2005–2024. It is worth noting that, over the past 20 years, the world merchant fleet in deadweight tonnes

experienced a higher growth rate compared to the world seaborne trade in tonnes. Given this observation, it is reasonable to perform calculations and estimate an average annual volume of seaborne trade per deadweight tonne of global fleet. As illustrated in Figure 2.10, this indicator followed a clear downward trend during the period under examination.

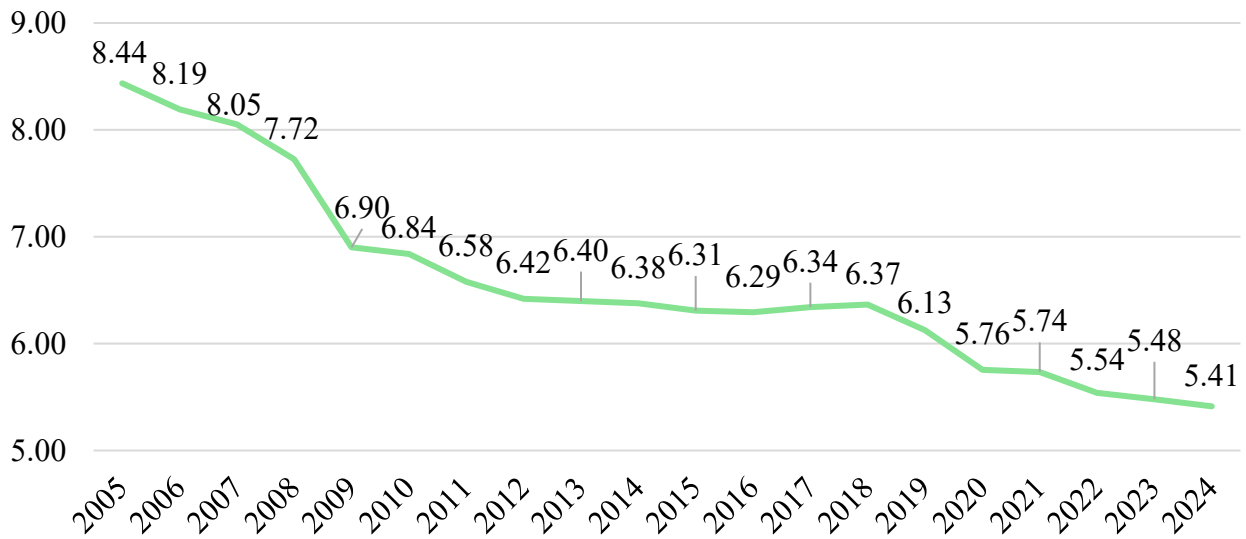


Fig. 2.10. Average global seaborne trade volume in tonnes per deadweight tonne of global fleet

Source: Calculated and compiled by the author based on data from Clarksons Research (n.d.)

On the one hand, it can be assumed that vessels' capacity utilisation decreased, as each year less cargo was transported by the same size of fleet. While this assumption is mathematically accurate, on the other hand, there are valid reasons which add more context to pure mathematics. With the decarbonisation regulations in shipping becoming more stringent (International Maritime Organization (IMO), 2023; IMO, 2018), it is recorded that vessels' average speed reduced by 20–30% between 2008 and 2024 (Creedon, 2025). At lower speeds, vessels can travel less distance.

In addition, it is observed that average haul in international seaborne cargo transportation gradually increased (Clarksons Research, n.d.). Average haul is understood as an average distance travelled by goods on board vessels and can be

calculated by dividing of seaborne trade measured in tonne-miles by seaborne trade measured in tonnes (Stopford, 2009, pp. 146–147). Figure 2.10 illustrates that, prior to the 2008 global crisis, a vessel transported more cargo on average. This highlights a shortage of fleet capacity the market experienced before the crisis.

During the 11-year period from 2009 to 2019, the average annual seaborne trade volume per deadweight tonne slowly declined. After 2019, it started to decrease more sharply. Shifts in trade patterns, which widened the distance between sellers and buyers, contributed to this trend. These changes were caused by the serious events in the world economy and global geopolitics, including but not limited to the COVID-19 pandemic (Brodeur *et al.*, 2021), the war in Ukraine, various trade wars (IMF, 2025b; Sutter, 2024; The Department of Foreign Affairs and Trade (DFAT) of the Australian Government, 2024), and the U.S. sanctions (The Office of Foreign Assets Control (OFAC) of the U.S. Department of the Treasury, n.d.).

Evidently, dry bulk, liquid bulk and container trade are the key components of global seaborne trade. While Figure 2.5 illustrates the asymmetric patterns of shares of particular type of cargo in trade volumes, it is worth assessing the role of each segment from different perspectives. On the one hand, the two measurements of seaborne trade volumes represent the demand for goods. On the other hand, the supply of vessels is represented by fleet size in deadweight tonnage and in vessel numbers.

The shares of each of the three major shipping segments in global seaborne trade and in global cargo fleet were calculated. The relevant figure illustrates the dynamics of each segment's share over the period from 2005 to 2024. The corresponding table summarises the changes over this 20-year period by presenting the values at the beginning and at the end of the period under examination.

Figure 2.11 and Table 2.1 demonstrate the gradual expansion of the dry bulk sector over the past 20 years – from 38.5% and 41.6% to 45.4% and 48.7% of total seaborne trade volumes if measured in tonnes and tonne-miles respectively. Similar

dynamics are observed in dry bulk fleet development if measured in deadweight tonnes. Regarding the pure number of dry bulk carriers, its share in global cargo fleet fluctuated between 14.7% and 21.6% throughout the period.

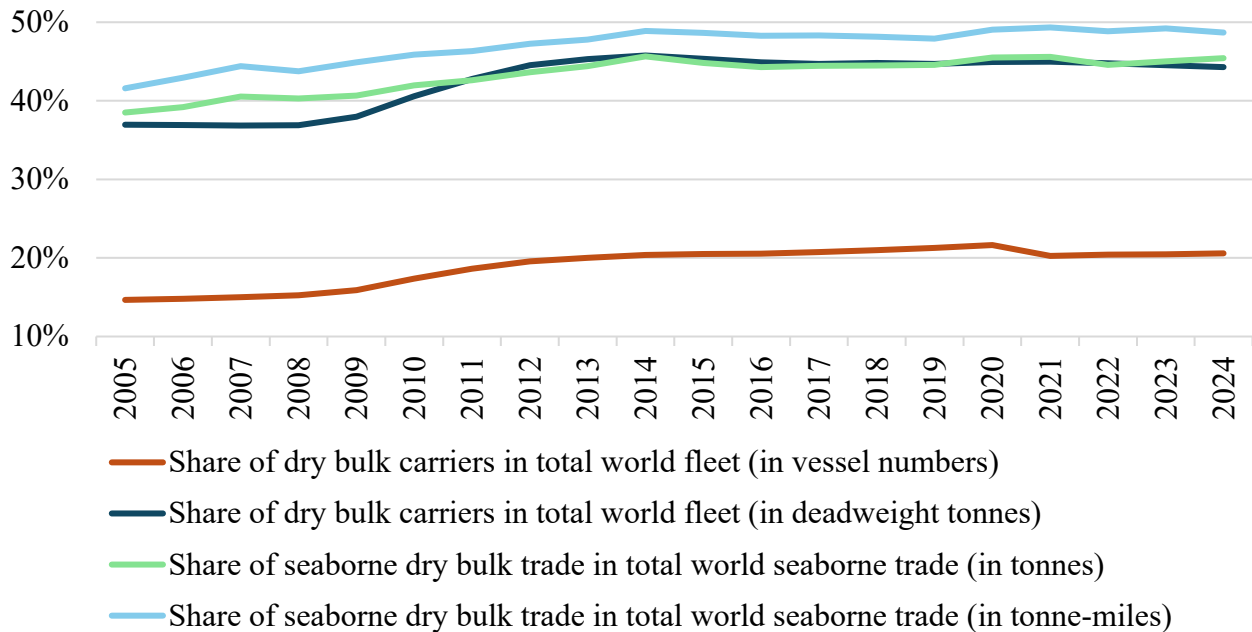


Fig. 2.11. Share of the dry bulk sector in global shipping in %

Source: Calculated and compiled by the author based on data from Clarksons Research (n.d.)

Table 2.1

Share of the dry bulk sector in shipping

Year	Seaborne trade		Fleet	
	In tonnes	In tonne-miles	In deadweight tonnes	In number of vessels
2005	38.5%	41.6%	37.0%	14.7%
2024	45.4%	48.7%	44.3%	20.6%

Source: Calculated by the author based on data from Clarksons Research (n.d.)

Unlike the dry bulk sector, the liquid bulk sector followed a downward trend over 2005–2024, as reflected in Figure 2.12 and Table 2.2. While at the start of the examined period wet bulk trade accounted for approximately a third of global seaborne trade, in 2024 its share decreased to 24.1% in tonnes and 21.9% in tonne-miles. In terms of fleet capacity, oil tankers' share declined from 34.7% to 27.9%. If measured in number of vessels, the percentage of oil tankers in global cargo fleet minorly increased.

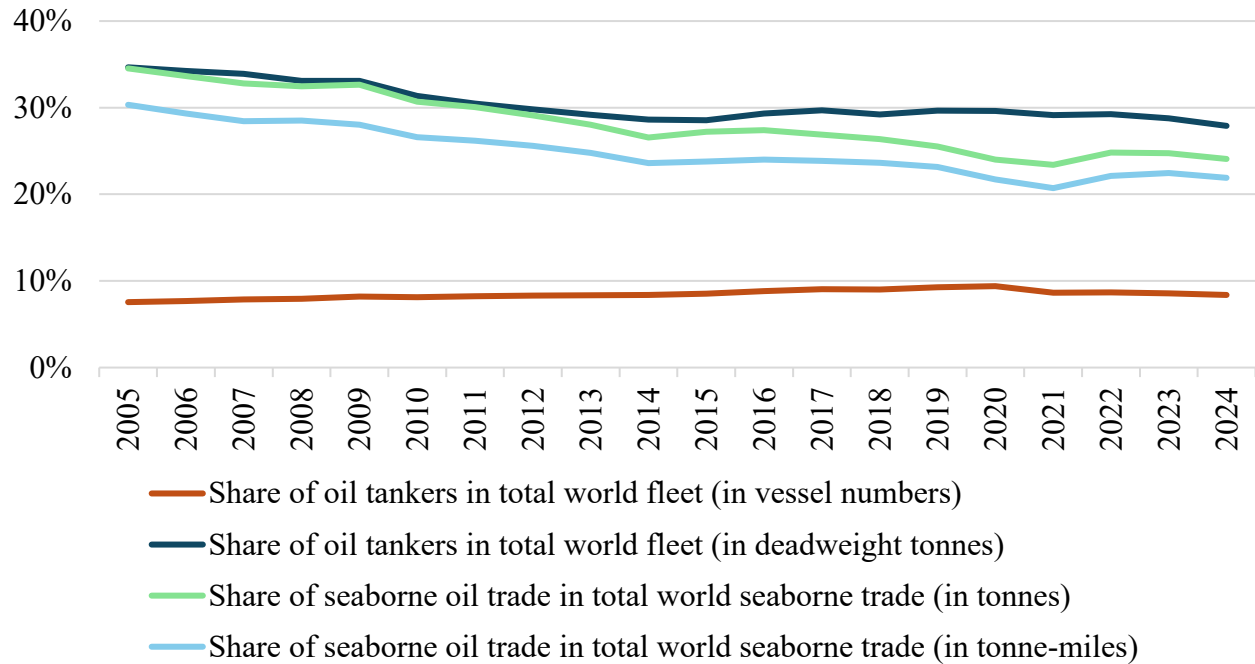


Fig. 2.12. Share of the liquid bulk sector in global shipping in %

Source: Calculated and compiled by the author based on data from Clarksons Research (n.d.)

It is essential to mention data limitation. The calculations presented in Figure 2.12 and Table 2.2 take into account all product and crude oil tankers whose deadweight exceeds 10,000 tonnes, namely, Handy-class, Panamax, Aframax, Suezmax and VLCC-ULCC classes. Concurrently, around 7,000 small oil tankers (less than 10,000 deadweight tonnes each) presently operate in the market and were not included in calculations. While small oil tankers could indeed positively impact the segment's share in fleet when measured in vessel numbers, their total deadweight capacity amounted to less than 3% of total oil tanker fleet, thereby making this group of vessels practically negligible for the purpose of this analysis.

Table 2.2

Share of the liquid bulk sector in shipping

Year	Seaborne trade		Fleet	
	In tonnes	In tonne-miles	In deadweight tonnes	In number of vessels
2005	34.5%	30.3%	34.7%	7.6%
2024	24.1%	21.9%	27.9%	8.4%

Source: Calculated by the author based on data from Clarksons Research (n.d.)

Turning to the container sector, Figure 2.13 and Table 2.3 illustrate that its share grew rapidly prior to the 2008 global crisis and afterwards remained stable with a marginal uplift. At the end of 2024, the containerised trade and containership fleet (in deadweight tonnes) accounted for approximately 15% of the industry. In vessel numbers, containership fleet developed in line with total merchant fleet and remained within the range of 8.7–10.2% of global during the entire period under consideration.

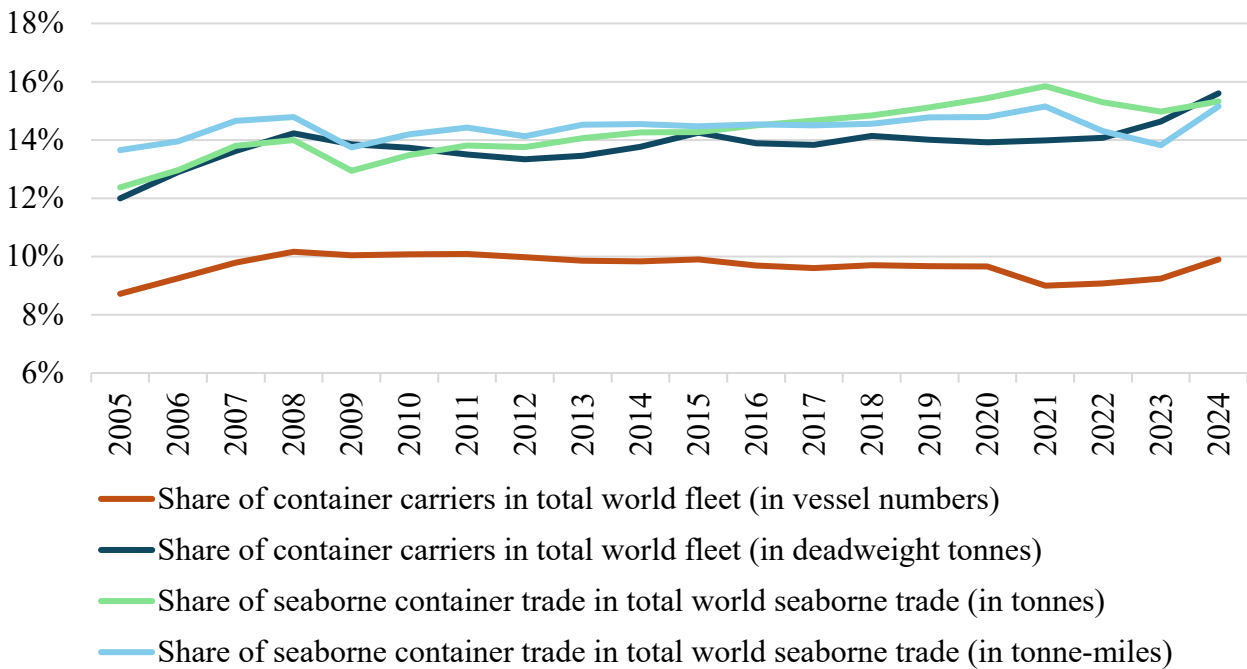


Fig. 2.13. Share of the container sector in global shipping in %

Source: Calculated and compiled by the author based on data from Clarksons Research (n.d.)

Table 2.3

Share of the container sector in shipping

Year	Seaborne trade		Fleet	
	In tonnes	In tonne-miles	In deadweight tonnes	In number of vessels
2005	12.4%	13.7%	12.0%	8.7%
2024	15.3%	15.2%	15.6%	9.9%

Source: Calculated by the author based on data from Clarksons Research (n.d.)

The findings of this analysis highlight the asymmetries in modern international seaborne trade and allow to outline the major trends in the global shipping industry over the past 20 years – a notable growth in the dry bulk segment, a more moderate

growth in the container segment, and a shrinking role of the oil tanker sector. In respect of the estimation of shares of each sector within the industry, the number of vessels was found to be unrepresentative; therefore, irrelevant to such analysis. This can be primarily explained by the abundance of small ships with low capacity, which can carry only an insignificant portion of total tonnage of goods transported by sea.

In parallel, the findings suggest that the other three indicators under investigation – namely, the fleet’s deadweight tonnage and seaborne trade volumes, both in tonnes and tonne-miles – can be reckoned as equally reliable tools to measure the share of each shipping sector (Yakubovskiy and Zaidman, 2024; Zaidman and Yakubovskiy, 2024a). According to Figures 2.11, 2.12 and 2.13, the graph lines representing each sector’s shares in these three parameters follow a similar pattern.

In respect of the dry bulk sector, all major bulks contributed to the stable growth of the segment over 2005–2024, including coal (see Figure 2.5). Despite tightening regulations in developed economies (The U.S. Environmental Protection Agency (USEPA), 2025; Assan, 2024), the growing demand for coal from developing countries offset the reduced demand from advanced countries (UNCTAD, 2024).

The evolving environmental regulatory pressure predefined the reduction of the oil tanker sector whose share contracted for 6–10%. Various global decarbonisation initiatives, ubiquitous green transition, focus on energy efficiency, and development of renewable energy sources in lieu of non-renewable fossil fuels, oil being the core representative of the latter (United Nations (UN), n.d.) – these factors influence all global industries which must comply with the requirements of the Paris Agreement (UN, 2015), as well as operate in alignment with the Sustainable Development Goals adopted by the UN (United Nations Development Programme (UNDP), n.d.). Shipping is a part of these global transformations, and facilitators of shipping’s decarbonisation comprise institutional structures and international instruments, with the IMO GHG Strategy (IMO, 2023) being the most prominent example.

Although demand for oil from developing countries persists (UNCTAD, 2024), the development of alternative energy does not overall support seaborne oil trade (DNV, 2022). While the share of oil trade gradually decreased, the absolute volumes of seaborne oil transportation are projected to grow till 2028 (UNCTAD, 2024).

The stable share of the containership segment is driven by its exclusiveness. The other vessel types cannot compete for the container traffic. The liner sector is still dependent on environmental regulations, as container vessels also consume fuel to operate. However, the long-term projections are positive regarding demand for containerised cargo and, subsequently, containership fleet.

2.2. Evaluation of the dynamics of freight rates and shipping companies' market capitalisation in the dry bulk sector based on econometric modelling

According to the literature review presented in Section 1.2, the existing research permanently takes attempts to improve forecasting accuracy of freight markets. Sometimes these tries produce opposite outcomes. This research attempts to analyse the world seaborne bulk trade through a unified methodological framework. Initially, the freight market is examined against the impactful factors. Thereafter, the attempt is taken to determine the variables which influence the development of market capitalisation indicators of the shipping companies operating in the sector.

To this end, stepwise OLS regressions are applied to the respective datasets. For computations, IBM SPSS Statistics software is used (IBM, n.d.). OLS technique defines the best-fitting regression equation as the one with the lowest sum of the error squares between real (factually observed) and theoretical (predicted) values of the dependent variable. In order to perform the regression analysis, two hypotheses have been made: the null hypothesis that implies insignificant relationship between the

dependent variable and each independent one, and the opposite hypothesis which suggests a significant relationship instead (Wooldridge, 2020, p. 120–127). Hypotheses are first examined against Student's t-distribution and p-value (Barrow, 2017, p. 285–287). Once null hypotheses are refuted, correlation between significant explanatory variables is assessed to ensure no bias in the resulting model (Barrow, 2017, p. 267; Michail and Massouras, 2014). For the purpose of calculating the correlation coefficients between variables, the Data Analysis functionality in Microsoft Excel is utilised (Microsoft, 2025).

The coefficient of determination (R-squared) helps to ascertain the predictive capability of the produced model. It is known as goodness of fit (Barrow, 2017, p. 281). In essence, R-squared demonstrates which portion of the variation in response variable can be explained by the independent (explanatory) variables (Wooldridge, 2020, p. 35). In addition, F-statistic measures the overall quality and significance of the resulting model (Greene, 2012, pp. 157–161). The target level of confidence in respect of outcomes is 95% (Barrow, 2017, p. 454–455). To test the presence of autocorrelation in the residuals, Durbin–Watson statistic is employed (Greene, 2012, p. 963). Barrow (2017) provides reference tables which include critical values for t-statistic (p. 451), F-statistic (p. 454–455) and Durbin-Watson statistic (p. 463).

Section 2.2 is focused on the dry bulk market. As Stopford (2009, p. 701) notes, the key part of the forecasting exercise is collecting and processing the right data about the present. Therefore, the dataset is obtained from various data sources, for instance, Macrotrends LLC (2025), Trading Economics (2025), Triami Media BV (2025), CompaniesMarketcap.com (2024), and the Federal Reserve Bank of St. Louis (n.d.). The dataset includes the following indicators (spelled out first, followed by their parenthesised abbreviations in italics and the respective sources):

- the Baltic Dry Index (*BDI*) (Trading Economics, 2025);
- London Interbank Offered Rate 1-year in % (*LIBOR*) (Triami Media BV, 2025);

- the S&P 500 index (*SP500*) (Macrotrends LLC, 2025);
- crude oil Brent price in USD per barrel (*P_OIL*) (Federal Reserve Bank of St. Louis, n.d.);
- iron ore price in USD per metric tonne (*P_IRON_ORE*) (Federal Reserve Bank of St. Louis, n.d.);
- coal price in USD per metric tonne (*P_COAL*) (Federal Reserve Bank of St. Louis, n.d.);
- wheat price in USD per metric tonne (*P_WHEAT*) (Federal Reserve Bank of St. Louis, n.d.);
- corn price in USD per metric tonne (*P_CORN*) (Federal Reserve Bank of St. Louis, n.d.);
- rice price in USD per metric tonne (*P_RICE*) (Federal Reserve Bank of St. Louis, n.d.);
- aluminium price in USD per metric tonne (*P_ALUM*) (Federal Reserve Bank of St. Louis, n.d.);
- the market capitalisation of Star Bulk Carriers (SBLK) in billion USD (*STAR_BULK_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Golden Ocean Group (GOGL) in billion USD (*GOLDEN_OCEAN_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Genco Shipping & Trading (GNK) in billion USD (*GENCO_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Eagle Bulk Shipping (EGLE) in billion USD (*EAGLE_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Seenergy Maritime (SHIP) in billion USD (*SEENERGY_MCAP*) (CompaniesMarketcap.com, 2024).

As the period of the analysis is 2005–2023, the dataset includes 19 annual observations (see Appendix C, Tables C.1, C.2, C.3). As long as data are collected from different sources, it is worth making the following notes prior to discussing the obtained outcomes. The annual data for the S&P 500 present the average closing price of the index. LIBOR and prices of oil and dry bulk commodities are represented by average values for any particular year. The BDI and MCAP values were collected as of the end of each year. The companies initiated public listing in different years; therefore, some historical MCAP data are unavailable.

Another meaningful note relates to LIBOR, which had been recognised as a benchmark for interest rates for a long period by all industries, including shipping. Banks used to establish conditions for fleet credits based on LIBOR (Zhykharieva *et al.*, 2023, p. 184). However, as a result of the competition between the leading global financial centres, LIBOR was replaced by the Secured Overnight Financing Rate (SOFR) during the completion of this PhD research (Triami Media BV, 2025; Alternative Reference Rates Committee, 2023). It is worth noting that this development imposes certain limitations on using LIBOR as an interest rates benchmark in future research, while it does not qualitatively affect the findings of this research.

To model the dry bulk freight rates and test the first hypothesis, a regression is run for the following model (Equation 2.1):

$$BDI = \beta_0 + \beta_1 * LIBOR + \beta_2 * P_{OIL} + \beta_3 * P_{IRON_ORE} + \beta_4 * P_{COAL} + \beta_5 * P_{WHEAT} + \beta_6 * P_{CORN} + \beta_7 * P_{RICE} + \beta_8 * P_{ALUM} \quad (2.1)$$

The outcome suggests that prices of oil and six dry bulk cargoes did not impact the BDI; therefore, the null hypothesis cannot be refuted. However, LIBOR demonstrated the significant impact on the BDI. Therefore, the resulting equation takes the following form (Equation 2.2):

$$BDI = 594.602 + 602.029 * LIBOR \quad (2.2)$$

As far as all variables, except one, were made redundant, it is worth thoroughly exploring nature and strength of the relationship between the dependent variable and the single independent one. To this end, the regression model is reconstructed to determine which equation can explain this relationship the best. The following equations are considered: linear, quadratic and cubic. Tables 2.4 and 2.5 provide the summary of statistical parameters of the respective models.

Table 2.4

R-squared and F-statistic indicators for linear, quadratic and cubic regression equations of the BDI on LIBOR

Equation	R-squared	F-statistic value	F-critical value	F-test p-value
Linear	0.349	9.116	4.451	0.008
Quadratic	0.473	7.187	3.634	0.006
Cubic	0.477	4.563	3.287	0.018

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow, 2017 (p. 454–455)

Table 2.5

Parameters of linear, quadratic and cubic regression equations of the BDI on LIBOR

Equation	Constant	β_1	β_2	β_3
Linear	594.602	602.029		
Quadratic	1,923.315	-939.842	269.956	
Cubic	2,362.848	-1,768.671	628.400	-41.350

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics

Cubic regression equation demonstrated the highest robustness, as its R-squared value is 0.477. Therefore, the regression equation of the BDI on LIBOR takes the following shape:

$$BDI = 2362.848 - 1768.671 * LIBOR + 628.4 * LIBOR^2 - 41.35 * LIBOR^3 \quad (2.3)$$

As per Equation (2.3), 47.7% of the variation in the BDI within 2005–2023 may be explained by changes in LIBOR with 98.2% probability. The model is adequate as the F-statistic value (4.563) surpasses the critical value (3.287 at 5% significance). The

actual significance level of F is 0.018 (less than 0.050). Figure 2.14 illustrates the graphs of respective linear, quadratic and cubic functions.

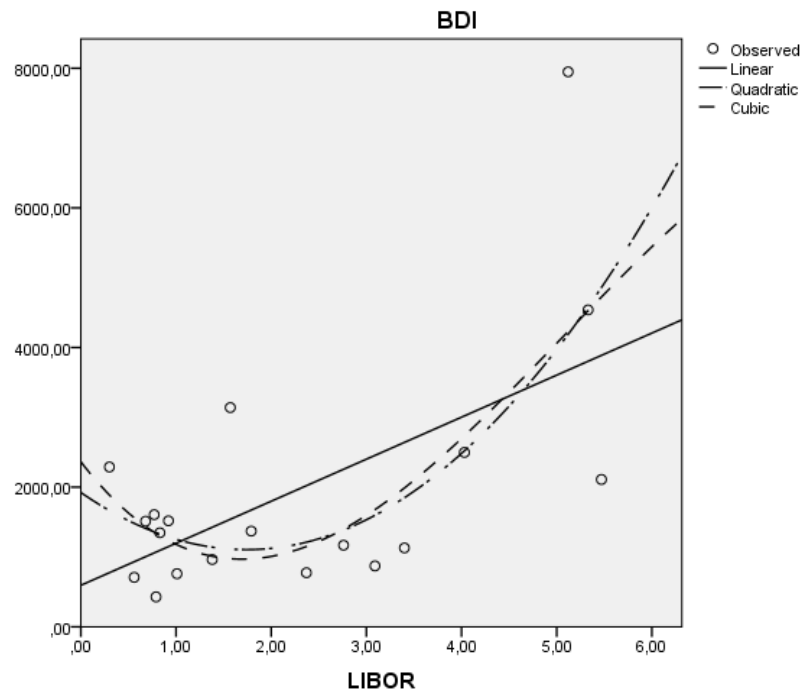


Fig. 2.14. Graphs of linear, quadratic and cubic regression equations of the BDI on LIBOR

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics

In essence, the BDI is a universal indicator of the cost of dry bulk maritime transport. The analysis reveals that the prices of major and minor dry bulk commodities included in modelling did not impact the freight rates during the period under examination. Neither did the price of oil, regardless of some observations presented in existing, earlier referenced studies. On the contrary, the price of money, which is represented by LIBOR, exhibits statistical significance for the freight rates. This highlights an important role of global monetary policy for dry bulk shipping.

According to the theory, the interest rates are expected to negatively impact freight rates (Michail, Melas and Louca, 2023). As seen in cubic graph in Figure 2.14, during the period of relatively low interest rates, an inverse relationship between

LIBOR and the BDI was indeed observed. This inverse relationship held until the cubic function reached the extremum at the point where the BDI value amounted to 968.984. When the graph surpassed this value, a further increase in LIBOR led to a growth in the BDI. Time lag can explain this effect, as the increase in operational, financial, and other types of costs resulting from higher interest rates normally takes time to transpire. According to the analysis, this period lasts 4–6 months.

From a practical perspective, this observation demonstrates how regulatory authorities impact dry bulk shipping. The interest rates are one of the monetary policy tools adopted by regulators either to restrict the economy or to stimulate its expansion depending on the circumstances (McConnel, Brue and Flynn, 2009, pp. 670–672). The fluctuations in interest rates were especially noticeable in 2020–2024. During this period, interest rates were first decreased to support the recovery of the global economy after COVID-19 slowdown and thereafter were significantly increased to tackle the inflation which hit the global markets after the outbreak of the Ukrainian war (Macrotrends LLC, 2025). The interest rates are not always taken into account by shipping research; however, the observation presented above indicates that they deserve greater consideration by researchers (Zaidman, Yakubovskiy and Romanenko, 2025).

Regarding MCAP of shipping companies, the five public listed specialised dry bulk carrier owners have been selected for the analysis: Star Bulk Carriers (Star Bulk Management Inc., 2024), Golden Ocean Group (Golden Ocean Group, 2022), Genco Shipping & Trading (Genco Shipping & Trading Limited, 2024a), Eagle Bulk Shipping (GlobeNewswire, 2024), Seanergy (Seanergy Maritime Holdings Corp., 2024). During the course of this PhD research, the following developments occurred: Star Bulk Carriers Corp. merged with Eagle Bulk Shipping Inc. (GlobeNewswire, 2024), and CMB.TECH merged with Golden Ocean Group Limited (belganewsagency.eu, 2025), which resulted in respective delisting of Eagle Bulk and Golden Ocean from stock

exchanges. However, these corporate transformations have not had any impact on the period examined and thus on the findings obtained.

To ascertain the determinants of MCAP of each company, a stepwise OLS regression is run for each company separately. The general model presented in Equation (2.4) is used accordingly. As independent variables, the model considers the S&P 500 index, the BDI, LIBOR, and prices of oil and various dry bulk commodities which are assumed to impact MCAP.

$$\begin{aligned} MCAP = & \beta_0 + \beta_1 * SP500 + \beta_2 * BDI + \beta_3 * LIBOR + \beta_4 * P_OIL + \beta_5 * \\ & P_IRON_ORE + \beta_6 * P_COAL + \beta_7 * P_WHEAT + \beta_8 * P_CORN + \beta_9 * \\ & P_RICE + \beta_{10} * P_ALUM \end{aligned} \quad (2.4)$$

Tables 2.6 and 2.7 summarise the statistical parameters of the five resulting models. The explanatory variables which did not exhibit relationship with MCAP are excluded, while statistically significant variables with the respective stock MCAP indicators are presented in the second column of Table 2.7.

Table 2.6

Diagnostics of the market capitalisation regression models (dry bulk sector)

Dependent variable	R-squared	Durbin-Watson statistic	F-statistic value	F-critical value	F-test p-value
STAR_BULK_MCAP	0.928	2.480	96.210	3.634	0.000
GOLDEN_OCEAN_MCAP	0.886	1.384	62.294	3.634	0.000
GENCO_MCAP	0.841	2.616	18.545	3.634	0.002
EAGLE_BULK_MCAP	0.720	2.414	20.609	3.634	0.000
SEANERGY_MCAP	0.467	1.193	12.265	4.451	0.004

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow, 2017 (p. 454–455)

The most robust model is produced for Star Bulk Carriers shipping company. The R-squared value (0.928) suggests that more than 92% of Star Bulk Carriers MCAP variation can be explained by changes in the S&P 500 index and price of aluminium. In addition to high predictive power, the high F-statistic value (96.210) supports the

inferred adequacy of the model. The t-statistic values for explanatory variables (13.147 and 2.771) surpass the threshold (2.120). In respect of potential autocorrelation, the Durbin-Watson value (2.480) is formally within the indeterminate range; however, it falls outside no autocorrelation zone (1.536–2.464) with insignificant margin. Therefore, low probability of autocorrelation can be assumed.

Table 2.7

Market capitalisation regression models: statistical significance of the independent variables (dry bulk sector)

Dependent variable	Significant independent variables	Standard coefficient	t-statistic value	t-critical value	t-test p-value
STAR_BULK_MCAP	SP500	0.920	13.147	2.120	0.000
	P_ALUM	0.194	2.771		0.014
	_cons	-1.356 ^a	-4.780		0.000
GOLDEN_OCEAN_MCAP	SP500	0.890	10.442	2.120	0.000
	P_ALUM	0.201	2.356		0.032
	_cons	-0.983 ^a	-3.373		0.004
GENCO_MCAP	P_OIL	0.655	3.849	2.120	0.006
	P_IRON_ORE	0.405	2.379		0.049
	_cons	-0.424 ^a	-2.859		0.024
EAGLE_BULK_MCAP	BDI	0.844	6.252	2.120	0.000
	SP500	0.361	2.678		0.017
	_cons	-0.077 ^a	-0.763		0.457
SEANERGY_MCAP	BDI	0.683	3.502	2.110	0.004
	_cons	-0.001 ^a	-0.059		0.954

Note: ^aUnstandardised coefficients are used for constants.

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow (2017, p. 451)

The coefficient of determination of the Golden Ocean Group model (0.886) indicates that more than 88% of fluctuations in the stock MCAP of this company can be attributed to the changes in the same variables – the S&P 500 and price of aluminium. The t-statistic values for both explanatory variables (10.442 and 2.356) are higher than the threshold value of 2.120. The F-statistic (62.294) comfortably exceeds

the critical value, with p-value being effectively zero. The Durbin-Watson statistic (1.384) falls within the inconclusive range.

In the resulting model for Genco Shipping & Trading shipping company, the statistically significant variables differ from those determined as impactful for Star Bulk Carriers and Golden Ocean Group. Prices of oil (t-statistic is 3.849) and iron ore (t-statistic is 2.379) turned to influence Genco's market capitalisation development. The model in itself is fit and reliable, as the R-squared value is 0.841, the F-statistic value is 18.545 (with the threshold at 5% significance being 3.634), and the F-test p-value is effectively zero. The Durbin-Watson statistic (2.616) falls within the neutral range, with no clear evidence of the autocorrelation.

As regards Eagle Bulk Shipping, the stock market capitalisation of this company demonstrates positive dependence on the BDI and the S&P 500 index. Overall, the model's characteristics are reasonable: the R-squared value amounts to 0.720; the F-statistic value (20.609) considerably exceeds the minimum of 3.634; the p-value for F-test is zero; the Durbin-Watson statistic (2.414) indicates absence of possible autocorrelation. Regarding the BDI and the S&P 500 index, both t-statistic (6.252 and 2.678) exceed the threshold value (2.120) and the p-values fall within the allowable boundary.

The resulting model of Seenergy Maritime MCAP demonstrates the lowest goodness of fit from among all models. The R-squared value (0.467) indicates that less than 50% of Seenergy Maritime MCAP variation can be explained by changes in the significant variable. Moreover, the BDI is the only one independent variable which exhibited statistical significance. Its t-statistic value (3.502) and p-value (0.004) meet the requirements, while the model's F-statistic (12.265) comfortably exceeds the critical value (2.110). The Durbin-Watson statistic (1.193) falls within indeterminate range, although close to the no autocorrelation range (Zaidman, Yakubovskiy and Romanenko, 2025).

The modelling outcomes appear rather identical for Golden Ocean Group and Star Bulk Carriers, as both companies share some common characteristics. For the last 7 years of the period under examination (2017–2023), these two companies had the highest MCAP from among considered dry bulk companies – both reached USD 2 billion in 2023 (CompaniesMarketcap.com, 2024). The stock market values of both major players of the dry bulk market are influenced by the S&P 500 index and price of aluminium. These two indicators explain more than 92% of variation in Star Bulk Carriers MCAP and more than 88% of variation in Golden Ocean MCAP.

While the relationship between market capitalisation of high-calibre shipping companies listed in the USA and the S&P 500 index is expected and consistent with existing theory, the dependence of market capitalisation on price of aluminium is not intuitive and apparent enough. Both bauxite, which is used for aluminium production, and aluminium do not account for the highest volumes within the seaborne dry bulk trade (CRSL, 2023b). The assumption can be made that both companies were actively engaged into bauxite and aluminium transportation over the period under examination.

The model constructed for Genco Shipping & Trading also demonstrates a rather high level of credibility. It explains more than 84% of the variation in Genco's market capitalisation by changes in prices of oil and iron ore. As discussed in Section 2.1, iron ore is a key dry bulk cargo in terms of seaborne trade volumes (Clarksons Research, n.d.), which is normally transported by large bulkers (Alizadeh and Nomikos, 2009, p. 33). Furthermore, it is widely acknowledged in the pertinent literature that the steel industry is the key driver of the dry bulk market (Alizadeh and Nomikos, 2009, p. 117). Genco Shipping & Trading historically operates a diversified fleet of dry bulk vessels, with Capesize tonnage accounting for a considerable portion of the company's portfolio (Genco Shipping & Trading Limited, 2024b). Given the above, the positive impact of iron ore price on Genco's MCAP appears reasonable.

Regarding the oil prices, Genco is the only company which has shown dependence on this variable. The existing studies support this observation (Melas and Michail, 2024; Drobetz, Schilling and Tegtmeier, 2010). Still, it is quite individualised as does not prove relevant to the other four considered dry bulk shipowners. Apart from general macroeconomic explanation, this relationship can be potentially attributed to Genco's internal chartering policy. The assumption can be made that the vessels under Genco's ownership were primarily employed under time-charter agreements over the examined period. Such contracts define that bunker costs fall under charterer's, not owner's responsibility (Institute of Chartered Shipbrokers (ICB), 2014, p. 96).

Similarly to Star Bulk and Golden Ocean, Eagle Bulk is found to depend on the S&P 500 index. Although the index is not dominated by shipping companies but by other industries, such as technology, financial services, and health care (S&P Global, 2024), it is reasonable to expect a U.S.-based shipping company to follow general trends. The BDI appears to be an even more powerful explanatory variable of Eagle Bulk's market capitalisation. The Eagle's model provides clear and intuitive findings, consistent with previous findings of the literature. The BDI and the S&P 500 index jointly explain 72% of variation in Eagle Bulk stock market value.

For Seenergy Maritime, the modelling exercise has not produced noteworthy insights. Less than 50% of variation in Seenergy's MCAP can be explained by the BDI. Being both simple and consistent, this observation does not offer a reliable tool for investors to forecast the price of Seenergy stocks. Seenergy Maritime is a relatively young shipowner with a growing fleet (Seenergy Maritime Holdings Corp., 2024), which is the underlying limitation for the modelling in the given case.

Taken together, the regression analysis findings suggest that the market capitalisation of dry bulk shipping companies have not demonstrated reliance on price of coal and grains. Similarly, no correlation with LIBOR is identified, in line with earlier observations (Michail, Melas and Liuca, 2023), presumably due to different

hedging strategies shipping companies adopt for risk mitigation purposes (El-Masry, Olugbode and Pointon, 2010). However, based on LIBOR's close relationship with the BDI which is revealed in the first regression, the interest rates should not be neglected for analysis, and the potential indirect effects of monetary policy should be factored in.

Conversely, the price of aluminium has been found impactful for the MCAP of the most established dry bulk companies under consideration. The price of iron ore and the price of oil are statistically significant for one shipowner. Two shipping companies demonstrate dependence on the BDI; three – on the S&P 500 index.

To summarise, the market capitalisation indicators of dry bulk shipping companies do not exhibit a unified behavioural pattern. This conclusion may be attributed to the specifics of dry bulk segment, wherein tramp trade dominates and so do voyage charterparties. Such a market structure implies less overall stability, higher fluctuations, as well as higher independence and individual growth trajectories of firms. Therefore, investors which consider adding dry bulk shipping stocks into their portfolios are advised to apply an individual approach towards each company in terms of the factors driving its development (Zaidman, Yakubovskiy and Romanenko, 2025).

2.3. Evaluation of the dynamics of freight rates and shipping companies' market capitalisation in the oil tanker sector based on econometric modelling

Following the same methodological framework, the oil tanker market is analysed empirically. The BCTI and BDTI act as benchmarks for oil tanker freight rates.

The structural market data used for modelling include annual observations for the period of 1998–2023 (see Appendix C, Tables C.4, C.5). The dataset is obtained from different data sources, such as Macrotrends LLC (2025), Triami Media BV (2025), CompaniesMarketcap.com (2024), Clarksons Research (n.d.), and

the Federal Reserve Bank of St. Louis (n.d.). The dataset presents the following indicators (spelled out first, followed by their parenthesised abbreviations in italics and the respective sources):

- the Baltic Clean Tanker Index (*BCTI*) (Clarksons Research, n.d.);
- the Baltic Dirty Tanker Index (*BDTI*) (Clarksons Research, n.d.);
- average earnings for all tankers in USD per day (*EARNINGS*) (Clarksons Research, n.d.);
- crude oil Brent price in USD per barrel (*P_OIL*) (Federal Reserve Bank of St. Louis, n.d.);
- LIBOR 1-year in % (*LIBOR*) (Triami Media BV, 2025);
- the S&P 500 index (*SP500*) (Macrotrends LLC, 2025);
- global inflation (consumer prices), percentage change year-on-year (*INFLATION*) (Clarksons Research, n.d.);
- global oil production in million barrels per day (*GLO_OIL_PROD*) (Clarksons Research, n.d.);
- world seaborne total oil trade in million tonnes (*SEAB_OIL_TRADE*) (Clarksons Research, n.d.);
- the market capitalisation of International Seaways (INSW) in billion USD (*INSW_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Euronav (EURN) in billion USD (*EURONAV_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of TORM (TRMD) in billion USD (*TORM_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Frontline (FRO) in billion USD (*FRONTLINE_MCAP*) (CompaniesMarketcap.com, 2024);

- the market capitalisation of Teekay (TK) in billion USD (*TEEKAY_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Scorpio Tankers (STNG) in billion USD (*SCORPIO_MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Nordic American Tankers (NAT) in billion USD (*NAT_MCAP*) (CompaniesMarketcap.com, 2024).

The annual data for the S&P 500 present the average closing price of the index. LIBOR, price of oil, freight indices, average tanker earnings, inflation, global oil production, and seaborne oil trade are represented by average values for any particular year. MCAP were collected at year-end. The companies initiated public listing in different years; therefore, some historical MCAP data are unavailable. A note made in Section 2.2 regarding LIBOR remains valid for the oil tanker market analysis, and the change in global financial benchmarks does not impact the period under examination.

To model the oil tanker freight rates and test the first hypotheses, a regression is run for the following models, as per Equations 2.5 and 2.6:

$$BDTI = \beta_0 + \beta_1 * P_OIL + \beta_2 * LIBOR + \beta_3 * INFLATION + \beta_4 * SP500 + \beta_5 * GLO_OIL_PROD + \beta_6 * SEAB_OIL_TRADE \quad (2.5)$$

$$BCTI = \beta_0 + \beta_1 * P_OIL + \beta_2 * LIBOR + \beta_3 * INFLATION + \beta_4 * SP500 + \beta_5 * GLO_OIL_PROD + \beta_6 * SEAB_OIL_TRADE \quad (2.6)$$

According to the regression analysis, each of the freight indices is statistically dependent on two variables. While both indices depend on the inflation, the second influencing variable differs. For the BDTI, the crude oil Brent price proved significant, while the BCTI demonstrated sensitivity to the volumes of global oil production.

Tables 2.8 and 2.9 summarise statistical parameters of the two models. The statistically significant explanatory variables are presented in the second column of Table 2.9.

Table 2.8

Diagnostics of the regression models for oil tanker freight indices

Dependent variable	R-squared	Durbin-Watson statistic	F-statistic value	F-critical value	F-test p-value
BDTI	0.389	1.205	7.314	3.420	0.003
BCTI	0.466	0.951	10.035	3.420	0.001

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow, 2017 (p. 454–455)

Table 2.9

Oil tanker freight indices' regression models: statistical significance of the independent variables

Dependent variable	Significant independent variables	Standard coefficient	t-statistic value	t-critical value	t-test p-value
BDTI	INFLATION	0.638	3.687	2.069	0.001
	P_OIL	-0.379	-2.192		0.039
	_cons	817.318 ^a	5.381		0.000
BCTI	INFLATION	0.571	3.739	2.069	0.001
	GLO_OIL_PROD	-0.333	-2.183		0.040
	_cons	1391.621 ^a	3.261		0.003

Note: ^aUnstandardised coefficients are used for constants.

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow (2017, p. 451)

There are common traits of regression models for both indices. According to the R-squared (0.389), the first regression model explains 38.9% of the variation in the BDTI. The F-statistic (7.314) surpasses the critical value (3.420). The Durbin-Watson test (1.205) falls nearby the indeterminate range (1.220–1.550) by insignificant margin, suggesting weak signs of positive autocorrelation. Inflation shows a positive influence on the BDTI, while the oil prices negatively affect this freight index.

Similar observations are relevant to the BCTI modelling exercise. Less than half of the variation in the BCTI (46.6%) can be explained by the resulting model; however, the F-statistic value (10.035) is in significant excess of the threshold (3.420). The

Durbin-Watson statistic (0.951) also demonstrates positive autocorrelation. Regarding the relationship between dependent and independent variables, inflation positively affects both indices. In addition, the BCTI shows a negative dependence on global oil production (Zaidman and Yakubovskiy, 2025).

The problem of autocorrelation in both models can be addressed through introduction of the lags concept. Incorporating lags for price of oil and global oil production does not significantly change the shape and composition of the resulting models but minorly improves forecasting capability and eliminates autocorrelation in the residuals. Practically, the lags concept offers more context to the outcomes interpretation. The delayed impact of oil prices and oil production on oil tanker freight rates is not surprising. This lag can be explained by short-term inelasticity of demand for oil and the fact that employment of large oil tankers is typically secured for longer periods under time-charter contracts with oil majors; therefore, short-term shocks and fluctuations do not induce an imminent reaction and volatility.

LIBOR, the S&P 500 index, and volume of seaborne oil trade do not demonstrate significance, whereas the positive influence of inflation is in line with the current theory which suggests that shipping cycles are dependent on business cycles (Stopford, 2009, p. 140–141), the latter being impacted by inflation among others.

The negative influence of oil Brent price on the BDTI and the similarly negative effect of global oil production on the BCTI are less straightforward observations, which may sound counterintuitive at first sight. However, as discussed in Section 1.2, opinions on how energy prices affect the tanker freight market diverge in existing studies. Concurrently, current research does not agree on the nature of relationship between tanker freight rates and global oil demand (Siddiqui and Basu, 2021).

Exercising the caution expressed by Michail and Massouras (2014), it is ascertained that both oil prices and global oil production do not positively correlate with inflation (-0.255 and -0.517 respectively). In contrast, high and positive

correlation (0.726) is recorded between oil prices and global oil production (see Appendix C., Table C.6), and it can be inferred that global oil production is affected by changes in oil prices. Therefore, the above suggests (a) the existence of the same underlying mechanism explaining negative impact of both explanatory variables on both tanker indices (Zaidman and Yakubovskiy, 2025), and (b) that both resulting models are statistically robust and not biased by correlation between explanatory variables.

According to expectations, oil prices and inflation should move and develop in one direction. The opposite has only been noticed in limited shipping research (Michail and Melas, 2020a). The assumption can be made that some specific factors inherent to the period under consideration were in play. In principle, growing tanker freight rates directly result in increase in transportation costs. As the transportation costs are asymmetrically passed to end consumers as a part of the overall price, growing freight rates may stimulate market participants to reduce the product costs to maintain stable end price and thereby competitiveness, and not to lose demand. In the oil tanker sector, oil plays the role of both bunker and cargo for tanker vessel, and the attempts to control the ultimate price under growing freight rates may lead to declining oil prices.

In contrast, the surge in oil prices can make the exploration and production of alternative oil sources profitable. One of the most prominent examples is shale oil. The USA is the key hub of shale oil, and it has been proved that its production becomes economically viable only at specific oil price level and above (Smith, 2018). Under growing oil prices, the local oil production in the United States could increase, thereby reducing the demand for oil imports from markets located far away from the USA. Consequently, this could reduce the demand for seaborne trade and vessels' space, causing oversupply of the tankers on the market. In this case, freight rates are expected to decline. These examples demonstrate how growth in oil prices can negatively impact tanker freight rates.

Under these conditions, inflation could still exert positive influence on oil tanker freight indices regardless of oil price levels. Inflation may not be necessarily driven by the price of oil. There is a wider range of possible scenarios and reasons, including but not limited to disruptions in global supply chains, changes in monetary policy, increased operational expenses, and fluctuating demand for transportation, either of which can prevail (Zaidman and Yakubovskiy, 2025). Furthermore, it is revealed that inflation is more significantly affected by the changes in shipping costs than by other global or local shocks (Anderl and Caporale, 2024). Additionally, the factor of seasonality, which is inherent to the tanker market, is also worth noting (Alizadeh and Nomikos, 2009, p. 117).

Regarding market capitalisation of oil tanker shipping companies, the seven public listed specialised oil tanker owners were selected for the analysis. They include INSW (International Seaways, Inc., 2024), Euronav (CMB.TECH nv, 2024), TORM (TORM, 2024), Frontline (Frontline, 2018), Teekay (Teekay Corporation Ltd., 2024), Scorpio Tankers (Scorpio Tankers, 2024), NAT (Nordic American Tankers, 2022). See Appendix C, Table C.7 for additional information.

To ascertain the determinants of market capitalisation of each company, a stepwise OLS regression is run for each company separately. The general model presented in Equation (2.7) is used accordingly. As independent variables, the model considers crude oil Brent price, LIBOR as a proxy for interest rates, inflation, the S&P 500 index, and the average tanker earnings as a proxy for freight rates, all of which are assumed to impact MCAP.

While the freight indices for transportation of dirty and clean oil products (the BDTI and BCTI) were considered to model freight market, it is decided to include the single variable (the average tanker earnings) representing tanker freight rates into the MCAP modelling. Empirical analysis suggests that the correlation between both Baltic indices and the average tanker earnings exceeds 0.807 (Appendix C, Table C.8). This

is consistent with existing theory that freight indicators within one shipping segment demonstrate co-movements (Alizadeh and Nomikos, 2009, pp. 44–55).

$$MCAP = \beta_0 + \beta_1 * EARNINGS + \beta_2 * P_OIL + \beta_3 * LIBOR + \beta_4 * INFLATION + \beta_5 * SP500 \quad (2.7)$$

Tables 2.10 and 2.11 summarise parameters of all models. The explanatory variables which did not exhibit a relationship with MCAP are excluded, while statistically significant variables are presented in the second column of Table 2.11.

Table 2.10

Diagnostics of the market capitalisation regression models (oil tanker sector)

Dependent variable	R-squared	Durbin-Watson statistic	F-statistic value	F-critical value	F-test p-value
INSW_MCAP	0.917	2.213	27.603	5.790	0.002
EURONAV_MCAP	0.886	1.858	46.554	3.880	0.000
TORM_MCAP	0.778	1.546	20.986	3.880	0.000
FRONTLINE_MCAP	0.672	2.021	23.566	3.420	0.000
TEEKAY_MCAP	0.576	1.692	9.510	3.740	0.002
SCORPIO_MCAP	0.482	1.573	11.176	4.750	0.006
NAT_MCAP	0.399	1.091	7.959	3.400	0.002

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow (2017, p. 454–455)

Table 2.11

Market capitalisation regression models: statistical significance of the independent variables (oil tanker sector)

Dependent variable	Significant independent variables	Standard coefficient	t-statistic value	t-critical value	t-test p-value
INSW_MCAP	INFLATION	0.599	3.590	2.571	0.016
	LIBOR	0.458	2.742		0.041
	cons	-0.129 ^a	-0.774		0.474
EURONAV_MCAP	SP500	0.580	5.403	2.179	0.000
	EARNINGS	0.538	5.010		0.000
	_cons	-0.700 ^a	-2.703		0.019

Table 2.11 (continued)

TORM_MCAP	LIBOR	0.649	4.345	2.179	0.001
	SP500	0.386	2.587		0.024
	_cons	-0.483 ^a	-1.901		0.082
FRONTLINE_MCAP	EARNINGS	0.772	6.448	2.069	0.000
	SP500	0.339	2.830		0.009
	_cons	-0.895 ^a	-2.152		0.042
TEEKAY_MCAP	EARNINGS	0.535	3.058	2.145	0.009
	SP500	0.488	2.791		0.014
	_cons	-0.228 ^a	-1.179		0.258
SCORPIO_MCAP	LIBOR	0.694	3.343	2.179	0.006
	_cons	0.507 ^a	1.552		0.147
NAT_MCAP	P_OIL	0.544	3.437	2.064	0.002
	EARNINGS	0.339	2.140		0.043
	_cons	-0.089 ^a	-0.472		0.641

Note: ^aUnstandardised coefficients are used for constants.

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow (2017, p. 451)

Six out of seven resulting models include two statistically significant explanatory variables, while the final equation for Scorpio Tankers includes only LIBOR. The model successfully passes all robustness checks; therefore, the model is reconstructed with the aim to potentially improve R-squared which in the case of linear relationship amounted to 0.482 (Zaidman and Yakubovskiy, 2025).

Tables 2.12 and 2.13 summarise parameters of the respective models for Scorpio Tankers MCAP on LIBOR: linear, quadratic and cubic.

Table 2.12

R-squared and F-statistic indicators for linear, quadratic and cubic regression equations of Scorpio Tankers MCAP on LIBOR

Equation	R-squared	F-statistic value	F-critical value	F-test p-value
Linear	0.482	11.176	4.747	0.006
Quadratic	0.491	5.295	3.982	0.025
Cubic	0.596	4.925	3.708	0.024

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics and Barrow, 2017 (p. 454–455)

Table 2.13

**Parameters of linear, quadratic and cubic regression equations of
Scorpio Tankers MCAP on LIBOR**

Equation	Constant	β_1	β_2	β_3
Linear	0.507	0.509		
Quadratic	0.691	0.277	0.043	
Cubic	2.043	-2.414	1.265	-0.143

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics

Cubic regression equation exhibits the highest robustness, as its R-squared value is 0.596. Therefore, the regression equation of the Scorpio Tankers on LIBOR takes the following shape:

$$SCORPIO_MCAP = 2.043 - 2.141 * LIBOR + 1.265 * LIBOR^2 - 0.143 * LIBOR^3 \quad (2.8)$$

As per Equation (2.8), nearly 60% of the variation in Scorpio's MCAP within 2010–2023 may be explained by changes in LIBOR with 97.6% probability. The model is adequate as the F-statistic value (4.925) surpasses the critical value (3.708 at 5% significance). Figure 2.15 illustrates the graphs of respective linear, quadratic and cubic functions.

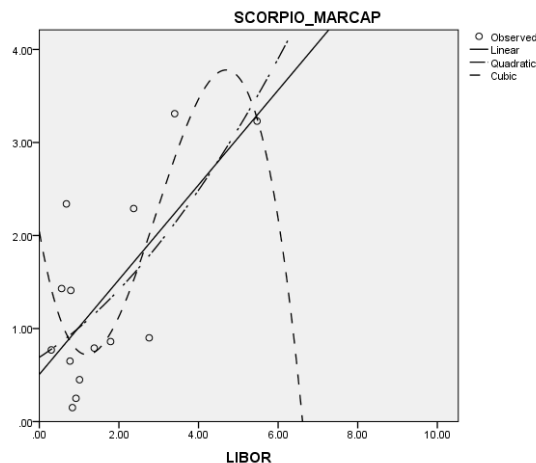


Fig. 2.15. Graphs of linear, quadratic and cubic equations of regression equations of Scorpio Tankers MCAP on LIBOR

Source: Compiled by the author based on regression analysis in IBM SPSS Statistics

According to the nature of a cubic function, while LIBOR increases from relatively low points, MCAP of Scorpio declines. However, beyond a certain level, further increases in LIBOR cause a growth in Scorpio's MCAP.

The most robust model has been produced for INSW. All statistical parameters underscore the model's adequacy: the F-statistic (27.603) comfortably exceeds the critical value (5.790), the Durbin-Watson value (2.213) falls within no autocorrelation zone. The high R-squared (0.917) indicates that more than 91% of the variation in INSW's MCAP can be explained by inflation and LIBOR (both t-statistics exceed the critical level). Both significant variables positively affect the dependent variable.

The resulting model for Euronav MCAP shows a similarly high degree of goodness of fit. 88% of variations in Euronav's MCAP can be explained by the changes in the S&P 500 index and tanker freight rates. The t-statistics for both explanatory variables (5.403 and 5.010 respectively) are more than two times higher than the critical threshold. The correlation between the S&P 500 index and tanker earnings is relatively weak (0.12), which confirms there are no signs of bias in the model. The F-statistic reaches an impressive level of 46.554, much greater than the critical value of 3.880, with the p-value being effectively zero. The Durbin-Watson test (1.858) suggests that there is no autocorrelation in the residuals.

The model constructed for TORM is also robust in terms of both forecasting accuracy and overall adequacy. The coefficient of determination (0.778) is rather high, indicating that changes in LIBOR and the S&P 500 index account for almost 78% of variation in TORM's market value over the period under examination. Both interest rates and stock market index positively impact market capitalisation of TORM, with both t-statistic values exceeding the critical level. The F-statistic (20.986) and p-value (effectively zero) emphasise the high quality of the model, while the Durbin-Watson statistic (1.546) does not demonstrate signs of autocorrelation in the residuals.

The modelling exercise of Frontline's stock market capitalisation has produced outcomes similar to those of the Euronav model. Frontline's MCAP is found to be influenced by tanker freight rates and the S&P 500 index, both exhibiting a positive relationship with the dependent variable. Variations in freight rates and the S&P 500 index explain over 67% of the fluctuations in Frontline's market value. The model's statistical parameters are robust: the F-statistic comfortably exceeds the critical value, and the same applies to the t-statistic of both explanatory variables. In addition, the Durbin-Watson score falls within the no autocorrelation range.

The resulting model for Teekay market value closely resembles the one of Frontline but with lower predictive capability. All parameters are robust and exceed the minimum thresholds, including the F-statistic (9.510), F-test p-value, the Durbin-Watson statistic (1.692), and t-statistic for tanker freight earnings (3.058) and the S&P 500 index (2.791). The key difference is that these indicators explain over 57% of variation in the Teekay's MCAP, compared to 67.2% in case of Frontline.

Turning to Nordic American Tankers, the resulting model demonstrates weaker goodness of fit and performance compared to earlier described ones. It explains only 40% of the variation in NAT's market capitalisation. The variables which positively influence NAT's market value are oil price and freight earnings, with t-statistics for both surpassing the critical threshold. While the F-statistic (7.959) comfortably exceeds the critical value (3.400), the Durbin-Watson test (1.091) is inconclusive, suggesting that the autocorrelation in the residuals may potentially exist (Zaidman and Yakubovskiy, 2025).

From among the seven shipping companies operating in the oil tanker sector which were considered, the INSW is the only one based in the US. Additionally, INSW has the shortest stock market performance history – since 2016 (Macrotrends LLC, 2026). Nevertheless, the modelling exercise for INSW has produced the most robust

outcomes. What distinguishes INSW from other companies under analysis is that it is the only one whose market capitalisation was found to be dependent on inflation.

Another influencing factor for INSW's MCAP is interest rates. They also exhibited influence on two other companies: TORM and Scorpio Tankers. Interestingly, according to the available data, INSW, Scorpio and TORM operate the largest fleets compared to the other four companies. This observation can be explained by the fact that fleet expansion is capital-intensive, and capital costs affect shipping companies' financial performance. Therefore, a change in financing costs leads to substantial implications for shipping companies (Kopylova, 2024; Michail, Melas and Louca, 2023), especially for those which have earlier invested more funds to presently deal with larger fleets. Additionally, Scorpio and TORM went public earlier than INSW, although not significantly – in 2010 and 2008 respectively. Interestingly, Euronav's stocks began trading in the same period, in 2009; however, interest rates were not impactful on Euronav's market capitalisation (Zaidman and Yakubovskiy, 2025).

Along with LIBOR, TORM's market value is driven by the S&P 500 index. This broad indicator demonstrates a relationship with three other companies as well – Euronav, Frontline and Teekay. While maritime companies do not constitute a significant portion of the S&P 500 index, the energy sector, which oil tanker companies depend on, constitutes over 3% (S&P Global, 2024). Consequently, tanker shipping companies expectedly follow wider market trends driven by U.S.-based large-cap giants. Furthermore, a clear correlation is observed between a company's longer history on the stock exchange and the impact of the S&P 500 on its market value.

Intuitively and in line with basic maritime economics theory, shipping companies are dependent on freight rates and freight earnings. The outcomes of the analysis reveal that MCAP of four out of seven companies under examination is influenced by tanker freight rates. Moreover, this factor is the most influential for Frontline and Teekay, whereas for Euronav and NAT, it plays a secondary role after the S&P 500 and oil price

respectively. Overall, the companies operating comparatively smaller fleets (Euronav, Teekay and NAT) are more dependent on freight market sentiment than larger companies, with Frontline being an exception to this observation.

NAT's fleet size is the smallest of all considered. And this may explain why only NAT's market capitalisation exhibited sensitivity to oil prices. Typically, smaller fleets are associated with lower level of diversification of company's chartering portfolio.

Notably, the geographical factor does not appear significant, as the origin of the company does not shape any specific behavioural pattern of its stock market value. Euronav, TORM, Frontline, Scorpio Tankers and NAT originate from Europe, while INSW and Teekay are headquartered in the United States and Canada respectively. What matters is that all companies are publicly listed on the U.S. stock exchanges, which underscores the global nature of the shipping business and higher importance of global economic and market indicators rather than local ones.

To summarise, the regression analysis has displayed that, likewise in the dry bulk sector, market capitalisation of oil tanker shipping companies does not exhibit a unified behavioural pattern; therefore, investors are advised to consider oil tanker shipping stocks individually rather than as a group.

Out of five explanatory variables included in the modelling exercise, each has exhibited statistical significance at least once. Crude oil Brent price and inflation have turned out to be less meaningful factors for forecasting market capitalisation of oil tanker companies compared to interest rates, freight rates, and the S&P 500 index. Nevertheless, oil prices and inflation should not be underestimated, as both are ascertained to impact tanker freight rates, along with global oil production.

The S&P 500 and freight rates are identified to influence four companies under consideration, while interest rates exhibit a positive relationship with three shipping companies. Company characteristics, for example, fleet size and stock market history, may assist in ascertaining the factors which determine its market capitalisation. The

larger companies in terms of number of owned vessel units typically follow wider economic dynamics, while for companies operating smaller fleets, shipping-specific indicators matter more. Companies with longer stock trading experience are more dependent on the S&P 500 index (Zaidman and Yakubovskiy, 2025).

2.4. Evaluation of the dynamics of charter rates in the container sector based on econometric modelling

The liner segment exhibits unique characteristics and follows different patterns, as compared to the bulk shipping; therefore, the modelling of charter rates in the container sector is attempted through a different framework. Via the VAR, the dynamics in various time series are captured. In order to perform such analysis, EViews software (EViews, n.d.) has been employed.

The data used for the modelling cover monthly observations (total 21) for the period from January 2020 till September 2021 (see Appendix C, Tables C.9, C.10). This period is known as a remarkable recovery and an unprecedented eightfold growth of containership charter rates after the slowdown caused by the COVID-19 pandemic (Clarksons Research, n.d.; Zaidman, 2021b). Containerships of feeder class of 2750 TEU capacity are chosen as a benchmark. The dataset is obtained from various sources, such as CompaniesMarketcap.com (2024), The Hong Kong Maritime and Port Board (2021), The Maritime and Port Authority of Singapore (2021), The Port of Los Angeles (2021), and Clarksons Research (n.d.). The dataset lists the following indicators (spelled out first, followed by their parenthesised abbreviations in italics and the respective sources):

- containership time-charter rates (2750 TEU capacity, 6–12 months of duration) in USD per day (*CC rate*) (Clarksons Research, n.d.);

- containership second-hand price (2750 TEU capacity, 10-year-old) in million USD (*CS SP*) (Clarksons Research, n.d.);
- containership newbuilding price (2750 TEU capacity) in million USD (*CS NP*) (Clarksons Research, n.d.);
- U.S. industrial production, percentage change year-on-year (*US IP*) (Clarksons Research, n.d.);
- European industrial production, percentage change year-on-year (*EU IP*) (Clarksons Research, n.d.);
- The Organisation for Economic Co-operation and Development (OECD) industrial production, percentage change year-on-year (*OECD IP*) (Clarksons Research, n.d.);
- South Korean industrial production, percentage change year-on-year (*SK IP*) (Clarksons Research, n.d.);
- Chinese industrial production, percentage change year-on-year (*CH IP*) (Clarksons Research, n.d.);
- Taiwanese industrial production, percentage change year-on-year (*TW IP*) (Clarksons Research, n.d.);
- Singapore port container throughput in TEU (*SP CT*) (Maritime and Port Authority of Singapore, 2021);
- Hong Kong port container throughput in TEU (*HK CT*) (Hong Kong Maritime and Port Board, 2021);
- Los Angeles port container throughput in TEU (*LA CT*) (Port of Los Angeles, 2021);
- crude oil Brent price in USD per barrel (*BP*) (Clarksons Research, n.d.);
- grain USG price in USD per metric tonne (*GP*) (Clarksons Research, n.d.);
- steel ship plate price in USD per metric tonne (*SP*) (Clarksons Research, n.d.);

- the market capitalisation of Maersk (Maersk-B.CO) in billion USD (*M MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Hapag-Lloyd (HLAG.DE) in billion USD (*H-L MCAP*) (CompaniesMarketcap.com, 2024);
- the market capitalisation of Orient Overseas Container Line (OOCL) (01316.HK) in billion USD (*OOCL MCAP*) (CompaniesMarketcap.com, 2024).

As a hypothesis, the assumption is made that the above listed variables, further denoted as *MI* (macroeconomic and economic indicators), influence containership charter rates and conversely, containership rates impact these indicators. To test the hypotheses, the following VAR systems are employed (Equations 2.9 and 2.10):

$$CC\ rate_t = \alpha_1 + \sum_{i=1}^p \beta_{1i} MI_{t-i} + \sum_{i=1}^p \gamma_{1i} CC\ rate_{t-i} + \varepsilon_{1t} \quad (2.9)$$

$$MI_t = \alpha_2 + \sum_{i=1}^p \beta_{2i} CC\ rate_{t-i} + \sum_{i=1}^p \gamma_{2i} MI_{t-i} + \varepsilon_{2t}, \quad (2.10)$$

where α is a constant term, β and γ are coefficients to be further estimated, and p represents the selected lag order. $\beta_{1i} = 0$ and $\gamma_{2i} = 0$ represent the null hypothesis of Granger non-causality from CC rate to MI and from MI to CC rate respectively.

The refutation of the null hypothesis implies that the past values of independent variables can help forecast the dependent one. The estimation and verification of the model include several steps: estimation of an unrestricted VAR, Granger causality test, selection of optimal lag order through Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). Thereafter the stability of the VAR is verified against correlation in the residuals through Autocorrelation Lagrange Multiplier test. In addition, all autoregressive roots are tested to lie within the unit circle, indicating the stationarity of the model (Greene, 2012, pp. 179–182, 358, 962–963, 987–989, 1004–1005). The target level of confidence regarding outcomes is 95%.

Table 2.14 presents the Granger test results regarding the hypotheses of relationship between containership charter rates and selected economic indicators,

while Table 2.15 provides the Granger test results for reciprocal influence. Extended Granger test results data are available in Appendix C, Table C.11.

Table 2.14

Granger causality test results for containership charter rates

Dependent variable: CC rate			
Factor	Chi-squared	p-value	Lag and type of causality
CS SP	8.7	(0.02) ^b	L=2 ↑
CS NP	12.82	(0.005) ^a	L=3 ↑
US IP	5.52	(0.02) ^b	L=1 ↑
EU IP	Statistically non-significant		
OECD IP	Statistically non-significant		
SK IP	2.82	(0.09) ^c	L=1 ↑
CH IP	742	(0.00) ^a	L=3 ↑
TW IP	Statistically non-significant		
SP CT	8.38	(0.08) ^c	L=4 ↑
HK CT	Statistically non-significant		
LA CT	8.63	(0.07) ^c	L=4 ↑
BP	Statistically non-significant		
GP	Statistically non-significant		
SP	9.97	(0.00) ^a	L=3 ↑
M MCAP	24.69	(0.00) ^a	L=2 ↑
H-L MCAP	Statistically non-significant		
OOCL MCAP	Statistically non-significant		

Note: ^a, ^b and ^c represent 1, 5 and 10% significance levels respectively; the ↑ symbol denotes a direct causality.

Source: Compiled by the author based on analysis in EViews

Table 2.15

Granger causality results: influence of containership charter rates on other variables

Independent lagged variable: CC rate			
Dependent variables	Chi-squared	p-value	Lag and type of causality
CS SP	6.3	(0.04) ^b	L=2 ↑
CS NP	Statistically non-significant		
US IP	Statistically non-significant		
EU IP	Statistically non-significant		

Table 2.15 (continued)

OECD IP	Statistically non-significant		
SK IP	5.13	(0.02) ^b	L=1 ↑
CH IP	57.17	(0.00) ^a	L=3 ↑
TW IP	11.27	(0.04) ^b	L=5 ↑
SP CT	30.4	(0.00) ^a	L=4 ↑
HK CT	17.57	(0.004) ^a	L=5 ↑
LA CT	Statistically non-significant		
BP	Statistically non-significant		
GP	Statistically non-significant		
SP	Statistically non-significant		
M MCAP	Statistically non-significant		
H-L MCAP	Statistically non-significant		
OOCL MCAP	Statistically non-significant		

Note: ^a, ^b and ^c represent 1, 5 and 10% significance levels respectively; the ↑ symbol denotes a direct causality.

Source: Compiled by the author based on analysis in EViews

Taken together, the findings indicate that containership charter rates exhibit a relationship with the following variables, which are found to be significant: prices of both new and second-hand container vessels of the same capacity, industrial growth in the USA and China, price of steel, and the MCAP of Maersk. Remarkably, price of 10-year-old containerships and Chinese industrial production are also influenced by containership charter rates. Conversely, for the following indicators null-hypothesis cannot be refuted based on their statistical non-significance for the modelling of containership charter rates: industrial growth in Europe, the OECD, South Korea and Taiwan, price of oil and grain, stock market value of Hapag-Lloyd and OOCL, and container throughput in ports of Singapore, Hong Kong and Los Angeles.

The positive relationship between freight rates and prices of existing and new ships could be anticipated. This observation reiterates inherent to the shipping industry interrelation of the freight, newbuilding, and S&P markets, as described in Section 1.1 and summarised in Table 1.1. Notably, while charter rates and second-hand vessel

prices mutually affect each other, there is no bi-directional causality between charter rates and new vessel prices. This underscores the dominating roles of the freight and S&P markets within shipping, while the newbuilding market follows the general market conjuncture. It is evident that the process of price formation in vessel markets is influenced by various market forces. This observation can be generalised, as such interplay between freight and vessel asset markets is equally relevant to all shipping sectors, including but not limited to the container one (Zaidman *et al.*, 2021).

A noteworthy observation can be made regarding the asymmetric impact of industrial production indicators. Out of the six indicators representing the industrial growth, only Chinese industrial development is found to impact and be impacted by the containership freights, which is clearly due to the leading role of China in container transportation. According to UNCTAD (2022), the list of the ten largest global container ports includes six Chinese ports. Based on the significant role of China in containerised trade, Chinese industrial growth also impacts containership rates. While industrial production in Taiwan and South Korea does not affect the cost of container transportation services, industrial production in both countries is positively influenced by containership charter rates in return. This finding aligns with the existing theory, as both Taiwan and South Korea are export-oriented countries (Chang, 2024) which are dependent on consumption, overall demand in the global economy, and consequently the income from transportation.

In contrast, container charter rates are influenced by the U.S. industrial production, but there is no reciprocal influence of container charter rates on the U.S. industry. This contrast illustrates another instance of asymmetry and can be explained by the difference in the U.S. and Asian economic systems. While the emerging Asian economic models demonstrate a higher dependence on exports and global trade, the U.S. economy is notably more stable and mature. In the US, the financial sector is the primary driver of the economy, which underlies its higher resistance to fluctuations in

trade activity. The non-significant relationship between container charter rates and European and the OECD industrial production can also be attributed to the nature of their economic models. Europe is known to be rather self-contained in continental trade and generally tends to exhibit a delayed response to external shocks.

According to the VAR outcomes, a similar pattern, reflecting regional differences in economic systems, is observed when examining container port activity. The numbers of containers handled at the ports of Singapore, Hong Kong and Los Angeles do not affect containership charter rates. This points to the conclusion that the unprecedented spike in containership charter rates during the period under examination was not driven by demand factors, since the volumes of containers loaded and unloaded at mentioned ports remained relatively stable and did not grow substantially. However, the reverse relationship is evident, as container rates have an effect on throughputs at Singaporean and Hong Kong ports. The port of Los Angeles, similarly to the U.S. industrial production, is not influenced by charter rates in container segment. In contrast, despite being among the ten largest container ports in the world, the Asian ports of Singapore and Hong Kong show a strong dependence on freight market fluctuations.

Overall, it can be concluded that regional similarities in the behaviour of indicators are dominant. The greater the dependence of a region or a country on seaborne trade and goods movement, the more significant influence is exerted by container charter rates, be it on the industrial growth of the country or the specific activity of the container port. Developed and emerging economies are asymmetrically connected with development of international seaborne container trade, with Asian economies being more closely dependent than the American and European ones.

Regarding prices of commodities considered in the analysis, the findings are aligned with expectations. The absence of a relationship between price of grain and containership charter rates is intuitive, as grain is usually transported by dry bulk carriers, not container vessels. In contrast, steel products are frequently transported in

containers, which explains why the price of steel is a statistically significant factor impacting container charter rates. In line with theoretical expectations, there is no bi-directional causality, as steel prices do not turn to depend on containership charter rates. Additionally, no connection has been revealed between oil prices and charter rates (Zaidman *et al.*, 2021). This can be attributed to the nature of the liner sector, as container vessels are typically employed under time-charter agreements less prone to short-term fluctuations and where the charterer is responsible for bunker costs (ICB, 2014, p. 96).

Turning to the stock market capitalisation of containership companies, OOCL and Hapag-Lloyd do not exhibit a relationship with container charter rates, as opposed to the Maersk's MCAP which has proved to significantly impact the rates. This can be attributed to the leading role of Maersk in the containership industry. Stock performance of Maersk can be considered as a barometer for overall market conditions in the container sector.

Conclusions to Chapter 2

Based on the research presented in Chapter 2, the following conclusions are reached:

1. The empirical analysis of the development of international seaborne trade over the period of 2005–2024 revealed a continuous growth of the volumes with temporary slowdowns due to the global financial crisis, the COVID-19 pandemic and the war in Ukraine. Similar trends are also observed in the development of global fleet. The cargo shipping industry consists of three major components: the dry bulk sector, the liquid bulk sector, and the container transportation. The development dynamics of these three sectors confirms the existence of sectoral, geographical and product

asymmetries in international seaborne trade. An analysis has demonstrated that the estimation of the share of each sector in global shipping throughout the examined period can relatively equally rely on either of the following parameters: the fleet's deadweight tonnage, seaborne trade in tonnes and seaborne trade in tonne-miles. At the current stage, due to the increasingly important role of the global decarbonisation agenda, contemporary shipping is shaped by the associated environmental regulations which determine strategic and tactical priorities in the industry.

2. The dry bulk freight index is found to depend on interest rates, which highlights the relationship between monetary policy and the dry bulk freight market. An analysis of the wet bulk segment has implicitly yielded partially similar findings. None of the tanker freight indices under analysis has demonstrated a statistical dependence on interest rates; however, both indices are found to be positively affected by inflation, which, in turn, closely correlates with interest rates. In addition, both tanker freight indices are negatively influenced by oil prices and global oil production levels. This meaningful observation for regulators and policymakers suggests an effect of more complex mechanisms, such as attempts to reduce product costs to maintain demand or exploration and production of alternative oil sources.

3. In respect of the market capitalisation of the leading firms in the industry, the individualised behaviour of dry bulk shipping companies has been observed, restricting the ability to generalise conclusions, which may be partially elucidated by the peculiarities of the dry bulk sector, wherein the freight market is largely driven by the tramp trade rather than long-term chartering agreements. The outcomes of econometric modelling are relatively consistent for the companies with the highest value, as their market capitalisation appears to positively depend on the S&P 500 index and the price of aluminium. The price of iron ore, along with the price of oil, is a meaningful factor for the only company. Two companies have been affected by the BDI, whereas three companies have demonstrated a dependence on the S&P 500 index.

4. According to the results of econometric modelling, the market capitalisation indicators of oil tanker companies operating relatively large fleets has exhibited a correlation with interest rates, while those running smaller fleets are dependent on freight rates. Moreover, the S&P 500 index has a greater impact on companies with a longer listing history. A company's geographical origin does not appear to play a significant role; however, purely in terms of statistical characteristics, the most reliable model has been developed for the U.S.-based oil tanker shipping company. Even though it is feasible to ascertain a few commonalities in the behaviour of market capitalisation of oil tanker companies, the conclusions can only be partially generalised; therefore, as in the dry bulk segment, investors are advised to apply a “personalised” approach and evaluate each firm separately prior to acquiring specific shipping stocks of oil tanker companies.

5. It has been shown that in the containership sector charter rates are influenced by several factors, such as prices of new and second-hand container vessels, the industrial growth in China and the USA, steel prices, and the MCAP of Maersk. An important finding underlining existing asymmetries is that industrial production and container port throughput indicators of emerging Asian countries, which are more reliant on seaborne trade, show a closer relationship with container freight rates as compared to the more advanced U.S. and European economies. Steel prices are also found to be a significant factor for charter rates. The market capitalisation of considered companies has displayed no relationship with charter rates, with the only exception of Maersk, largely due to its leading role in the containership sector.

The major findings and outcomes of the research described in Chapter 2 have been reported in the following author's publications: Yakubovskiy and Zaidman (2024); Zaidman and Yakubovskiy (2025); Zaidman *et al.* (2021); Zaidman, Yakubovskiy and Romanenko (2025).

CHAPTER 3

INTERNATIONAL SEABORNE TRADE IN THE WORLD ECONOMY: STRATEGIC OUTLOOK AND THE ROLE OF UKRAINE

3.1. Shipping strategies under asymmetric dynamics of international seaborne trade and decarbonisation

As one of the most genuinely international industries, shipping is known to be “over-regulated” due to its extensive regulatory framework which covers safety, security, piracy, and training (Goulielmos, 2019). In addition to the mentioned elements, environmental regulations are developed with the aim of reducing pollution from shipping. Shipping’s contribution towards combating global climate change became a priority and has direct implications for global maritime economics.

The concept of environmental sustainability in shipping covers a wide range of aspects, including but not limited to ballast water treatment, recycling, plastics and discharge management, and essentially defines shipping strategies. Decarbonisation in itself focuses on greenhouse gas (GHG) emissions’ reduction (Lloyd’s Register Group Limited, 2024). According to the estimations, international maritime transport accounts for approximately 3% of global GHG emissions (Ap Dafydd Tomos *et al.*, 2024).

To ensure alignment of international maritime transport with the global climate agenda, the compliance requirements for shipping were developed and documented in the IMO Initial Strategy on the Reduction of GHG Emissions from Ships adopted in 2018 (IMO, 2018), which was later updated by the 2023 IMO GHG Strategy (IMO, 2023). The IMO Strategies are aligned with the Kyoto Protocol (UN, 1998) and the Paris Agreement (UN, 2015). The latter reflects lessons learned from key critiques of the Kyoto Protocol, such as limited coverage and high attention to demand function indicators (Sinn, 2008).

In 2018, the IMO introduced several initiatives promoting the implementation of the global shipping decarbonisation strategy at the national level. After several reassessments and considerations of critical analysis (van Leeuwen and Monios, 2022), the IMO recognised the need to increase the targets. Stricter requirements were formalised in the 2023 Revised Strategy:

1) The initial ambition “to reduce the total annual GHG emissions by at least 50% by 2050 compared to 2008” (IMO, 2018) transformed into net-zero decarbonisation goal, namely, “to reach net-zero GHG emissions by or around, i.e. close to, 2050”, with “indicative checkpoints”: “to reduce the total annual GHG emissions from international shipping by at least 20%, striving for 30%, by 2030, compared to 2008” and “(...) by at least 70%, striving for 80%, by 2040, compared to 2008” (IMO, 2023).

2) Earlier the focus was on emissions generated by on-board fuel combustion. The updated Strategy introduced a new perspective, namely, “the levels of ambition and indicative checkpoints should take into account the well-to-wake GHG emissions of marine fuels” (IMO, 2023), which means measuring emissions during the entire lifecycle of fuel, that, in addition to on-board consumption, also includes production and transportation.

3) The Revised Strategy requires “uptake of zero or near-zero GHG emission technologies, fuels and/or energy sources to represent at least 5%, striving for 10%, of the energy used by international shipping by 2030” (IMO, 2023). The target “to reduce CO₂ emissions per transport work, as an average across international shipping, by at least 40% by 2030, compared to 2008” (IMO, 2023) remained unchanged.

The decarbonisation trends continue to reshape the shipping industry as a whole, impact the formation of modern shipping strategies, and bring significant economic implications (Wiernicki, 2024; Zaidman and Yakubovskiy, 2023). While Emission Control Areas were introduced earlier as a form of regional environmental

requirements, new regional principles, particularly in the EU and the US, create additional pressure beyond the global IMO standards (DNV, 2024; Hein, 2022). All these requirements add complexity to the already complex operational and financial planning elements of shipping strategies.

When considering the evolving environmental regulations in shipping, it is worth noting two types of impact. First, vessels consume fuel to ply between destinations. Second, fuel is transported from production to consumption centres by sea. Individually, vessels are evaluated against various environmental compliance indices (IMO, 2021b). A special document was introduced to monitor and manage vessel's energy efficiency – Ship Energy Efficiency Management Plan (ClassNK, n.d.). In order to encourage shipowners to actively engage in decarbonisation, vessel pooling is explored. This option offers certain flexibility and opportunities for shipowners. For example, an individual vessel, not meeting energy efficiency criteria, may still be deemed compliant as a part of a pool, given that the pool jointly achieves the required environmental targets (DNV, 2024).

According to the formulae of energy efficiency indices, vessel's emission is determined by vessel's specific fuel consumption level and speed (Hein, 2022). Since 2008, the average speed of vessels across major shipping sectors has decreased by 20–30%. While the initial slowdown was considered as a response to the excess of vessel capacity occurred on the market as a result of the 2008 global financial crisis, further reductions were mainly driven by decarbonisation requirements and fluctuations in fuel prices. Market conditions can still affect vessels speed on a temporary basis, particularly during strong demand, high freight rates, or global shocks. Nevertheless, the long-term downward trend of vessels speed observed in the past decades is expected to persist even regardless of technical capability of modern ships to operate at higher speeds than older vessels, while remaining within the compliant limits (Creedon, 2025; UNCTAD, 2025; UNCTAD, 2024).

This trend directly affects the supply side of the global seaborne trade market, as cargo carrying capability of the global fleet becomes limited. As discussed in Section 2.1, the average volume of trade carried by a deadweight tonne of the global fleet follows a continuous downward trend. This tendency implies that the contribution of an individual vessel towards global trade volumes gradually decreases. While vessels do reduce speed operating under regulatory pressure, the other reason behind the declining volume of trade carried by each vessel, especially in recent years, can be attributed to the growth in average distance travelled by cargo vessels of all types due to disruptions in several key maritime checkpoints (UNCTAD, 2024). Under the assumption that these effects persist in future, an inference can be made that, *ceteris paribus*, more vessels may be required to handle even the same level of seaborne trade.

As demonstrated in Section 1.2, the development of global trade, and consequently, international seaborne trade heavily relies on the developments in the world economy. According to the long-term forecasts (see Figure 3.1), the world's GDP is expected to double by 2050 compared to 2022 with an average annual growth rate of approximately 2.5% (PricewaterhouseCoopers LLP, 2017; Capital Economics, n.d.).

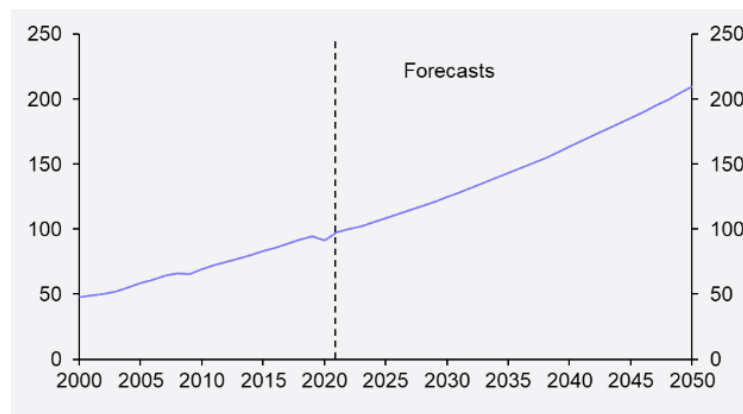


Fig. 3.1. Real world GDP: long-term projection

Note: Indexed to 2022 = 100.

Source: Capital Economics (n.d.)

In respect of asymmetries, it is important to mention that the emerging market and developing economies (EMDEs) are expected to develop faster than advanced

economies; therefore, their shares in the global economy are estimated to increase. As per projections, this may result in China, India and Indonesia becoming three of the four largest economies in the world, while the shares of the United States and Europe are likely to shrink (PricewaterhouseCoopers LLP, 2017; Capital Economics, n.d.). At least in the medium term until 2029, this forecast is supported by the IMF (2025a) (see Figure 3.2 and Appendix D, Table D.1). According to the World Bank (2026), the income convergence between EMDEs and advanced economies slowed down since the COVID-19 pandemic; however, the overall trade dynamics in EMDEs remain positive.

Increased level of protectionism, new tariffs, overall tensions, ongoing geopolitical and macroeconomic instability (IMF, 2026; World Bank, 2026; UNCTAD, 2025), and stringent environmental regulations – all these factors lead to the asymmetric changes in global trade. Pollution-intensive industries are moved to countries with less rigorous environmental standards (“pollution haven hypothesis”), which even increases emissions, according to the estimates. On the other hand, such relocations stimulate transfer of technologies through FDI (Linhai, 2024).

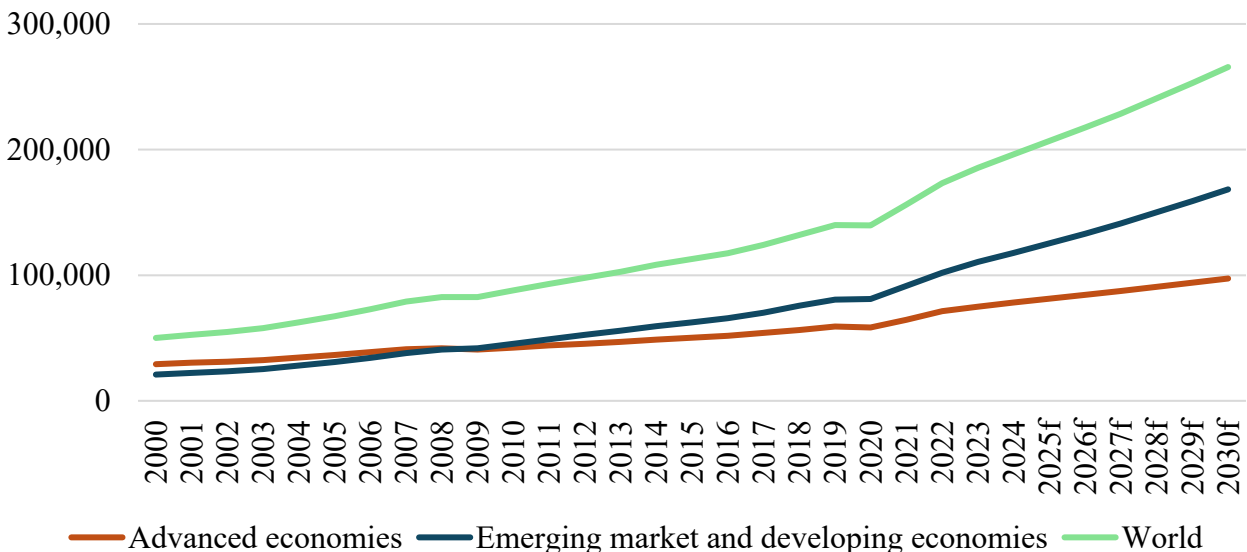


Fig. 3.2. World GDP in current prices (purchasing power parity) in billions of international dollars: historical data and medium-term projection

Source: Compiled by the author based on data from the IMF (2025a)

In view of the development of EMDEs and the wider asymmetric shift from advanced to developing economies at a global level, traditional trade patterns may undergo transformation. However, for the shipping industry, these changes could be even beneficial, as the expansion of emerging economies across different regions and continents is projected. In addition to the major Asian economies (China, India, Indonesia), high growth is expected in Brazil and Mexico (Americas), Nigeria (Africa), Turkey (Europe and Central Asia), several Middle Eastern economies, and others (IMF, 2026; World Bank, 2026; IMF, 2025a; Yakubovskiy and Zaidman, 2024; PricewaterhouseCoopers LLP, 2017). Therefore, the potential change in the world's economic leadership is not expected to negatively impact overall economic activity and seaborne trade volumes, since all above mentioned developing countries are expected to actively participate in global trade, export and import resources and goods, thereby relying primarily on maritime transport. And these changes are expected to have no impact on the asymmetric character of international seaborne trade.

Furthermore, several reports, although diverge in detailed scenarios, are generally aligned in forecasting a stable long-term demand for international maritime transport (DNV, 2022; IMO, 2021a). According to the estimations, international seaborne trade in tonne-miles may develop disproportionally, i.e. significantly increase over the next decade and slow down after the mid-2030s (DNV, 2021). International seaborne trade measured in tonnes is projected to consistently increase in the medium term at an average annual growth level of around 2% (UNCTAD, 2025).

While the overall seaborne trade is projected to grow, within its structure different cargo trades are expected to follow asymmetric trends (UNCTAD, 2025; UNCTAD, 2024; CRSL, 2023b; DNV, 2021). Figure 3.3 illustrates these projected dynamics on the demand side. The trends are connected to the global decarbonisation agenda and reflect how the world, and shipping, is expected to respond to it. The most significant change is the anticipated decrease in oil and coal trade (the main carbon-

intensive fuels) and the growing share of gas trade (alternative energy sources). Additionally, the share of demand for container transportation is expected to rise.

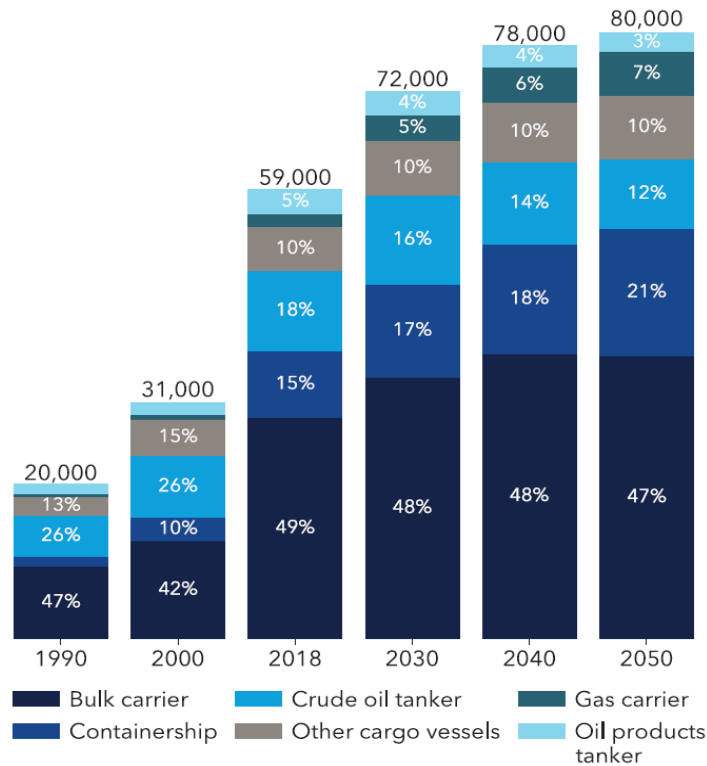


Fig. 3.3. Projected dynamics of world seaborne trade by vessel type in billions of tonne-miles

Source: DNV (2021)

From the demand perspective, the long-term developments seem relatively straightforward. From the supply perspective, the developments in fleet structure, especially under stringent compliance requirements, are expected to appear more complex. There is a caution that demand for transportation may outpace vessels efficiency improvements (DNV, 2021). In general, the same factors such as energy shifts, green transition, and decarbonisation initiatives are driving structural asymmetric changes within the global fleet, similarly to the demand patterns. Although total world's fleet size is anticipated to increase in the long term, the shares of different vessel types may either grow or decline, as they may probably adjust to the changes in demand for the transportation of respective cargo types, which may develop differently.

As shown in Figure 3.4 in consensus with the other sources (BRS Shipbrokers, 2025a; UNCTAD, 2024; Ferris, 2023; DNV, 2022), dry bulk and liquid bulk carriers may continue to trade in the market, but at lower levels due to the projected peak of global coal and oil demand by the 2030s. However, the dry bulk fleet (in deadweight tonnes) is projected to retain its dominant role. In contrast, the share of gas carriers is expected to increase sharply over the next 20 years. Containerships are also expected to experience significant growth, becoming the second-largest vessel type in the world fleet (when measured in deadweight tonnes), overtaking crude oil tankers. In addition, DNV (2022) forecasts that the average size of a dry bulker, container vessel and LNG carrier may asymmetrically increase by 10%, 30% and 40% respectively by 2050.

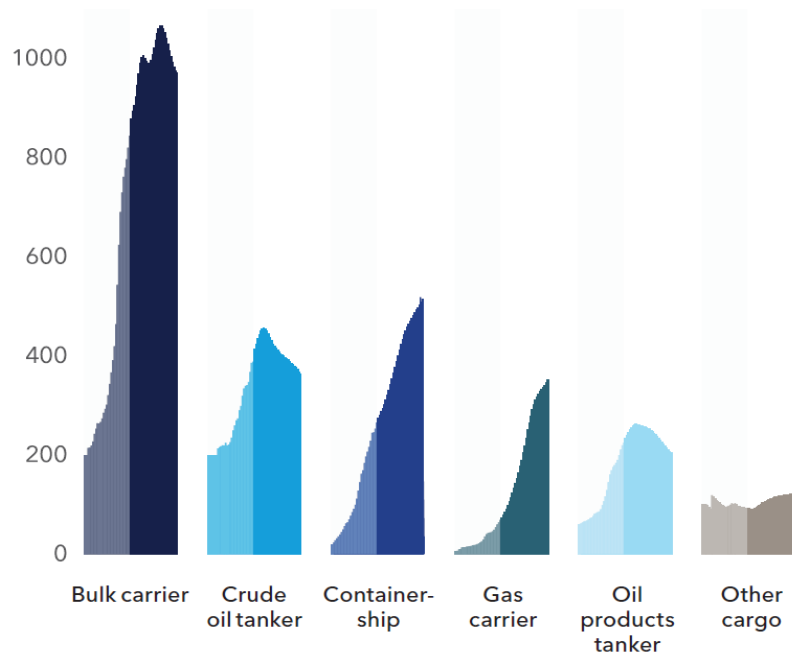


Fig. 3.4. Projected dynamics of world cargo fleet by vessel type by 2050 in millions of deadweight tonnes

Source: DNV (2021)

Apart from the long-term environmental goals and the need to reduce speed to comply with interim targets, the age of existing fleet is an additional factor affecting supply forecasts. While dry bulk carriers and containerships are relatively younger, a

significant portion of tankers and general cargo ships are nearing the end of their typical service life (BRS Shipbrokers, 2025a; UNCTAD, 2024).

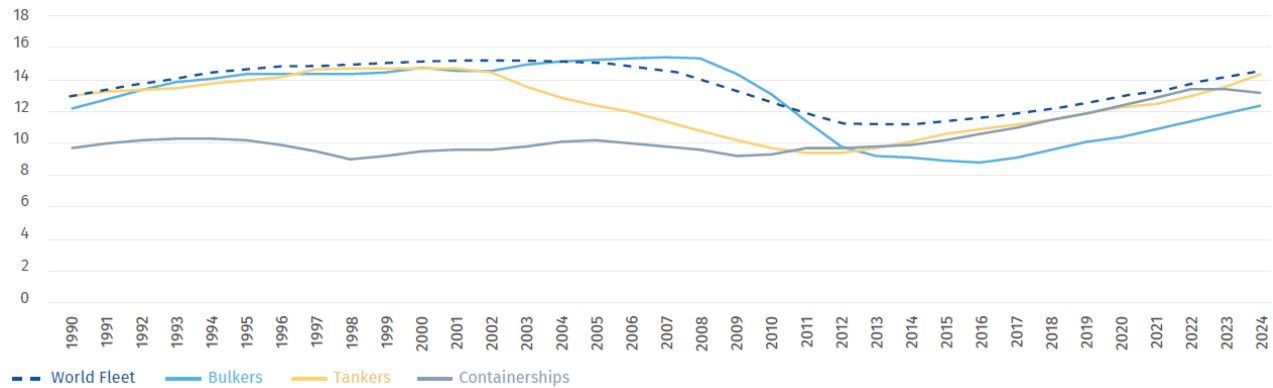


Fig. 3.5. Average age of world fleet and key vessel types in years

Source: BRS Shipbrokers (2025a)

As regulatory pressure increases and operational efficiency becomes more critical for shipping strategies formation, older vessels are gradually being phased out. Figure 3.5 illustrates the dynamics of the average age of the global fleet and key vessel types while Figure 3.6. and Appendix D, Table D.2 present the global fleet's average age distribution by vessel type in 2024. Both figures highlight the scale of the structural challenge required to meet shipping's green ambitions.

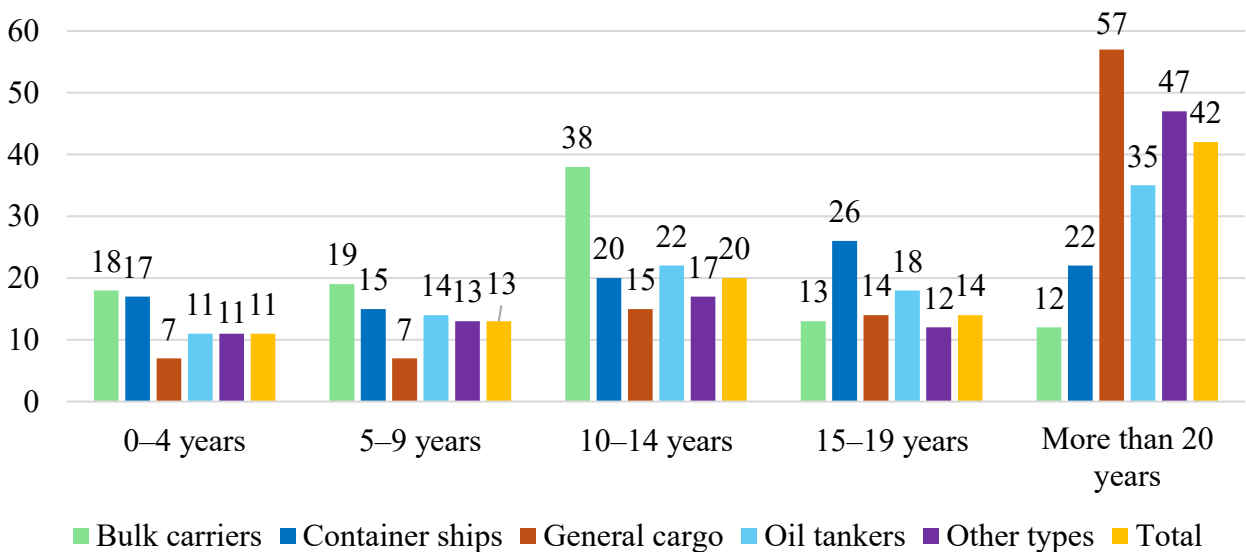


Fig. 3.6. Average age of world fleet in % of vessel numbers as of 2024

Source: Compiled by the author based on data from UNCTAD (2024)

The consensus in the literature indicates that replacement of mature vessels by younger ones is expected both to support the shipping's environmental objectives and help to meet future demand for maritime transport services. As an indicator of future fleet expansion, maritime industry practitioners typically evaluate the vessels orderbook, which counts the vessels ordered but not yet delivered, meaning still under construction (Stopford, 2009, p. 173). According to BRS Shipbrokers (2025a), vessel ordering activity surged in 2024, reaching the second-highest volume after 2007. Some orders placed in 2024 are expected for delivery in 2028 and later. Consistent with the findings of DNV (2025), the research also notes a disproportionately sharp increase in containerships orders, which is aligned with the previously presented projections of seaborne trade and global fleet development. A considerable increase in orders for large crude tankers is also in line with forecasts which suggest that tankers will remain relevant beyond 2050 while current tankers are ageing. Although the decarbonisation transition is underway, it is not expected to completely contract global oil demand.

According to the data (UNCTAD, 2025), alternative fuel capable tonnage constitutes around half of the existing orderbook. From among vessel types, the largest number of orders is for car carriers and containerships. The majority of orders for these vessel types placed in the 2020s are for alternative fuel capable vessels. Both dry bulk carriers and oil tankers demonstrate significantly lower uptake of the initiative, as the majority of new orders in the bulk sector are still for vessels consuming conventional fuels. DNV (2022) and DNV (2025) noted the trend that shipowners tended to consistently order alternative fuel capable vessels in larger vessel size segments.

The effects of this newbuilding activity will become evident in the future. However, in 2025, it was estimated that 91% of existing vessels continued to operate on conventional fuels (DNV, 2025). From among existing vessels which are able to use alternative fuels, LNG dominates as an alternative fuel option chosen by shipowners. The same holds true for recently placed orders, although the other options, such as LPG,

methanol and ammonia, started to gradually gain traction (DNV, 2025; Ap Dafydd Tomos *et al.*, 2024; DNV, 2024; DNV, 2022), as illustrated in Figure 3.7.

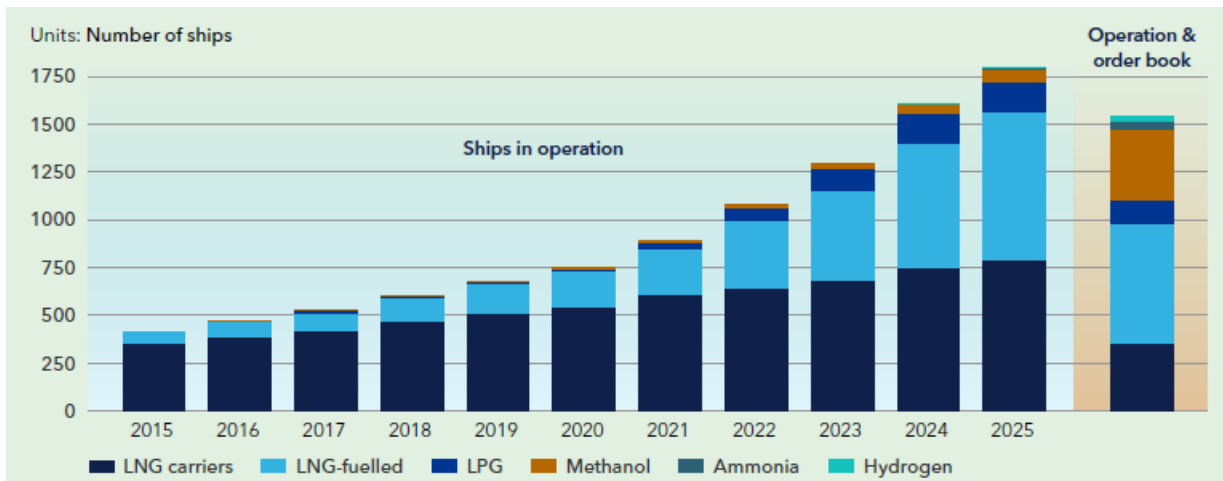


Fig. 3.7. Alternative fuel capable world fleet in vessel numbers as of August 2025

Source: DNV (2025)

Figure 3.8 shows the three key conditions for the adoption of alternative fuel in shipping. As an alternative fuel, LNG currently satisfies all three conditions:

- 1) Safety and technology: in case of a spill, LNG is less harmful than fuel oils. Due to its low carbon content, LNG provides a 23% reduction in GHG emissions compared to traditional fuels and zero emission of particulate matters.
- 2) Availability and supply chain: gas is continuously extracted and transported across the globe both through pipelines and by sea. During 1990–2022, the volume of seaborne LNG transportation increased by 553% and continues to increase.
- 3) Established infrastructure capable of provision of reliable and convenient bunkering operations amounted to 200 ports globally as of the end of 2024 (UNCTAD, 2025; Wiernicki, 2024; Esau, 2022; Michail and Melas, 2022).

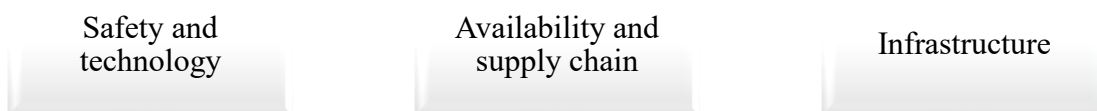


Fig. 3.8. Three boundary conditions for alternative fuel adoption

Source: Compiled by the author based on Wiernicki (2024); Esau (2022)

There is an alignment in existing research that complete decarbonisation of shipping has a long way to go, due to a need to develop and improve zero-carbon fuels in multiple aspects. LNG is, therefore, widely acknowledged as not an ideal long-term solution but the most attractive one for transition. LNG is regularly referred to as “the cleanest fossil fuel” (Esau, 2022) and “the least environmentally interventional” (Michail and Melas, 2022) from among existing fossil fuels, which still cannot make a significant environmental improvement (Mayanti, Hellström and Katumwesigye, 2025).

Therefore, LNG in itself is considered as “fuel in transition”, the “methane slip” being one of the reasons. Currently, it is addressed via the development of bio-LNG and e-LNG. Existing LNG infrastructure is capable of handling bio-LNG. It can also be blended with fossil LNG. At a 20% blending ratio, bio-LNG is projected to meet up to 63% of global energy demand by 2050 (Wiernicki, 2024). This “drop-in” capability is particularly attractive to shipowners and is another driver of LNG’s relatively high uptake at the current stage, despite limitations of its adoption in the long run.

The composition of the future energy mix, which will allow for sustainable growth globally, attracts the attention of scholars from various regions and different industries (Mayanti, Hellström and Katumwesigye, 2025; Koval *et al.*, 2022). For each country, stable and safe supply of energy sources determines its energy security which is a crucial component of the overall national security. Thus, competition between countries for access to limited global resources may lead to further deterioration of international relations (Linhai, 2024; Michail and Melas, 2022). This could clearly affect the maritime industry and shipping strategies. Following the energy shock in 2022, countries had to modify their energy preferences and improve energy efficiency in various spheres (IMF, 2025b). Decarbonisation is expected to amplify this trend.

Similarly in shipping, achievement of ambitious decarbonisation goals would require the adoption of a mix of fuels, with relative weights of different fuels being

unclear at the current stage. A one-size-fits-all solution is unlikely. On the contrary, a flexible approach should be expected, as per Esau (2022). As global disparities in access to carbon-neutral energy sources are expected to remain, the preferred fuel is projected to vary across ship types, ship sizes, and trade routes. Therefore, DNV (2022) notes that no industry is in possession of sufficient resources to decarbonise solo – coordination between global industries is crucial for success. Shipping's fuel market is expected to become more diverse but there is no consensus regarding dominant fuels and technologies yet, although various scenarios were proposed in the literature. It can be assumed that future energy mix in shipping may become another manifestation of asymmetry.

Current LNG's popularity is additionally driven by the fact that substantial investment is required to develop renewable energy solutions which satisfy the three boundary conditions illustrated in Figure 3.8. Carbon-neutral fuels require considerable amount of capital investment to increase production capacity, set up reliable distribution channels, and develop appropriate bunkering infrastructure (Ap Dafydd Tomos *et al.*, 2024; DNV, 2022). Since these developments will take time, alternative solutions are being considered for the transition phase. The introduction of carbon capture and storage (CCS) facilities is one of them.

Energy efficiency initiatives represent another focus area. Ultimately, these technologies offer direct benefits to shipowners through reduction of fuel consumption and operating costs, thereby improving cash flow. According to the estimations, such solutions may reduce fuel consumption by 4–16% by 2030 (DNV, 2024), confirming previously presented projections that global oil demand may peak in this period.

On the other hand, full-scale decarbonisation presupposes the development and piloting of new technologies; therefore, it remains a capital-intensive undertaking. Although shipboard energy optimisation equipment offers long-term savings for shipowners and environmental benefits for the entire humanity, its implementation

often requires significant upfront capital investment and may carry additional operational and financial risks for shipping companies. Some of them may be due to fluctuations in the prices of alternative fuels. Thus, it can be concluded that as shipping decarbonises, the cost of maritime transport services is expected to increase across all shipping segments in the medium term.

These additional costs may be asymmetrically transferred to end consumers through higher freight rates and final product prices. In such a scenario, it is worth assuming that the overall growth of the freight market may be spilled over to the other shipping markets. For example, prices for newbuildings and compliant second-hand ships may increase. In contrast, non-compliant vessels are likely to depreciate to scrap value, despite the overall growth in the industry.

As regulatory requirements for vessels compliance continue to tighten, the freight market is expected to be additionally driven upwards by supply-side constraints in the short to medium term. Accordingly, the market capitalisation of compliant shipping companies across various sectors is also likely to increase in the medium term. As vessels are the core assets of shipping companies, ongoing structural shifts in global fleet composition and the adoption of modern, capital-intensive technologies are expected to support long-term upward trend in shipping stock prices under the assumption that listed companies take active steps to decarbonise the owned fleets.

Once a critical mass of the world's fleet is modernised and new technologies start to deliver operating costs savings, the freight rates, as well as second-hand and newbuilding vessel prices, are expected to stabilise or even decline in the long term. Such kind of transition reflects a typical innovation cost curve (McConnel, Brue and Flynn, 2009, pp. 168; 11W-10): efficiency improvements, economies of scale, and various costs reductions gradually offset the initial capital intensity of the initiative. Thus, it is worth assuming that overall freight rates are likely to decrease in the long term. In parallel, as most of the modern vessels are expected to be compliant with

requirements by that time, the market capitalisation of shipping companies which operate low-emission fleets is expected to remain high, even if shipping transportation costs decline (Zaidman, 2025a).

Another important factor influencing the present and future shipping strategies is digitalisation. Digitalisation and decarbonisation represent two major megatrends. They are closely interrelated, and the literature introduced the term “digitainability” (Lichtenthaler, 2021). Digital technologies in shipping include big data analysis, blockchain technologies, remote monitoring, autonomous navigation, AI-assisted route planning (Zeng *et al.*, 2025). These solutions change and improve how shipping companies operate vessels and plan the schedule of their deployment, as well as investments in fleet maintenance and renewal. From the economic perspective, digital instruments improve decision-making, planning, operational efficiency, and reduce costs. They are expected to contribute towards the future maritime economic landscape in line with the above forecasts. Importantly, both megatrends show a need for market participants to shift the mindset – from a focus on pure cost optimisation to long-term sustainable development driven by innovative solutions.

In addition to the above factors, financial frameworks are noteworthy for their enhanced role in determining the future state of the shipping industry. The historical periodisation of shipping finance presented in Section 1.1 and Table 1.2, as well as in the subsequent analysis, enabled identification of the seventh and eighth phases of shipping finance (Zaidman, 2025a). Table 3.1 presents these findings, highlighting recent trends and systemic changes that define the new phases of shipping finance.

The seventh phase of shipping finance was marked by rapidly increasing popularity of public listings among shipping firms observed since the late 2000s. Within traditional bank lending, the European banks lost positions mainly to the Chinese ones. The primary funding tools of shipping companies overall shifted from bank credits towards issuance of stocks (mainly IPO) and high-yield bonds. Leasing

developed as a shipbuilding financing method. The decrease in freight rates during and after the global financial crisis led to massive insolvencies, loan defaults, and collapse of German KG funds. The latter turned out to be effective merely during the positive growth regime and did not sustain the first lengthy trough in the freight market. These factors coupled with the introduction of the Basel III banking principles, which both made the overall regulation of banking activity more stringent and access to capital by smaller owners more complicated, supported the transition in shipping finance (Kopylova, 2024; Zhykharieva *et al.*, 2023, p. 177; Merikas, Gounopoulos and Nounis, 2009; Cullinane, 2005, p. 7).

Earlier, only the limited number of the U.S.-based transport companies engaged into listing in the global equity markets to acquire funds (Kavussanos and Marcoulis, 2005, p. 124). As of 2024, there were more than 120 listed shipping companies operating in the dry bulk sector only (Melas and Michail, 2024). At the beginning of 2026, the number of listed shipping firms operating across all sectors exceeded 500 (GuruFocus.com, 2026). The significant increase in public listings of shipping companies underscores the importance of incorporating equity indicators, including the market capitalisation of shipping companies, into shipping research.

Shipping stocks differ from stocks of companies operating in other service or industrial sectors. As a rule, the price of an IPO is based on a company's net asset value (Merikas, Gounopoulos and Nounis, 2009). For shipping companies, vessels are the core physical assets which determine the company's value, while the price of each vessel on the second-hand market fluctuates according to the stage of the shipping cycle and vessel's specific characteristics (Stopford, 2009, p. 98). These fluctuations do not necessarily reflect the company's income or cash flow at a given time.

The eighth phase of shipping finance began in the late 2010s. It mainly reflects a new financial paradigm in shipping, driven by the decarbonisation agenda and the introduction of the Poseidon Principles in 2019. As of March 2026, 36 leading banks,

collectively covering around 80% of global shipping portfolios, joined this initiative. The principles oblige financial institutions to assess, monitor and disclose the information about the vessels under their financial coverage. Therefore, banks are not only expected to provide transparent reporting but also be jointly accountable for the environmental performance of their shipping clients (Poseidon Principles, n.d.).

In essence, lenders no longer just observe but actively participate in the shipping decarbonisation process. While the Poseidon Principles strengthen the contribution of the financial sector to the global climate agenda, they also create barriers to capital access, particularly for shipping companies operating older or less efficient vessels. In practice, this leads to higher financing costs and a lower level of lending flexibility, which in turn confirms earlier projections that general freight rate levels may tend to grow in the medium term. The increased prices of modern vessels will require higher investments from shipping companies, while access to capital becomes more difficult (Zaidman, 2025a). In 2024, the average score under the Poseidon Principles was below the minimum and desired trajectories (BRS Shipbrokers, 2025a). This highlights the significant gap between current fleet performance and long-term climate goals.

Table 3.1

Contemporary phases of shipping finance

Phase	Name	Period	Key characteristics	Freight market context
Phase 7	Listing	Late 2000s – mid-2010s	Massive rise in public listings of shipping companies	Spike in freight rates by 2007-2008 and subsequent decline
			Reduction in bank financing	
			Active use of leasing in financing shipbuilding	
Phase 8	Decarbonisation	Late 2010s – present	Introduction of the Poseidon Principles with increased focus on vessels' environmental performance	Freight rates following regular cyclicity, impact of geopolitical instability
			Rise in secondary and non-public offerings	
			Increased direct lending	

Source: Developed by the author

In addition, the shipping industry continues to adopt innovative alternative funding methods. In contrast to the seventh phase, IPO gave way to secondary public offering (SPO), follow-on public offering (FPO) and private, non-public, offering as the most popular tools. While the share of bank credits in financing new vessel orders continued to decline (42% in 2023), direct lending gained momentum in shipping due to its flexibility and higher security, since non-bank lenders do not operate within a highly regulated banking framework, being more prompt in decision-making as far as large-scale deals are concerned (Kopylova, 2024). It is worth mentioning the increasing role of geopolitical uncertainty during the eighth phase.

At the level of a specific market, according to the models presented in Chapter 2, it is advisable to consider additional factors apart from the general trends outlined in this section. For example, monetary policy plays and may further play an influential role, particularly in the dry bulk market. Since ongoing global instability is expected to continue to drive fluctuations in interest rates, this may directly impact dry bulk freight rates. In contrast, in the oil tanker sector, intensified pressure of inflation and oil prices on freight market dynamics may be expected.

The market capitalisation of shipping companies is expected to remain dependent on individual factors. Nevertheless, as demonstrated by the modelling outcomes, the freight rates influenced market capitalisation of the majority of analysed companies in both the dry bulk and oil tanker segments, and given the projected increase in freight rate levels, it is reasonable to anticipate a growth in MCAP indicators at least in the middle term.

The outlook presented above covers the course of global decarbonisation with associated implications for shipping under the main scenario. For comparison, it is also worth considering alternative high-level scenarios which may modify the environmental development trajectory that humanity (and the global shipping industry as a part of global economy) has already begun to follow. Table 3.2 summarises major

characteristics of three alternative decarbonisation scenarios, as well as their reflection on the development of the global shipping industry.

Table 3.2

Alternative environmental scenarios for international shipping

Scenario	Dominant policy of	Energy transition	Fuel mix	Key policy characteristics	Shipping implications
Selective decarbonisation	the USA	Uneven	Fossil fuels and LNG prevail	Protectionism and tariffs; sanctions; climate deregulation	Fleet control; transport costs fluctuate within the regular cyclicity; long-term transport cost reduction and international seaborne trade volumes growth
Enforced decarbonisation	the EU	Rapid	Accelerated widespread development of clean alternatives	Circularity; targets on climate neutrality; intensified monetary pressure	Emission taxation mechanisms; compliance implies higher transport cost; increased freight rates; compliant vessels shortage; reduction in international seaborne trade volumes
Controlled decarbonisation	China	Moderate	Reliance on conventional fuels with gradual low-carbon development	Priorities of long-term stability, national food and energy security; central control over supply chains	Relatively stable indicators of shipping markets; market-driven freight rates and vessel prices; moderate international seaborne trade growth

Source: Developed by the author

Under the U.S. hegemony in the global policy, particularly in institutional sphere, the global decarbonisation route turns into selective decarbonisation with uneven energy transition trajectory. This inconsistency implies the solidified role of traditional

fossil fuels and LNG in global energy consumption, with limited adoption of alternative greener sources. Prevalence of protectionism, tariffs, sanctions, trade wars, and deregulation steps in various sectors, including environmental (USEPA, 2026; Executive Office of the President, 2025), are referred to as pillars of this type of policy that may manifest in shipping in the form of heightened fleet control, with transport costs fluctuating in accordance with the standard business and shipping cycles. Deceleration of initiatives under the Paris Agreement, suspension of implementation of emission pricing mechanisms for shipping companies (Adjin, 2025; U.S. Department of State (DOS), 2025) may result in the long-term downward trend for transportation costs with potential acceleration in international seaborne trade volumes through increased competition and variety in sea transport services market.

In contrast, the global dominance of the EU policies may intensify the existing trend and further strengthen the current global environmental agenda as a non-negotiable element of further economic development wherein climate regulations are enforced through high-level emission-control objectives supported by ambitious targets with regular checkpoints on progress in all sectors of the global economy (UNCTAD, 2025; European Commission, n.d.). On the one hand, accelerated pace of energy transition, as well as development and acceptance of alternative fuel types, are expected to be established as the key prerequisites for the concepts of circularity and climate neutrality, underscoring the world's strong commitment to the Paris Agreement. On the other hand, this scenario implies a risk of slower global economic growth. High decarbonisation compliance levels may be achieved through intensified pressure and monetary levers that, in the shipping context, may emerge as emission taxation, penalty schemes, surcharges and other instruments, making non-compliance a more costly and operationally constrained option than strict adherence to. Due to a rupture between compliant vessels supply and trade demand, this scenario presupposes a higher increase in transportation cost and freight rates compared to the main trend scenario. Another

core difference between the enforced decarbonisation and the main scenario lies in the projection of middle- to long-term reduction in international seaborne trade, as more stringent regulations may make more vessels obsolete and extend the time required for supply to adjust accordingly.

Turning to the China's supremacy in the global policy, the shift towards controlled decarbonisation course is projected, with the middle-term reliance on traditional energy sources and gradual exploration of low-carbon opportunities. Under this scenario, the energy transition approach suggests an action plan wherein the wide adoption of alternative fuels only follows comprehensive validation and high confidence in the ability of alternatives to replace conventional fuels at the required scale (www.gov.cn, 2025). Until such robustness is proved and visible, the risks mitigation and long-term stability of global supply chains, including national food and energy security, remain the core postulate and governing principle of the policy. For higher alignment across countries, developing economies may get additional support on their decarbonisation pathway to achieve greater autonomy. The behaviour of the major shipping economic indicators – freight rates and vessel prices – is expected to demonstrate relative stability in the long term and fluctuate based on the market fundamentals along with moderate growth in international seaborne trade.

While these alternative scenarios contrast to the general trend observed at this stage and prevailing IMO-based projections to a different extent, it is noteworthy that the above listed trajectories present the main alternative pathways and do not exhaust the entire range of possible alternative scenarios for global decarbonisation and, subsequently, international shipping.

All things considered, shipping in its current condition needs to withstand geopolitical, macroeconomic and environmental challenges and risks. At present, decarbonisation is not merely a regulatory framework, but a major trend and a signification of a new era which started to transform the shipping industry. Nonetheless,

the positive, although asymmetric, outlook for international seaborne trade underscores the importance of maritime transport for the world economy and global prosperity and suggests that shipping must develop reliable strategies to satisfy the evolving global standards and become more environmentally friendly and innovative. The main scenario projections imply that as a result of this adaptation, the cost of maritime transportation service increases in the medium term before stabilising in the long term. In order to retain compliant and competitive positions, shipping companies' strategies should take into account a need to invest significant capital in new technologies, equipment, and low-emission fuels, while the capital itself becomes less available and more expensive for shipping.

3.2. A maritime competitive advantage strategy for Ukraine in the context of modern international seaborne trade

Decarbonisation and digitalisation as the two megatrends define the present and the future of the global shipping industry. Their implementation presents both challenges and opportunities for emerging maritime economies such as Ukraine. At present, Ukraine remains in the process of integration into the global maritime transport market, and the development of this process was significantly hampered by the war outbreak in 2022. This integration includes two elements: first, increasing the role of Ukraine in international seaborne trade and flows of goods; and second, strengthening the position of Ukraine in the international maritime transport services market.

Such integration should consider a wide range of political, environmental, social and surely economic factors which impact the development of a competitive maritime transport sector. Effective entry into the global transport system is a strategic direction for the national economic growth of Ukraine, as it stimulates the inflow of investment,

development of infrastructure, higher competitiveness, and job creation. Therefore, seaborne trade and shipping are also the important contributors to socio-economic development and international cooperation of the country.

Successful integration into any global market requires strategic planning, assurance of compliance with international standards, and cooperation with international institutions, and seaborne trade market is no exception. Seaborne trade represents a significant source of public revenue, mainly via tax income, which contributes to the growth in GDP and strengthens the country's balance of payments. Further development of the maritime sector fosters establishment, growth, productive operations and ultimate economic success of small and medium-sized enterprises which are crucial for the economic stability of any country.

At the international level, the benefits which Ukraine may gain after successful integration into the global maritime transport system include but are not limited to higher investment attractiveness of the country and its improved connectivity, new potentially lucrative trade agreements with international partners and other various economic opportunities. However, the process of Ukraine's integration into the global shipping industry is accompanied and hindered by several challenges: the need to diversify exports, qualitatively improve the transport services, modernise both port and shore infrastructure, and eventually establish an investment-friendly environment. This section of the thesis focuses primarily on the trade of goods transported by sea and trade in maritime transport services. The port facilities are not analysed in detail but are mentioned for the context where relevant.

According to the data from the NBU (2025), Ukraine's economy was characterised by a permanently negative trade balance over the 2005–2024 period. As shown in Figure 3.9 (and supported by Appendix D, Table D.3), 2005, 2006, 2009, 2015, 2020 and 2021 are the years with the lowest deficits of trade – in the range from USD 2.2 billion to 6.9 billion. In 2020 and 2021, the low deficits can be explained by

the lockdown measures in response to the COVID-19 pandemic. The other years of alleged improvement were not driven by an increase in exports but rather by a decrease in imports and fluctuations in global commodity prices due to economic crises. At present, Ukraine experiences a particularly significant trade imbalance. In 2023, the trade deficit amounted to almost USD 30 billion and exceeded this level in 2024.

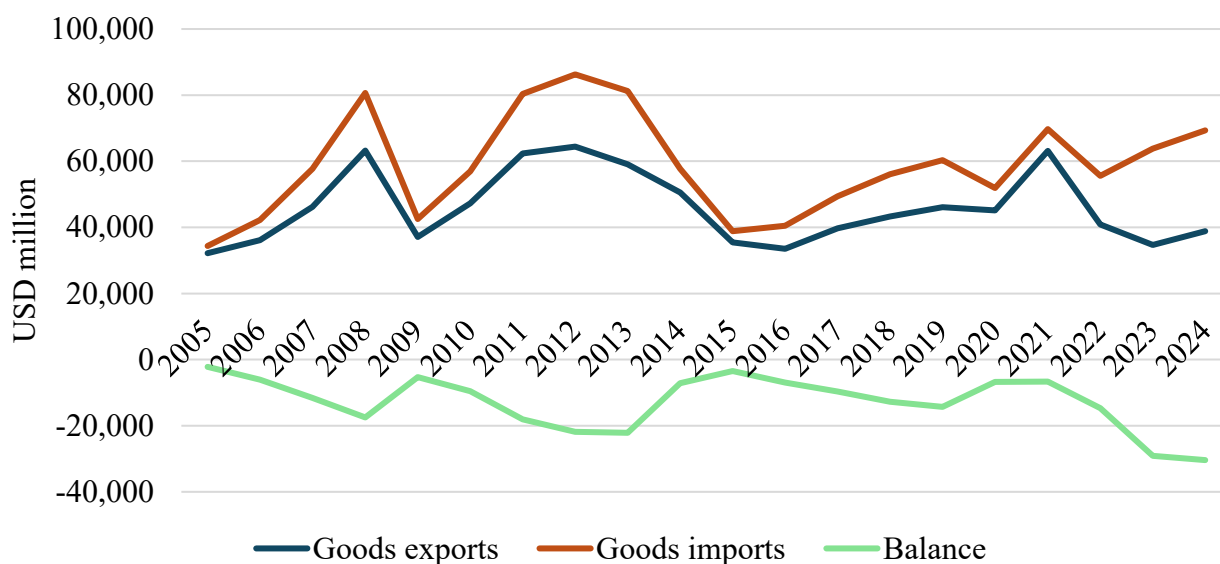


Fig. 3.9. Dynamics of Ukraine's foreign trade in goods

Source: Calculated and compiled by the author based on data from the NBU (2025)

It is worth mentioning that asymmetries are observed in the goods exports from Ukraine and its structure significantly changed over the last 20 years. In 2005, metals accounted for 43% of total export volumes, followed by agricultural products, minerals, and chemicals, with each group comprising between 11% and 13%. In 2024, the total value of Ukraine's goods exports exceeded USD 38 billion. Agricultural products accounted for over 60%, ferrous and non-ferrous metals for over 11%, and mineral products – over 8% (see Appendix D, Tables D.4, D.5). This structural shift demonstrates how the ongoing war impacted Ukrainian exports, as metallurgical industry is mainly concentrated in the eastern regions of Ukraine, which are heavily affected by the hostilities. In respect of grain, the Black Sea Grain Initiative and the EU's Solidarity Lanes played an important role in stabilising grain exports and

supporting Ukraine's trade and economy overall (Tuliakov, Yakubovskiy and Truba, 2024; UNCTAD, 2024; UNCTAD, 2023).

For further analysis, it is important to evaluate how Ukraine is positioned in the global trade market. It should be noted that the data used to assess Ukraine's exports and imports values at international scale are retrieved from the UN Comtrade. The figures presented in this international source (UN, 2025) slightly differ from the data published by the Ukrainian officials – the NBU (2025) and the State Statistics Service of Ukraine (2025). Nonetheless, the difference in annual values remains within a 5% margin (with the only exception of 2024), which is considered acceptable for analysing general trends. Furthermore, the trends are consistent across all sources consulted.

According to the UN (2025), Ukraine constantly improved its position in the global grain export market and progressed from the eleventh place in 2005 to the fourth place in 2021 in terms of total grain export value. Before the war, Ukraine accounted for around 9% of the world's grain exports and thereby was a key contributor to the food security of different countries in North Africa and the Middle East. Evidently, Ukraine's position deteriorated in 2022 and 2023, but the country was able to regain momentum in 2024, mainly due to the establishment of the workable and safe sea corridor. As a result, in 2024, Ukraine became the third-largest grain exporter in the world after the United States and India. These data clearly illustrate one of the competitive advantages of Ukraine. Furthermore, in 2024, Ukraine occupied the fourth place in the global exports of oil seeds and oleaginous fruits. With respect to the exports of ores, slag and ash category, Ukraine reached the ninth place in the world.

In 2024, the value of Ukrainian goods imports exceeded USD 69 billion. As opposed to the exports, the structure of Ukrainian imports remained relatively stable over the last 20 years and did not undergo significant shift. The most noticeable change is related to mineral products whose share shrank from 29% to 13%. In 2024, machinery and equipment (35%) and chemicals (17%) were the major groups of

Ukrainian imports (see Appendix D, Tables D.6, D.7). The structures of exports and imports reflect the imbalance and asymmetries in Ukraine's foreign trade which heavily impact the Ukrainian economy overall. While exports from Ukraine mainly consist of raw materials and intermediate goods with relatively low technological intensity, imports in Ukraine mostly include high value-added and technology-intensive products, and energy resources.

Given such structural composition, Ukraine's foreign trade is imbalanced and demonstrates sensitivity to fluctuations in global commodity prices and various economic shocks. In order to reduce this vulnerability and increase international competitiveness of the Ukrainian economy, production processes in Ukraine require complete modernisation while economy overall needs to become more innovative. In line with this goal, Ukraine's export strategy identifies several sectors which require support and development on a priority basis. These sectors include the manufacturing components for the aerospace and aviation industries, mechanical engineering, and the food and beverage sector (Tuliakov, Alekseevskaya and Yakubovskiy, 2023; Kozak and Fedoruk, 2021). In terms of economic structure, Ukraine is closer to the members states of the Visegrad Group rather than to the countries of Western Europe. The experience of the former demonstrates that FDI has asymmetric influence. FDI can drive country's export growth in the short and medium term, while to gain further economic benefits from FDI, the country needs to undergo fully-fledged structural transformation towards a knowledge-intensive economy (Lomachynska *et al.*, 2020).

The EU is the key trading partner of Ukraine. Existing research confirms significant contribution of the EU–Ukraine trade to Ukrainian GDP growth regardless of recent logistical challenges and import restrictions imposed by the EU with the aim to support domestic European producers. After the signing of the EU–Ukraine Association Agreement, the EU's share in Ukraine's foreign trade increased roughly from 30% to 40% (Tuliakov, Yakubovskiy and Truba, 2024), and further increased in

2022, reaching nearly 60% in exports and over 50% in imports. The major importers of Ukrainian goods are Poland, Spain and China while Ukraine imports the highest volume of goods from China, Poland and Germany (see Appendix D, Tables D.8, D.9). Apart from top exporters and importers, Turkey, Italy and the United States are also important foreign trading partners of Ukraine (NBU, 2025). Regarding Poland, it is important to note that, according to the research, a considerable portion of Ukrainian exports to Poland is not entirely consumed in Poland, as Poland also performs a function of a transit hub for goods which are exported from Ukraine to those EU markets which are located further (Tuliakov, Yakubovskiy and Truba, 2024).

From the perspective of seaborne trade, Ukraine's role in the global maritime transport industry can be enhanced by increasing both exports and imports transported by sea and irrespective of the product type. As discussed in earlier sections, the dry bulk segment is the largest shipping sector in terms of both volume of seaborne trade transported and fleet capacity and is projected to retain strong positions in the long term. This is a positive projection for Ukraine whose major groups of exported goods and some of imported goods (agricultural products, metals, minerals) fall within the dry bulk category transported by dry bulk carriers.

To evaluate the level of importance of seaborne trade for the economy of Ukraine at the current stage, it is worth assessing the share of seaborne trade in total export and import activities of Ukraine. However, such kind of analysis and accurate assessment of seaborne trade of Ukraine present a complex task due to limited availability of country-specific data and differences in methodologies adopted by different institutions which publish data. For example, data published by UNCTAD and the UN Comtrade provide a comprehensive overview of global trade statistics; however, the disaggregation of total trade value by the mode of transport is not always available, particularly in case of Ukraine. The Ukrainian official resources also publish data with limitations. For instance, the NBU does not provide separate statistics on seaborne trade

volumes. In contrast, the State Statistics Service of Ukraine published data of goods exports and imports broken down by transport mode only for 2022 and 2023.

Based on these limitations regarding data availability, this PhD study proposes implementation of a two-stage approach to assess the structure and dynamics of international seaborne trade flows where Ukraine is involved. Initially, the official customs data published by the State Customs Service of Ukraine (2023) were used to evaluate the distribution of Ukraine's foreign trade between transport modes and particularly estimate the share of sea transport in total foreign trade volumes of Ukraine. Thereafter, data on volumes of various cargoes handled at Ukrainian sea ports were used as a proxy for seaborne trade flows. Another meaningful caveat related to the data quality worth making is that numbers on Ukrainian total goods exports and imports provided by the NBU, the State Statistics Service of Ukraine, and the State Customs Service of Ukraine do not entirely match. This misalignment may be attributed to the methodological differences and the reliance on different primary data sources for reporting, for example, enterprise reports, banking reports, and customs declarations (Zaidman, 2025b). Nevertheless, these discrepancies do not affect the course of the research. The data provided by all authorities mentioned above remain within the same order of magnitude, making it possible to identify, analyse and generalise main trends.

In addition, the database publicly available on the website of the State Customs Service of Ukraine provides disaggregation of Ukrainian foreign trade data by mode of transport till July 2023 only, later data of 2023 and beyond are unavailable. Nonetheless, the shares of various transport types in Ukrainian exports, imports, and total trade are calculated based on available data. These calculations are summarised in Table 3.3. As shown, sea, railway and road transport modes carry a major part of Ukraine's foreign trade volumes. Therefore, air transport, inland water transport, post, and stationary transportation modes are excluded from the comparative analysis.

As illustrated in Table 3.3, pronounced modal asymmetry is observed in Ukraine's foreign trade. The share of sea transport in Ukrainian exports steadily increased until 2022 and accounted for more than 60%. However, following the outbreak of hostilities, sea transport's share dropped to approximately 40%. The share of sea transport in Ukrainian imports decreased from nearly 20% before the war to 6–8% after the war outbreak. In contrast, the share of road transport in both exports and imports increased in 2022–2023. The share of railway transport in exports also increased, while its share in imports slightly declined.

Table 3.3

Ukraine's foreign trade in goods by mode of transport

Year	2017	2018	2019	2020	2021	2022	2023 Jan–Jul
Total goods exports, USD bn	43.35	47.43	50.18	49.32	68.24	44.8	21.93
By sea transport, USD bn	25.1	27.27	30.54	31.01	42.55	18.01	9.09
<i>Share of sea transport, %</i>	<i>58%</i>	<i>57%</i>	<i>61%</i>	<i>63%</i>	<i>62%</i>	<i>40%</i>	<i>41%</i>
By road transport, USD bn	10.93	12.29	11.99	12.05	15.44	16.35	8.44
Share of road transport, %	25%	26%	24%	24%	23%	36%	38%
By rail transport, USD bn	5.75	6.21	6.05	4.75	8.3	9.37	4.21
Share of rail transport, %	13%	13%	12%	10%	12%	21%	19%
Total goods imports, USD bn	49.54	56.88	60.39	54.03	73.28	59.54	35.66
By sea transport, USD bn	9.04	11.05	13.37	11.29	15.02	3.31	2.8
<i>Share of sea transport, %</i>	<i>18%</i>	<i>19%</i>	<i>22%</i>	<i>21%</i>	<i>20%</i>	<i>6%</i>	<i>8%</i>
By road transport, USD bn	22.29	24.86	26.75	27.05	33.27	35.07	25.93
Share of road transport, %	45%	44%	44%	50%	45%	59%	73%
By rail transport, USD bn	8.35	9.32	8.75	6.27	10.48	7.35	3.28
Share of rail transport, %	17%	16%	14%	12%	14%	12%	9%
Total trade in goods, USD bn	92.89	104.31	110.57	103.35	141.52	104.34	57.59
By sea transport, USD bn	34.14	38.32	43.91	42.3	57.57	21.32	11.89
<i>Share of sea transport, %</i>	<i>37%</i>	<i>37%</i>	<i>40%</i>	<i>41%</i>	<i>41%</i>	<i>20%</i>	<i>21%</i>
By road transport, USD bn	33.22	37.15	38.74	39.1	48.71	51.42	34.37
Share of road transport, %	36%	36%	35%	38%	34%	49%	60%
By rail transport, USD bn	14.1	15.53	14.8	11.02	18.78	16.72	7.49
Share of rail transport, %	15%	15%	13%	11%	13%	16%	13%

Source: Calculated and compiled by the author based on data from the State Customs Service of Ukraine (2023)

Data on total Ukraine's foreign trade in goods suggests that maritime transport was the leading transport mode in moving goods in and out of Ukraine until 2021. In 2022–2023, road transport overtook sea transport and significantly increased its share up to 60% while the share of sea transport dropped to approximately 20%. The share of railway transport remained relatively stable between 11% and 16% during the examined period from 2017 to the middle of 2023 and was not impacted by the disruptions caused by wartime. Figure 3.10 illustrates how the shares of the transport modes in Ukraine's foreign trade asymmetrically developed over the 6.5-year period.

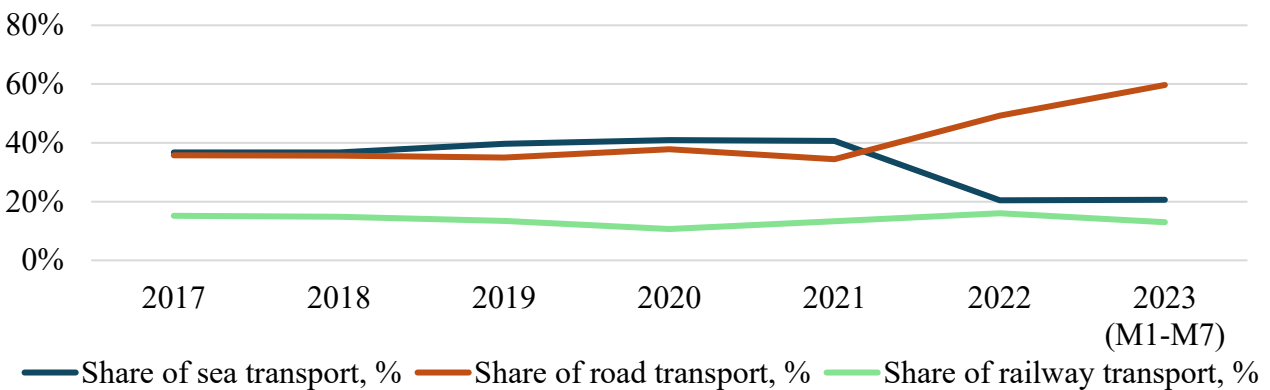


Fig. 3.10. Distribution of Ukraine's foreign trade in goods by transport mode

Source: Calculated and compiled by the author based on data from the State Customs Service of Ukraine (2023)

The structural specifics of Ukraine's foreign trade discussed earlier determine the structure of the Ukrainian seaborne trade as its component. During the research of cargo handling statistics at Ukrainian sea ports as a proxy for seaborne trade flows, it was observed that earlier papers which analysed cargo throughput at Ukrainian sea ports utilised statistical data from the Ukrainian Sea Ports Authority (USPA). However, the hyperlinks mentioned in the reference lists of those studies appeared inactive upon checking (for example, "such page does not exist"). This may be due to the changes in the USPA's website contents which at present contains only recent data on cargo throughput at Ukrainian ports. Historical data can be only retrieved from posts on the USPA's official Facebook page or archived media reports. Therefore, this PhD research

refers to statistical data published by the Centre for Transport Strategies, which presents data in infographic format, including statistics for the wartime period. Additional pre-war data are found on the website of the Department of Maritime Affairs, Transport Infrastructure and Communications of the Odesa Regional State Administration.

Another important note related to the quality of data is worth making before further discussion. Initial publications estimated that sea ports of Ukraine handled 59 million tonnes of cargo in 2022. However, the later reports mentioned 51.2 million tonnes of cargo handled in 2022. This revision can be explained by complexities in collecting data during the first wartime year, although it does not affect the overall trends identified in Ukrainian seaborne trade. Some cells in Table 3.4 do not contain data due to unavailability. Nonetheless, the collected information offers a reasonable basis for analysing the level of Ukraine's integration into the international seaborne trade market and the relevant structural transformations observed during the wartime.

Table 3.4

Cargo throughput at Ukrainian ports

Year	2019	2020	2021	2022	2023	2024
Total cargo throughput, mln tonnes	160	159.1	153.3	51.2	62	97.2
% of world seaborne trade	1.3%	1.4%	1.3%	0.4%	0.5%	0.8%
Grain, mln tonnes	53.9	47.3	49.5	28.8	45.5	60.3
% of world seaborne grain trade	11.2%	9.1%	9.3%	5.6%	8.7%	11.2%
Ore, mln tonnes	37.3	44.2	37.9	N/A	1.9	18.5
Black metals, mln tonnes	16.2	16.6	16.2	N/A	1.7	4.2
Liquid bulk, mln tonnes	N/A	8.4	N/A	N/A	6.3	7.5
Cont., TEU (000s)	1007.4	1048.9	1021.6	N/A	677	129.9
Exports, %	75.6%	77.4%	77.2%	81.0%	90.8%	90.6%
Imports, %	16.1%	14.9%	15.7%	10.5%	8.6%	9.1%
Cabotage/Transit, %	8.3%	7.7%	7.1%	8.5%	0.6%	0.3%

Note: N/A – not available.

Source: Calculated and compiled by the author based on data from Department morehospodarskoho kompleksu, transportnoi infrastruktury ta zviazku Odeskoi oblasnoi derzhavnoi administratsii (2021); Centre for Transport Strategies (n.d.); Clarksons Research (n.d.)

According to the data presented in Table 3.4, the largest volume of cargoes was handled at Ukrainian ports in 2019. However, it is important to note that this record volume still accounted for less than 70% of the overall cargo handling capacity of Ukrainian ports, which was estimated at the level of 230–240 million tonnes at that time (Mihai *et al.*, 2021).

In 2019, the ports of Ukraine handled 18% more cargo than in 2018, reaching an all-time high of 160 million tonnes. This was mainly due to an increase in seaborne export volumes by 22% (Departament morehospodarskoho kompleksu, transportnoi infrastruktury ta zviazku Odeskoi oblasnoi derzhavnoi administratsii, 2021). In 2020 and 2021, the total cargo throughput at ports slightly declined. In 2022, a major decrease occurred as a result of the blockade of Ukrainian sea ports. Nonetheless, more than 50 million tonnes of cargo were handled, including almost 30 million tonnes of grain. The Danube ports played a critical role to sustain Ukrainian maritime industry and handled the highest volume of cargo in the history of independent Ukraine. In 2023, total 60 million tonnes of cargo handled were almost equally distributed between the three Black Sea ports (30 million tonnes) and the Danube ports (32 million tonnes). The situation shifted back in 2024 with the activation of the Ukrainian sea corridor – more than 80% of total seaborne cargo were handled by the ports of Greater Odesa, while the Danube ports' share significantly shrank (Zaidman, 2025b).

In terms of commodity structure, it is highly asymmetric. Grains dominate Ukrainian seaborne trade. Until 2022, annual volumes of iron and manganese ores handled at ports were comparable to grain volumes, but after the outbreak of the war the difference in volumes increased due to the heavy impact of hostilities on the mining industry. According to Table 3.4, in 2022–2024, apart from ores, there was a notable decline in the volumes of black metals and containerised cargo handled at Ukrainian ports. In respect of the liquid bulk cargoes, the volumes remained relatively stable; however, due to the overall decrease of seaborne trade, liquid bulk trade maintained its

share and also improved its position by progressing from the fifth to the second place in cargo throughput at Ukrainian ports in absolute terms. In 2024, 7.5 million tonnes of liquid bulk cargo were handled.

Volume of ore handled at ports partially recovered and reached 18.5 million tonnes in 2024, which accounted for almost 20% of total cargo volume handled at Ukrainian sea ports (still lower than 23% in 2019). In respect of grain trade, it exceeded even the pre-war volumes in 2024 (over 60 million tonnes, which amounted to 62% of total cargo volume). In contrast, black metals and containerised trade did not recover after the war outbreak: the share of black metals accounted for 4% in 2024 (10% in 2019), the share of container transportation shrank from 7.8% in 2021 to 1.4% in 2024 (Centre for Transport Strategies, n.d.).

There is also a shift in the cargo distribution between exports and imports, whose asymmetry even deepened. Before the war, around 77% of the cargo handled at Ukrainian ports was exported. In 2023 and 2024, the share of exports exceeded 90%. Subsequently, the share of imports decreased from 15% pre-war to less than 10%. Cabotage and transit shipments also significantly decreased from 8% to less than 1%. These numbers highlight the changes which occurred after the war outbreak and how these changes reinforce the export orientation of Ukrainian seaborne trade in line with earlier discussed foreign trade structural imbalance. Regardless of the reality that raw materials and low-tech goods dominate seaborne trade of Ukraine, these goods remain indispensable to global markets, underscoring an important role of Ukraine in global exports.

This is supported by data presented in Table 3.4. During the period of 2019–2021, 1.3–1.4% of world seaborne trade volumes in tonnes transited through Ukrainian sea ports. After the war outbreak, this share sharply declined and fluctuated within 0.4–0.8% range during 2022–2024. In world seaborne grain trade, Ukraine managed to sustain its positions, despite all challenges. From approximately 10%, Ukrainian's level

of involvement into world seaborne grain trade declined to 5.6% in 2022 and started to gradually recover, reaching 8.7% in 2023 and 11.2% in 2024. The latter is equivalent to the highest share observed in 2019. It is worth noting that data on global seaborne trade volumes and cargo throughput at Ukrainian sea ports have been obtained from different sources which may use different methodologies of data collection and processing; therefore, the calculations of shares may not be entirely accurate though sufficient to analyse general trends.

In addition to the analysis of Ukraine's trade in goods, including seaborne, it is worth considering trade in services. While the goods trade balance of Ukraine is permanently negative, the services trade balance was positive before the war, as illustrated in Figure 3.11 and supported by Appendix D, Table D.10. The surplus was especially high in 2011 and 2012, while the lowest surplus was recorded in 2016 and 2017. In 2022, due to around 10% decline in services exports and almost twofold increase in services imports, the negative services balance was registered for the first time during the period of 2010–2024. In 2023 and 2024, the deficit persisted; however, it gradually decreased and amounted to USD 5.5 billion in 2024 (NBU, 2025).

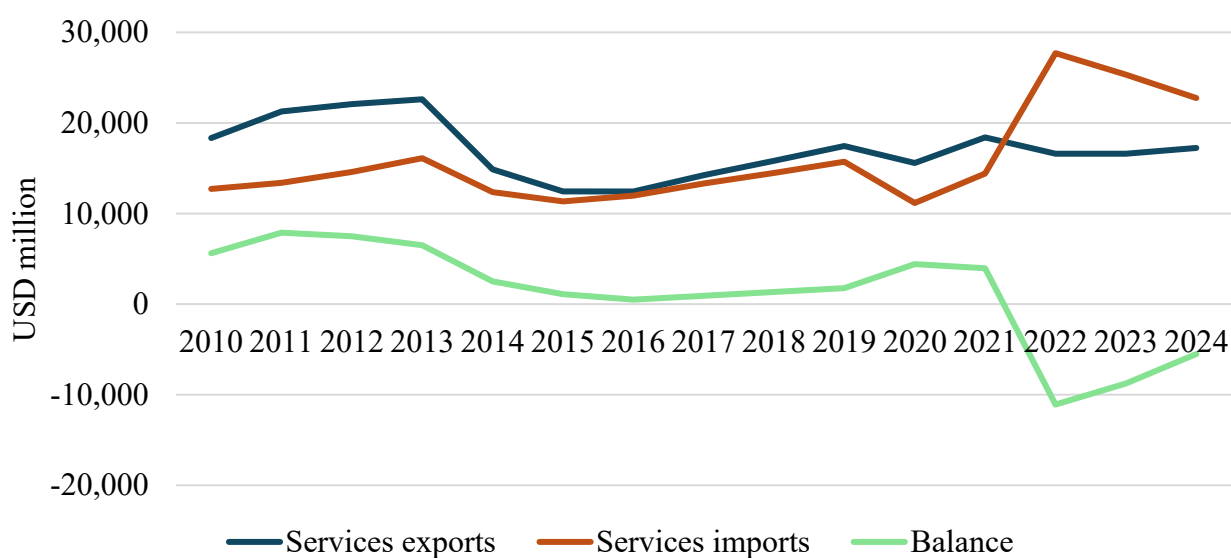


Fig. 3.11. Dynamics of Ukraine's foreign trade in services

Source: Calculated and compiled by the author based on data from the NBU (2025)

It is noteworthy that data published by the NBU includes foreign trade in goods since 2005 while in services since 2010, which explains the difference in periods used for investigation. In 2010–2024, services exports from Ukraine fluctuated within a rather limited range, and the difference between absolute values of 2010 and 2024 falls within 10% margin; however, the structural composition of exports changed significantly (see Appendix D, Tables D.11, D.12). In 2010, the major types of exported services were transport (44%) and travel (21%). Over time, telecommunications, computer and information services gained leadership. This group, largely driven by computer services, increased ninefold in absolute terms (from USD 0.7 to 6.6 billion) and constituted 38% of services exports in 2024 compared to 4% in 2010. Transport services constituted 24% while other business services, which include research and development, consulting, legal, accounting, advertising, accounted for 19%. Travel services' share shrank to 6% (NBU, 2025).

The services imports structure also changed, albeit differently (see Appendix D, Tables D.13, D.14). In 2010, transport (32%) and travel (29%) services were the dominant imports groups, other business services constituted 13%. During the period, the share of transport services imported by Ukraine decreased. In contrast, the travel services' share expanded, notwithstanding a decline during COVID-19. In 2024, 62% of services imported by Ukraine were travel services, transport services decreased to 15%, and other business services accounted for 6% (NBU, 2025). Clearly, asymmetries are intrinsic to both exports and imports of Ukraine's services trade.

The ability to deeply analyse the geographical structure of Ukraine's foreign trade in services is limited due to data availability. The State Statistics Service of Ukraine does not publish data on geographical structure of foreign trade in services. The data published by the NBU is limited – only computer services are broken down by foreign partners. The data on services exports and imports are broadly disaggregated between the EU and rest of the world, although such breakdown is unavailable after

2021. According to the NBU (2025), the EU is the key trading partner in services for Ukraine, and the share of EU countries in Ukraine's services imports is higher than in services exports. The highest imports share (75%) was recorded in 2018, while the highest exports share (35%) was observed several times throughout the period.

While Ukraine's total services trade balance shifted from surplus to deficit in 2022, the balance of transport services remained positive during the period of 2010–2024. However, transport services surplus steadily declined after 2021 and reached USD 780 million in 2024. According to the NBU's methodology (NBU, n.d.), transport services data are compiled based on the banking International Transactions Reporting System (ITRS) and official statistics provided by the State Statistics Service of Ukraine.

Available data for trade in transport services are broken down by mode of transport, including sea, air, rail, road, and other transport, with strong asymmetries observed. The “other transport” category mainly consists of pipeline transport. Inland waterway and specialised technical transport services also fall under the “other” group. Postal and courier services are excluded from this analysis. Thus, in Table 3.5, the sum of the volumes of transport services of the presented types does not match the total value of transport services and the sum of shares does not equal 100%.

The balance of trade in sea transport services gradually decreased during 2010–2024. It turned from surplus to deficit in 2018, and the deficit consistently increased thereafter, reaching almost USD 1 billion in 2024. The share of sea transport in total transport services exports decreased from 15% in 2010 to 12% in 2024. Air transport demonstrated similar dynamics, while the share of road transport services increased from 3% to 20%. This spike can be attributed to the outbreak of the war, as while the other modes of transport were disrupted, road transport turned out to be the most viable option to carry trade flows in and out of Ukraine. The share of rail transport was not affected by the war, as it remained below 10%. The share of other transport in total transport services exports fluctuated between 42% and 55% and was effectively the

largest due to the significance and cost of pipeline transportation services. However, as the gas transit agreement between Ukraine and Russia expired on 01 January 2025, this trend is expected to change in 2025 and beyond (Gak, Stambaugh and Cooban, 2025).

Table 3.5

Ukraine's foreign trade in transport services (TS) by mode of transport

Year	2010	2019	2020	2021	2022	2023	2024
Services exports, USD mln	18,328	17,465	15,564	18,391	16,618	16,602	17,226
TS, USD mln	7,991	6,253	5,089	4,760	3,832	3,789	4,111
<i>TS, % of total services</i>	<i>44%</i>	<i>36%</i>	<i>33%</i>	<i>26%</i>	<i>23%</i>	<i>23%</i>	<i>24%</i>
Sea transport, USD mln	1,232	596	605	616	387	403	503
<i>Sea transport, % of total services</i>	<i>7%</i>	<i>3%</i>	<i>4%</i>	<i>3%</i>	<i>2%</i>	<i>2%</i>	<i>3%</i>
<i>Sea transport, % of TS</i>	<i>15%</i>	<i>10%</i>	<i>12%</i>	<i>13%</i>	<i>10%</i>	<i>11%</i>	<i>12%</i>
Air transport, USD mln	1,176	1,420	803	1,047	423	389	503
Air transport, % of TS	15%	23%	16%	22%	11%	10%	12%
Rail transport, USD mln	1,455	501	406	462	305	353	354
Rail transport, % of TS	18%	8%	8%	10%	8%	9%	9%
Road transport, USD mln	253	338	338	414	865	706	802
Road transport, % of TS	3%	5%	7%	9%	23%	19%	20%
Other transport, USD mln	3,647	3,277	2,789	2,051	1,792	1,875	1,892
Other transport, % of TS	46%	52%	55%	43%	47%	49%	46%
Services imports, USD mln	12,712	15,715	11,164	14,420	27,703	25,346	22,749
TS, USD mln	4,083	2,516	1,920	2,834	2,482	2,939	3,331
<i>TS, % of total services</i>	<i>32%</i>	<i>16%</i>	<i>17%</i>	<i>20%</i>	<i>9%</i>	<i>12%</i>	<i>15%</i>
Sea transport, USD mln	965	826	838	1,360	1,262	1,215	1,455
<i>Sea transport, % of total services</i>	<i>8%</i>	<i>5%</i>	<i>8%</i>	<i>9%</i>	<i>5%</i>	<i>5%</i>	<i>6%</i>
<i>Sea transport, % of TS</i>	<i>24%</i>	<i>33%</i>	<i>44%</i>	<i>48%</i>	<i>51%</i>	<i>41%</i>	<i>44%</i>
Air transport, USD mln	952	854	374	644	276	228	353
Air transport, % of TS	23%	34%	19%	23%	11%	8%	11%
Rail transport, USD mln	1,487	470	345	429	290	404	417
Rail transport, % of TS	36%	19%	18%	15%	12%	14%	13%
Road transport, USD mln	654	231	275	274	509	695	646
Road transport, % of TS	16%	9%	14%	10%	21%	24%	19%
Other transport, USD mln	21	116	60	71	116	173	206
Other transport, % of TS	1%	5%	3%	3%	5%	6%	6%

Source: Calculated and compiled by the author based on data from the NBU (2025)

As shown in Table 3.5, the share of sea transport in total transport services imports of Ukraine is much higher compared to exports. It increased from 24% in 2010 to 44% in 2024, while the peak was recorded at 51% in 2022. The share of air transport services in imports fluctuated between 23% and 35% until 2020 and sharply decreased thereafter due to the COVID-19 pandemic and the war. Rail transport followed a similar downward trend, while road transport demonstrated opposite dynamics and increased its share in 2022–2024. The share of other transport in services imports is rather low.

A closer examination suggests that in the dataset published by the NBU (2025), Ukraine's sea transport services trade is categorised into passenger, freight and other. Absolute values in USD and shares of each category in both exports and imports are presented in Table 3.6. It is worth mentioning that the structure of Ukraine's foreign trade in sea transport services remained stable during the entire period of 2010–2024.

Table 3.6

Ukraine's sea transport services trade by type

Year	2010	2019	2020	2021	2022	2023	2024
Sea transport services exports, USD mln	1232	596	605	616	387	403	503
Passenger, USD mln	4	0	0	0	0	0	0
Freight, USD mln	48	37	35	43	32	26	19
Freight, % of sea transport services	4%	6%	6%	7%	8%	6%	4%
Other, USD mln	1180	559	570	573	355	377	484
Other, % of sea transport services	96%	94%	94%	93%	92%	94%	96%
Sea transport services imports, USD mln	965	826	838	1360	1262	1215	1455
Passenger, USD mln	0	1	0	1	0	0	0
Freight, USD mln	850	690	704	1128	1057	1033	1245
Freight, % of sea transport services	88%	84%	84%	83%	84%	85%	86%
Other, USD mln	115	135	134	231	205	182	210
Other, % of sea transport services	12%	16%	16%	17%	16%	15%	14%

Source: Calculated and compiled by the author based on data from the NBU (2025)

As shown in Table 3.6 and Appendix D, Table D.15, passenger category constitutes an insignificant portion of sea transport services and is effectively negligible for both exports and imports. As regards freight sea transport services (the category which represents cargo transportation), their share in sea transport services exports is less than 10%; however, in imports, it is incomparably higher – consistently more than 80%. According to the methodology document published by the NBU on its website, “the procedure of accounting of freight transport is based on the single principle of cost estimates of goods – at FOB [Incoterms – Free on Board] prices” (NBU, n.d.).

In contrast, other sea transport services account for approximately 15% of imports, but completely dominate in exports (over 90%). While the balance of freight sea transport services was constantly negative, the balance of other sea transport services was permanently positive during the period of 2010–2024. It is important to note that, while passenger and freight categories are self-explanatory, the official methodology of the NBU (n.d.) does not specify which components are included into “other” sea transport services. In order to clarify this, an official enquiry was submitted to the NBU. According to the response, other sea transport services include freight forwarding, warehousing, cargo loading and unloading, services which support maritime infrastructure, pilotage, agency services related to passenger and freight transport, commission fees. According to the IMF (2014) classification, these types of services fall under “other auxiliary services related to the transportation”.

Data presented above underline the condition and specifics of Ukrainian maritime industry, which are clearly determined by the structural characteristics of the Ukrainian economy discussed earlier. While the vast majority of cargo volumes handled at Ukrainian ports is exported, exports of sea transport services are dominated by “other” services rather than freight services themselves. In contrast, freight sea transport services dominate sea transport services imports, while only between 9% and 16% of cargo throughput at Ukrainian sea ports are imported by Ukrainian consumers,

as per Table 3.4. This asymmetry in seaborne-related foreign trade activities highlights the specific role of Ukraine in the global maritime system.

As national merchant fleet in Ukraine is limited, this makes it possible to identify another manifestation of asymmetry inherent to Ukraine – fleet asymmetry, which generates certain risks. The majority of international seaborne trade flows where Ukraine is involved is carried out by foreign vessels owned by non-resident shipping companies. In order to arrange for a seaborne transportation of goods from Ukraine, Ukrainian exporters need to purchase transportation service from foreign carriers. Payments for transportation are classified as imports of freight type of sea transport services. In parallel, Ukraine actively provides (exports) auxiliary services to foreign partners whose vessels call at Ukrainian ports. These supportive services are indispensable for maritime transportation and are provided by Ukrainian enterprises to foreign shipping and trade companies. Freight forwarding, cargo storage prior to shipment, cargo loading and unloading operations, quay rental, mooring, towage, pilotage, documentation support, agency and brokerage services provided at Ukrainian ports – all of them fall under exports of other sea transport services, and an ability to provide them constitutes a competitive advantage of Ukraine’s maritime sector.

Therefore, Ukraine as a carrier is unable to generate high revenues from maritime transport; however, it provides a broad range of logistics and port services. In the global shipping ecosystem, Ukraine acts as a service centre, offering maritime infrastructure for shipping players to realise seaborne transportation. It is important to recognise, factor in and draw on this structural specific when forming actionable national strategies for development of the maritime sector (Zaidman, 2025b).

Since the European Union is the major trading partner for Ukraine, the Association Agreement between the European Union and Ukraine, signed in 2014 (European Union, 2014), predetermines the development of maritime transport sector in Ukraine. Subsection 7 of the Agreement is titled “Transport services” and includes

Article 135 “International maritime transport”. This article contains provisions aimed at liberalisation and integration between the parties in the shipping sector, among others:

- “Each Party shall grant to vessels flying the flag of the other Party or operated by service suppliers of the other Party treatment no less favourable than that accorded to its own vessels, or those of any third country, whichever are the better, with regard to, inter alia, access to ports, the use of infrastructure and services of ports, and the use of maritime auxiliary services, as well as related fees and charges, customs facilities and the assignment of berths and facilities for loading and unloading”;
- “The Parties shall apply effectively the principle of unrestricted access to the international maritime markets and trades on a commercial and non-discriminatory basis”;
- “Each Party shall permit international maritime transport service suppliers of the other Party to have establishments in its territory under conditions of establishment and operation no less favourable than those accorded to its own service suppliers or those of any third country, whichever are the better” (European Union, 2014), with the ability to engage in marketing activities, voyage organisation, documentation, and procurement of auxiliary services;
- “Each Party shall make available to service suppliers of international maritime transport of the other Party on reasonable and non-discriminatory terms and conditions the following services at the port: pilotage, towing and tug assistance, provisioning, fuelling and watering, garbage collecting and ballast waste disposal, port captain’s services, navigation aids, shore-based operational services essential to ship operations, including communications, water and electrical supplies, emergency repair facilities, anchorage, berth and berthing services” (European Union, 2014).

The commitments in maritime sector are supplemented by other sections of the Agreement, stipulating the removal of technical barriers to trade. In order to monitor

progress on committed actions, the Cabinet of Ministers of Ukraine established the Pulse of the Agreement (Cabinet of Ministers of Ukraine, n.d.). According to this report (see Appendix D, Figure D.1), as of April 2026, Ukraine fulfilled 89% of obligations related to technical trade barriers. However, in the transport and infrastructure sector, the fulfilment rate is 59% – the lowest after the financial sector and anti-fraud activity.

It is stated that progress was made across all transport modes, including road, rail, aviation, and inland water transport. In the maritime transport, the outstanding obligations were mainly related to the harmonisation of Ukrainian legislation with the EU requirements. These requirements cover the following areas: safety standards for ships and ports, inspection protocols, waste reception facilities, systems for information exchange, and insurance certification control. The existing deviations of Ukrainian legislation from the EU standards represents another asymmetry at the national level.

A recent study, which addressed the reasons why Ukraine lagged behind the transport and infrastructure obligations under the EU–Ukraine Association Agreement, revealed the influence of a combination of factors. Apart from noting the local specifics and power of Ukrainian businesses, the research also suggested that shifting from conventional, purely quantitative compliance metrics towards adoption of additional sector-specific, qualitative approaches may help to understand the root causes of implementation delays. The paper recommended widening stakeholder consultations, improving institutional coordination and increasing public participation in the compliance evaluation process (Rabinovych and Egert, 2023).

In 2021, Decision No. 1/2021 of the EU–Ukraine Association Committee in Trade Configuration amended the initial provisions of the Association Agreement (European Union, 2021). This document reflects an updated framework which regulates the integration of Ukraine into the EU transport area. The amended provisions of the Agreement mainly cover the aspects of tariff liberalisation and trade, transport, and technical standards.

Furthermore, the amendments provide for the alignment of Ukraine's maritime legislation with the EU environmental and digital standards. In addition, the requirement for streamlining logistics and customs processes in Ukraine is mentioned. These changes are intended to generate a number of benefits, namely, improved competitiveness of the shipping sector in Ukraine, attraction of foreign investment into port infrastructure, and integration of Ukraine into the European transport network. In practice, the implementation of these provisions is delayed for an indefinite period as maritime infrastructure of Ukraine is being regularly damaged due to the ongoing war. As a result, the Pulse of the Agreement website does not publish updates related to the maritime sector after 2020, while updates on progress in the transport sector overall and the other modes of transport are available.

Ukrainian researchers reached a consensus that Ukraine's maritime potential has not been fully unleashed yet. According to Mihai (2020), the core obstacles include underdeveloped infrastructure, low-efficient cargo handling processes, and limited adoption of modern technologies. On the contrary, the following advantages are mentioned: favourable geographical location, ability to accommodate deep-draught vessels, availability of land territory to build new and expand existing infrastructure, and proximity to reserves of major raw materials. These strengths are expected to facilitate deeper integration of Ukraine into the global transport system. This integration is projected to increase the competitiveness of Ukrainian port terminals at a global scale, bring local port services in line with high standards, foster innovations, and improve efficiency of operations and quality of service provided (Tuliakov, Alekseevska and Yakubovskiy, 2023).

In order to complete the review of the core regulatory framework in the sector, it is worth noting the following fundamental documents which underpin Ukraine's ambition to further establish and mature as a maritime nation, and which form the basis for a maritime competitive advantage strategy for Ukraine. The Merchant Shipping

Code of Ukraine governs the commercial shipping activity and protects the rights of all concerned stakeholders. The Maritime Doctrine of Ukraine for the period to 2035 was adopted in 2009, then amended in 2018 and 2020, and finally updated in 2025 to expand on the directions of revival of the shipping industry in Ukraine in line with the contemporary global economic and legal trends, including support of local shipping companies, development of competitive fleet, and enhanced participation of Ukraine in the activity of international organisations within the global shipping industry.

Furthermore, the updated Strategy for the Development of Sea Ports of Ukraine for the period to 2038 was adopted. The Strategy is ultimately aimed at attracting investment, optimising port administration processes, adopting and promoting digital and environmentally safe technologies. The port sector is extensively analysed in existing literature due to its significance; however, it falls outside the scope of this research.

While Ukraine acceded to the fundamental international shipping conventions that provide for standards for safety, navigation, collision regulation, pollution prevention, and tonnage measurement (Verkhovna Rada of Ukraine, 2026), in order to fully harmonise with the global leading maritime community, Ukraine also requires to ratify the Maritime Labour Convention (MLC), 2006, which upholds seafarers' rights and decent working conditions (International Labour Organization (ILO), 2024).

In order to integrate into the global maritime transport market, it is recommended that Ukraine should adopt a comprehensive approach and implement a holistic maritime competitive advantage strategy that builds on the core strengths of Ukraine's maritime potential and addresses key weak aspects through suggested mechanisms enabling competitiveness and alignment of Ukraine's maritime economy with evolving global standards. Figure 3.12 schematically summarises the key proposed strategic initiatives, as well as the core expected outcomes of their implementation.

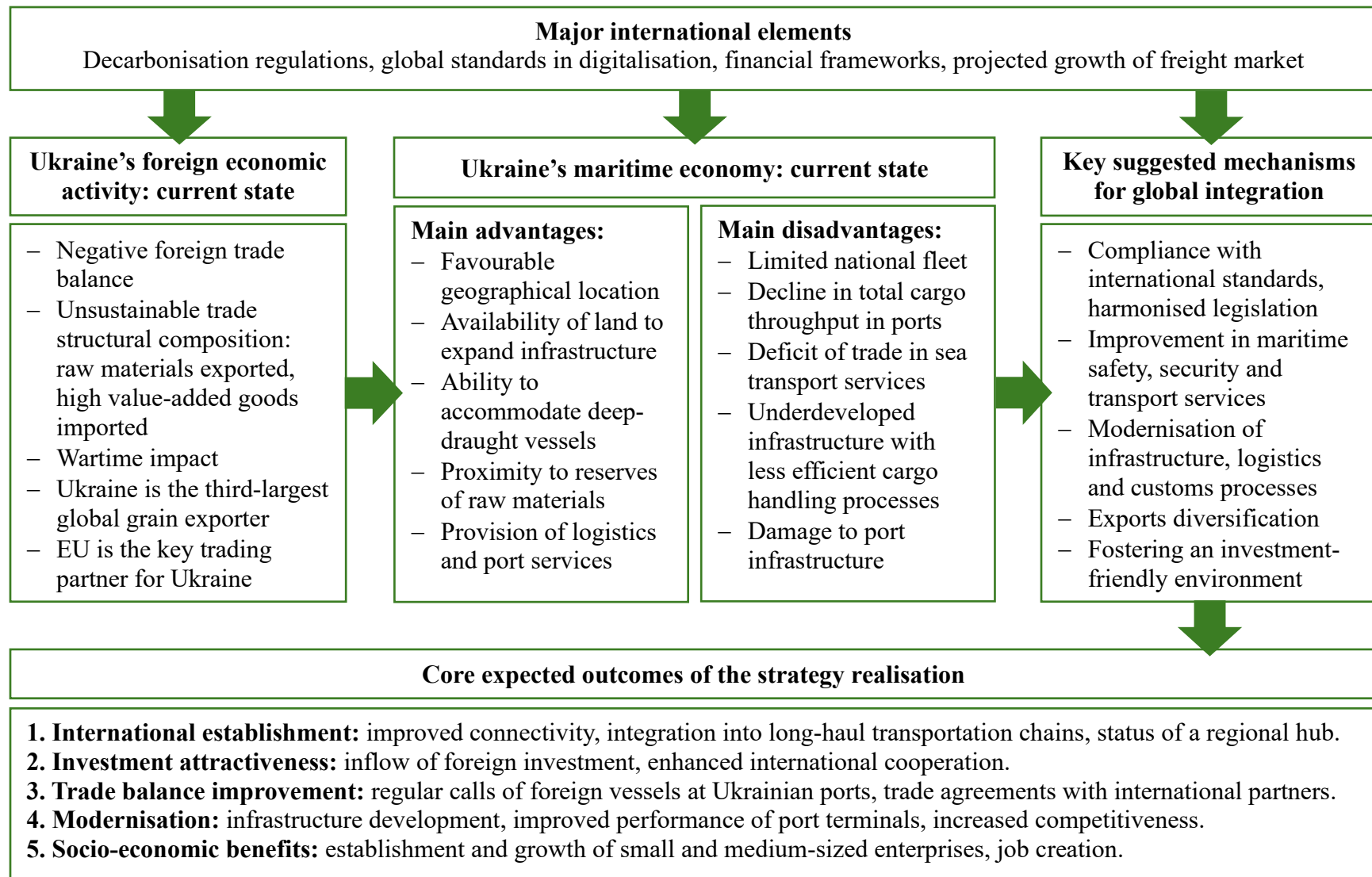


Fig. 3.12. A maritime competitive advantage strategy for Ukraine

Source: Developed by the author

Based on the wartime challenges faced by Ukraine and simultaneously considering the economic importance of maritime sector, it is essential to define medium- and long-term priorities for its development. The cooperation with the EU, the primary trading partner for Ukraine at the current stage, is expected to deepen, as documented by the EU–Ukraine Association Agreement. Moreover, the recent decision to include Ukraine into the trans-European transport network (TEN-T) (European Commission, 2023) highlighted an additional opportunity for Ukraine where the EU can perform a function of an access channel for Ukrainian goods to reach wider European and international markets.

Once closer integration between Ukrainian and European markets is achieved, it may lead to an increase in trade flows, including seaborne ones. It can be assumed that sea transport may recover the volumes lost to road transport due to the war outbreak. Although minor signs of this recovery were recorded in 2024, the progress was limited to only certain categories of goods. The fundamental changes and revival of seaborne trade flows in the medium term imply the reconstruction of port infrastructure and significant improvement in maritime safety and security aspects.

Increase in seaborne trade flows may stimulate higher demand for shipping services. As Ukraine is unlikely to address its fleet asymmetry and significantly expand the national merchant fleet instantaneously, exports of freight sea transport services are not expected to grow. However, more frequent calls of foreign vessels at Ukrainian ports may enhance demand for exports of “other” sea transport services, which is expected to positively contribute to the Ukrainian economy and trade balance.

With regard to imports of sea transport services, it can be assumed that post-war economic recovery and growing national income may support increase in demand for imports of goods, including machinery, equipment, and materials required for construction and reconstruction. It is important to note that an increase in imports of goods and freight sea transport services can be projected under the conditions that sea

transport is cost-competitive with road transport and Ukrainian ports are cost-effective and capable of handling increased cargo volumes.

In this context, it is vital to carefully consider the market outlook. As the global freight market is expected to grow in the medium term, making maritime transportation services more expensive, the value of freight sea transport services imported by Ukraine are projected to increase accordingly. If the value of exported “other” sea transport services lags behind, Ukraine’s trade balance in sea transport services may deteriorate. Therefore, the competitiveness of Ukrainian ports and a favourable environment for Ukrainian maritime transport enterprises gain particular significance.

From among other drivers, it is worth mentioning the creation of an investment-friendly environment and the attraction of FDI and other types of foreign capital into the development of mineral resources. This is expected to stimulate extraction, processing and exports, which may in turn induce demand for sea transport services and increase seaborne trade flows. Moreover, foreign investment could help to address disproportions in Ukrainian economy and diversify its export structure – from primarily grains and ores to a wider range of goods, including critical metals.

Significant investment is also required to rebuild port infrastructure. The modernised infrastructure should be able to accommodate increased seaborne trade flows in and out of Ukraine, as well as to meet the stringent environmental regulations. However, bringing infrastructure in line with evolving decarbonisation standards has a dual effect: while it suggests long-term benefits for the entire maritime sector of Ukraine, the challenges stem from capital-intensity of those initiatives.

Another opportunity worth considering is development of Ukrainian ports into regional hubs involved into long-haul energy and container transportation. In this area, Ukrainian ports are expected to compete with Istanbul, Piraeus, Constanta and others.

At the companies’ level, Ukrainian maritime transport enterprises are recommended to keep abreast of wider market trends, with freight market conjuncture,

evolving environmental standards, and ongoing developments in trade patterns being the key considerations when formulating actionable shipping strategies. It can be assumed that the mentioned trends may determine market competition in the future, as well as raise entry barriers into the industry. In order to sustain market positions and respond to challenges, companies should consider adopting agile strategies and exploring niche markets, for instance, short-sea and feeder trade. Conventional chartering practices of securing long-term contracts with cargo owners should be also prioritised.

Due to the local specifics and limitations mentioned, the global role of Ukraine is not expected to shift from a goods exporter to a carrier in the forthcoming future. Therefore, the following strategic aspects of the future development of the maritime sector of Ukraine are crucial: reinforcement of the significance of Ukraine as a regional hub; provision of a wide range of high-quality and digitalised services; diversification of exports and increase in production of higher value-added goods; modernisation of maritime infrastructure according to the highest standards by attracting foreign investment; short-term increase in seaborne imports to support post-war recovery; and integration into wider long-haul maritime transport chains in the long term.

Conclusions to Chapter 3

Based on the research presented in Chapter 3, the following conclusions have been reached:

1. The shipping industry's ambition and action plan to fully decarbonise by 2050 are documented in the Strategy on the Reduction of GHG Emissions from Ships adopted by the IMO. While the leading international organisations project a long-term shift in global economic leadership from developed countries to EMDEs, this change

is not expected to negatively influence the development of international seaborne trade volume wise. However, as per the core forecast scenarios, the structure of trade is projected to change while retaining asymmetric characteristics. Accordingly, the global fleet is expected to undergo a structural transformation driven by fleet ageing, energy efficiency initiatives and alternative fuels. Future shipping strategies may be defined by both asymmetric dynamics of seaborne trade and decarbonisation.

2. The seventh and eighth phases in the shipping finance history have been identified. The seventh phase is characterised by a high growth in public listings of shipping companies in the late 2000s, thereby highlighting the importance of stock market indicators for shipping analysis. The eighth phase that began in the late 2010s is marked by the focus on vessels' environmental performance and introduction of the Poseidon Principles which have effectively increased the cost of capital for shipping companies and have made financial institutions active participants of the shipping decarbonisation.

3. It has been established that, regardless of savings and environmental benefits, decarbonisation solutions require significant investments from shipowners. Therefore, it is expected that under decarbonisation and higher cost of capital, the cost of maritime transportation, along with prices of compliant vessels, may increase across all segments in the medium term while the cost of non-compliant vessels may depreciate to scrap. The market capitalisation of compliant shipping companies is expected to grow. In the long term, freight rates, as well as second-hand and newbuild compliant vessel prices, are expected to stabilise or even decline, while market capitalisation indicators are likely to continue the upward trend. Where risks arise, a deviation from the main trend scenario is possible in the form of alternative decarbonisation scenarios that vary from the selective and controlled to the enforced decarbonisation depending on the dominant policy within the industry.

4. The key advantages of Ukraine's maritime economy include beneficial geographical location, ability to accommodate deep-draught vessels, availability of land to develop infrastructure, proximity to raw materials, and provision of auxiliary sea transport services to foreign companies whose vessels call at Ukrainian ports. The main disadvantages comprise asymmetric and imbalanced structure of Ukraine's seaborne trade flows determined by imbalances in the foreign trade, limited national merchant fleet, underdeveloped infrastructure and low efficiency of cargo handling processes, as well as impacts of the ongoing war, which made sea transport an overall less viable option compared to road transport.

5. A suggested maritime competitive advantage strategy for Ukraine implies a comprehensive approach towards integration of Ukraine into the global maritime transport market through realisation of core strategic initiatives aimed at addressing the main disadvantages identified. Leveraging on the Association Agreement between the EU and Ukraine, Ukraine is expected to harmonise the legislation with the European standards and comply with the global requirements in various aspects, including decarbonisation, digitalisation, maritime safety and security, and quality of the associated transport services. Modernisation of infrastructure and streamlining of logistics and customs services presents another direction which would allow Ukraine to unleash its maritime potential. Exports diversification and investment-friendly environment may turn beneficial not only for Ukraine's maritime economy but also for the wider economic stability. The proposed mechanisms may help Ukraine to improve its position in international seaborne trade market. The key expected outcomes of the strategy implementation include international establishment, investment attractiveness, trade balance improvement, overall modernisation and socio-economic benefits.

The major findings and outcomes of the research described in Chapter 3 have been reported in the following author's papers: Yakubovskiy and Zaidman (2024); Zaidman (2025a); Zaidman (2025b).

CONCLUSIONS

Based on the results yielded during this PhD research regarding comprehensive examination of development of the global shipping industry under asymmetries in international seaborne trade, the following conclusions have been drawn:

1. A comprehensive analysis of disproportions intrinsic to the international seaborne trade made it possible to refine the definition of asymmetries in international seaborne trade to emphasise their inherent complexity and better capture current trends in the structure and development of international seaborne trade. Examination of the cyclicity in shipping suggests the four-stage pattern of a short shipping cycle that reflects the intersection of demand for vessels' cargo carrying capacity generated by shippers and its supply provided by shipowners, with the latter responding with a delay due to time- and capital-intensity of shipbuilding. This highlights the enduring role of capital in the industry, which has always been crucial, though its accessibility varied, drawing on the changing relationship between financial institutions and shipping companies. Six phases of the history of shipping finance from the 1950s to the 2000s have been identified.

2. The existing literature in maritime economics has been systematised into four broad categories, highlighting the high relevance of market intelligence reports regarding sea transport services and industry reviews in shipping in addition to conventional academic sources – books and scientific publications. A holistic literature review has allowed for identification of the major focus areas of the pertinent research, in particular, examination of trends followed by key shipping economic parameters, including cross-market spillovers; evaluation of the effects of external events on shipping; analysis of the policy implications of energy transition in maritime transport, and elaboration of fleet renewal investment strategies. Key determinants of the freight rates have been identified from a thorough analysis of the factors attributing to the

development of cargo shipping markets. It has also been established that the relationship between stock and shipping markets remains less explored as compared to the research's main focus areas.

3. Comprehensive methodological approaches to studying the dynamics of freight indices in the bulk sector and charter rates in the container sector are suggested through a combination of theoretical and empirical methods. The multiple regression models have been developed to evaluate the relation between freight indices in the dry bulk and oil tanker sectors and a set of key economic parameters that vary across both segments and capture general trends in the real economy and commodity markets, international trade development, global financial markets, including capital and equity markets, and macroeconomic price dynamics. Considering the unique characteristics of the containership segment, for container charter rates, a VAR model has been developed to examine their relationship with the real economy and international trade, as well as the shipping, commodity, and equity markets. The lag factor is introduced where appropriate to enhance the freight modelling outcomes. In addition, multiple regression models have been proposed to assess the dynamics of market capitalisation of shipping companies operating in the bulk sector.

4. The dynamics and structure of cargo maritime transportation have been examined, which allows of outlining the trends in its development, highlighting the profound impact of decarbonisation, and explicitly illustrating sectoral, geographical and product asymmetries as noticeable characteristics of modern international seaborne trade. While the volumes of trade follow an overall upward trend, they exhibit sensitivity to extreme disruptions, such as the financial crisis, the COVID-19 pandemic and the war in Ukraine. Notably, similar trends apply to the dynamics of the world's fleet development. Based on the analysis of global fleet deadweight capacity, as well as seaborne trade volumes in tonnes and in tonne-miles, equal reliability of these

parameters for the evaluation of shares of the major segments within the global shipping industry has been confirmed which enables to enhance the analytical toolkit.

5. As a result of econometric modelling, individual trends and interrelations for each of the analysed shipping sectors are detected, which enables formation of various models of the influence of key economic variables on the selected shipping indicators. For the dry bulk freight rates, interest rates turn out to be the most influential factor, while the freight indices representing the oil tanker sector demonstrate dependence on inflation, and oil prices and oil production levels. Considering high correlation between interest rates and inflation, such a dependence on these parameters makes it possible to partially generalise the performance trend of the dry bulk and oil tanker freight indices. In turn, containership charter rates appear to be predetermined by vessel prices, industrial growth in China and the USA, prices of steel and capitalisation of Maersk company. Furthermore, it has been established that the development of market capitalisation indicators for leading dry and liquid bulk shipping companies is largely individualised and depends on different factors. In the oil tanker sector, certain patterns are identified, in particular a similar behaviour of market capitalisation indicators of companies with relatively similar fleet size or stock market history. Geographical origin does not play a significant role. Based on the results of the modelling, investors that consider inclusion of shipping stocks into their investment portfolios are recommended to apply an individualised approach and adopt a company-based assessment, given that behavioural characteristics among major shipping companies display a limited unification.

6. The research has demonstrated that modern and future shipping strategies are formed under the influence of a combination of factors. According to the core forecast scenarios, a positive projection with regard to global GDP and international trade indicates that the demand for maritime transport is expected to increase in the long term. While asymmetry remains a distinctive feature of global shipping, the

projections suggest structural transformations in international seaborne trade and global cargo fleet, which have to be taken into consideration when setting strategic priorities in shipping. Furthermore, decarbonisation implications and evolving financial frameworks are identified as equally important determinants of strategic decisions at the current stage due to capital-intensity of environmental initiatives. For the shipping industry, the main development scenario implies a continuation of the current general trend, wherein the projections are made regarding strengthened regulations, less available capital, and medium-term growth of all shipping markets with stabilisation in the long term as far as compliant shipping companies and vessels are concerned. Alternative environmental scenarios for international shipping developed in this research diverge from the main trend scenario and presuppose either relaxation or tightening, or different control mechanisms over decarbonisation compliance with subsequent economic impact on global shipping markets.

7. Through systematisation of modern trends in shipping finance, it is suggested extending the existing periodisation of shipping finance from six to eight phases. Through introduction of listing and decarbonisation phases, the extended periodisation factors in and reflects the effects of major recent changes, such as increased public listings of shipping companies, decreased bank financing, and greater emphasis on vessel performance compliance within the context of shipping finance.

8. As a result of a comprehensive assessment of Ukraine's foreign trade of goods carried by sea and maritime transport services, which are characterised by asymmetries, a maritime competitive advantage strategy for Ukraine has been developed. The distinctive features of the proposed strategic provisions include a detailed analysis of the effects of international elements and current shipping trends, as well as recognition of specific deep-rooted characteristics of wider foreign economic activity and maritime transport of Ukraine, some of which are unlikely to change instantaneously. In this regard, the maritime competitive advantage strategy allows for

the local specifics, relies on key advantages of Ukraine's maritime economy and addresses the major weak aspects that hinder realisation of full maritime potential of Ukraine. Therefore, the strategic framework suggests mechanisms through which Ukraine may accelerate integration into the global maritime transport market and reach the desired level of international establishment, investment attractiveness, and modernisation thus enabling competitiveness and alignment of Ukraine's maritime economy with evolving global standards.

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APPENDICES

Appendix A

CERTIFICATES OF IMPLEMENTATION OF RESEARCH FINDINGS



No. 1102 from 11 February 2026

CERTIFICATE OF IMPLEMENTATION OF RESEARCH FINDINGS

This is to certify that the research findings obtained by Grygorii Zaidman in the PhD study titled “Development of the global shipping industry under asymmetries in international seaborne trade”, conducted in the course of the research programme “Financial Policy as a Factor of Socio-Economic Development of Countries” (state registration No. 0121U113869) carried out at the Department of World Economy and International Economic Relations of Odesa I. I. Mechnikov National University, have been implemented in the activity of Inter Trans Logistics in the following aspects, which positively contributed to the overall resilience and competitiveness of the company:

- Placement of greater emphasis on economic indicators of Asian countries when evaluating charter rates levels within containership segment globally and forecasting company’s operational revenues;
- Adjustment of the strategic planning, including internal resources expansion and team size, based on the decarbonisation main trend and alternative decarbonisation scenarios presented in the PhD research;
- Consideration of the directions of post-war development of maritime sector of Ukraine for long-term operational planning, as per the main provisions of the suggested Ukraine’s maritime competitive advantage strategy.

Inter Trans Logistics is one of the leading freight forwarders in Ukraine, operating in containership segment and known for the provision of simple and quick yet safe and efficient transportation solutions.

Inter Trans Logistics is interested in ongoing improvement of services provided in order to maintain and expand market position under the growing uncertainty impacting international trade markets and heightened competition in the sector. Therefore, Inter Trans Logistics considers the findings of G. Zaidman’s PhD research mentioned above highly relevant for modern shipping practitioners.



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Appendix A (continued)

ACT of Implementation of the Results of the PhD Thesis

LIMITED LIABILITY COMPANY "TULLY LOGISTICS" provides cargo handling, transshipment and freight forwarding services for a wide range of cargoes, including dry bulk, liquid bulk and vehicles. Financial stability of our company is directly dependent on the market conditions of these commodity markets and the respective freight markets.

In LIMITED LIABILITY COMPANY "TULLY LOGISTICS", research is ongoing in terms of identifying more efficient methods for market analysis and forecasting in order to support the planning of operational activity, cash flow and profitability.

In this regard, we consider it appropriate to implement the research results as suggested by Grygorii Zaidman in the PhD thesis "Development of the global shipping industry under asymmetries in international seaborne trade" conducted in the course of the research programme "Financial Policy as a Factor of Socio-Economic Development of Countries" (state registration No. 0121U113869) carried out in the Department of World Economy and International Economic Relations of Odesa I. I. Mechnikov National University, in particular the following:

- i. Assessment of dynamics in the main shipping sectors and modelling of freight rates in respective areas;
- ii. Evaluation of impact of wider strategic priorities for the post-war revival of Ukraine's maritime economy on the company's long-term strategic planning;
- iii. Development of new service types based on the market niches identified through modelling of Ukraine's maritime competitive advantage strategy suggested in the mentioned PhD research.

In view of above, our company finds the results of the PhD study conducted by G. Zaidman of practical use for all types of Ukrainian and overseas enterprises operating within global maritime transport industry under current conditions.

Director



J. Erokhin

18.02.2026

Appendix A (continued)

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15 January 2026

CERTIFICATE OF IMPLEMENTATION OF RESEARCH FINDINGS

V.Group is the world's leading independent ship management company, providing a full range of ship management and marine support services to ship owners and operators around the globe. With responsibility for management of 600 assets across multiple vessel types including tankers, bulk carriers, gas carriers, cruise, offshore, passenger vessels and containerships. V.Group has access to an international network of over 44,000 seafarers across all sectors who are supported by an onshore team of over 3,000 colleagues spread throughout 30 countries in 60 regional offices.

Based on the scale of operations, accurate planning and forecasting has always been an integral part of our company's stability and efficiency.

This is to certify that the following provisions of the PhD study by Grygorii Zaidman titled "Development of the global shipping industry under asymmetries in international seaborne trade" have been successfully applied in the demand and capacity forecasting activity of V.Ships within Marine HR Department, particularly in respect of:

- Cargo vessel demand and supply in different sectors – short-, medium- and long-term projections;
- Seagoing manpower resources demand and supply in different sectors – short-, medium- and long-term projections;
- Demand for new recruits in different sectors – short-, medium- and long-term projections.

Refinement of a forecasting approach based on the provisions presented in G. Zaidman's PhD thesis regarding evaluation of sectoral proportions in cargo shipping and identification of development trends in modern international seaborne trade that account for asymmetries, enabled planning of a higher accuracy as well as entailed a revision of the company's global seafarer recruitment strategy towards more specific determination of a sought profile of expertise. The practical recommendations of G. Zaidman's PhD study helped to translate inherent and projected shipping risks and opportunities into a reliable forecast, driving organisation towards growth and providing Senior Leadership with ability to take data-backed decisions.

Rebecca Hughes
Global Director Crew Management
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Hajnalka Kiss
Crew Resources Director
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CERTIFICATE OF IMPLEMENTATION
OF RESEARCH RESULTS

Warden Chartering s. r. o. operates in sea transport industry providing transportation services within the deep sea and coastal waters as well as developing modern chartering solutions.

Our company has always explored ways to optimise operations and improve financial agility, which has become increasingly important considering growing tensions in global geopolitics that heighten the risks and increase volatility in shipping freight markets worldwide.

In view of above, we reviewed the research results obtained by Grygorii Zaidman in the PhD thesis “Development of the global shipping industry under asymmetries in international seaborne trade” and found them practically valuable. Therefore, based on the recommendations presented in G. Zaidman’s PhD thesis, our company decided to adopt the following:

1. Reshaped approach to the medium-term freight revenues planning in oil tanker sector by incorporating suggested variables, including global oil production, oil price and inflation rate;
 2. Refined chartering policy to assess and emphasise the further impact of global decarbonisation regulations on tanker freight market conditions;
 3. Initiated new markets research taking into consideration variations in local decarbonisation requirements.
-

27 Jan 2026

Anton Antokhov


Warden Chartering s.r.o.
Dvořákovo nábrežie 8, 811 02 Bratislava
IČO: 54 765 145

Director

Appendix A (continued)

UAE, Dubai
 AG Tower, Unit No: AG--PF-12
 Plot No: JLT-PH1-I1A, DMCC JLT
 PO Box 414080

TO: WHOM IT MAY CONCERN

05-Feb-2026

CERTIFICATE OF IMPLEMENTATION OF PhD RESEARCH FINDINGS

"Development of the global shipping industry
 under asymmetries in international seaborne trade"
 by Grygorii Zaidman

BPG Shipping (www.bpgshipping.com) is a modern shipping company within the largest sector of the cargo shipping business – dry bulk segment, focused on development and provision of reliable and cost-effective transportation solutions. Operating across geographies and various dry bulk commodities, we are both part of the global economy and simultaneously dependent on it.

With the growing uncertainty in international economic relations that impacts all business operations, BPG Shipping strives to increase sustainability in terms of reducing risk factors as well as improve adaptability to the inherent volatility of the shipping markets.

Focusing on our strategic priorities and having had a chance to review the research findings as presented by Grygorii Zaidman in the PhD study titled "Development of the global shipping industry under asymmetries in international seaborne trade", we found the following findings worthwhile practical use and implemented them in our operational planning and forecasting:

- a. Modelling approach towards dry bulk freight market through greater consideration of global cost of capital;
- b. Evaluation of asymmetries in global seaborne trade through projecting more precisely the dry bulk sector size and transportation volumes as well as structure of dry bulk sector with some types of cargoes losing the relevance for the wider economy;
- c. Ongoing trends related to the transformation of global fleet structure and their influence on the transportation cost and freight rates, coupled with the economic impact of decarbonisation.

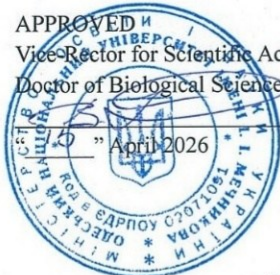
Name: Gennadii Ivanov, PhD

Position: Managing Director/Co-founder BPG Shipping



Appendix A (continued)

APPROVED
Vice-Rector for Scientific Activity
Doctor of Biological Sciences, Professor
V. Ivanytsya
"14" April 2026



APPROVED
First Vice-Rector
PhD in Political Sciences, Associate Professor
M. Nikolareva
"15" April 2026



CERTIFICATE

of implementation of the PhD research findings

by Grygorii Zaidman on the subject "Development of the global shipping industry under asymmetries in international seaborne trade" submitted in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in the field of study 29 International Relations in speciality 292 International Economic Relations

This PhD study was conducted within the research programmes of the Department of World Economy and International Economic Relations of Odesa I. I. Mechnikov National University in the course of the implementation of the research topic "Financial Policy as a Factor of Socio-Economic Development of Countries" (state registration No. 0121U113869), wherein the author comprehensively investigated asymmetries in modern international seaborne trade and their impact on the dynamics of development of the global shipping industry.

The PhD study findings have been implemented into the educational process during the delivery of lectures and seminars in the following courses: "Workshop on World Economy Research", "World Economy", "Theory of International Economic Relations".

Deputy Dean for Scientific Activity of the
Faculty of International Relations, Political
Science and Sociology
Doctor of Political Sciences, Professor
Yu. Uzun
"14" April 2026

Acting Dean of the Faculty of International
Relations, Political Science and Sociology
Doctor of Political Sciences, Professor
S. Koch
"14" April 2026

Academic Supervisor
Doctor of Economic Sciences, Professor
S. Yakubovskiy
"14" April 2026

Acting Head of the Department of World
Economy and International Economic Relations
Doctor of Economic Sciences, Professor
S. Yakubovskiy
"14" April 2026

*Appendix A (continued)***APPROVED**

Vice-Rector for Scientific and Pedagogical
Activity

Odesa National Maritime University



Oleksandr SHUMYLO

2026

CERTIFICATE

**OF IMPLEMENTATION OF THE PhD RESEARCH FINDINGS
BY GRYGORII ZAIDMAN INTO THE EDUCATIONAL PROCESS
OF ODESA NATIONAL MARITIME UNIVERSITY**

This is to certify that the findings of the PhD study by Grygorii Zaidman, an applicant for the third (educational and research) level of higher education at Odesa I. I. Mechnikov University, titled “Development of the global shipping industry under asymmetries in international seaborne trade”, submitted in fulfilment of the requirements for the degree of Doctor of Philosophy (PhD) in the field of study 29 International Relations in speciality 292 International Economic Relations (Educational and Research Programme “International Economic relations”), are used in the educational process of Odesa National Maritime University, namely:

- within the academic course “Economics of Maritime Transport” for students of the first (Bachelor’s) level of higher education in speciality 051 Economics, Educational and Professional Programme “Enterprise Economics” – implemented the PhD research findings regarding assessment of the influence of real economy, commodity and global financial markets’ indicators on the dynamics of freight rates in different sectors of the shipping industry based on the econometric models developed as well as evaluation of trends in respect of economic impact of decarbonisation requirements within shipping;
- within the academic course “Economics of Shipping Companies” for students of the second (Master’s) level of higher education in speciality C1 Economics and International Economic Relations, Educational and Professional Programme “Economics and Corporate Development” – included the provisions as regards historically and economically substantiated interrelation between phases of

Appendix A (continued)

shipping finance and freight markets dynamics; the suggested extension of shipping finance periodisation is used; the proposed analytical framework for evaluation of sectoral asymmetries in global seaborne trade is applied.

Director of Educational and Scientific
Institute of Marine Business of ONMU



Nataliia PAVLOVA

Head of the Department "Economics
and Finance",
lecturer of the course
"Economics of Shipping Companies"



Vlada ZHYKHARIEVA

Associate Professor of the Department
"Economics and Finance",
lecturer of the course
"Economics of Maritime Transport"



Olha VORKUNOVA

Head of the Academic Affairs Department



Oleh ROSSOMAKHA



Засвідчую підпис

Факівель ВК

и *Наталії Павлової; Влада Зихарєвої;*
Ольги Воркунової; Олега Россомакхи

LIST OF THE CANDIDATE'S PUBLICATIONS ON THE SUBJECT OF THE PhD RESEARCH

Publications that present the major scientific findings and outcomes of the PhD research

1) Papers in scientific publications included in the List of Scientific Professional Publications of Ukraine

1. Yakubovskiy, S. and Zaidman, G. (2024) 'Dynamics and structure of world seaborne trade in 2009-2023: impact of COVID-19 pandemic and Ukrainian war', *Aktual'ni Problemi Mižnarodnih Vidnosin* [Actual Problems of International Relations], 1(158), pp. 70–84. doi: <https://doi.org/10.17721/apmv.2024.158.1.70-84>
The candidate's personal contribution includes empirical analysing the dynamics, trends and structural changes in international seaborne trade, and suggesting an enhancement of the analytical toolkit for evaluating sectoral proportions in shipping. The co-author contributed by performing academic supervision and validation of the findings.
2. Zaidman, G. (2025a) 'Evoliutsiia svitovoi sudnoplavnoi haluzi v umovakh asymetrii mizhnarodnoi torhivli ta dekarbonizatsii' ['Evolution of the global shipping industry under asymmetries in international seaborne trade and decarbonisation'], *Galic'kij Ekonomičnij Visnik* [Galician Economic Journal], 97(6), pp. 17–28. doi: https://doi.org/10.33108/galicianvisnyk_tntu2025.06.017 [in Ukrainian].

Appendix B (continued)

3. Zaidman, G. and Yakubovskiy, S. (2021a) 'Ekonomika morskoho transportu ta morska torhivlia v suchasnykh doslidzhenniakh uchenykh iz postradianskykh krain' ['Maritime economics and seaborne trade in current studies of scientists from post-Soviet states'], *Pričornomors'kì Ekonomìčni Studii* [Black Sea Economic Studies], (63), pp. 11–19. doi: <https://doi.org/10.32843/bses.63-2> [in Ukrainian].
The candidate's personal contribution includes a critical review and categorisation of the literature sources, and generalisation of observed trends. The co-author contributed by performing academic supervision and validation of the findings.
4. Zaidman, G. and Yakubovskiy, S. (2021b) 'Peculiarities of current world scientific researches on maritime economics and specifically seaborne trade', *Aktual'ni Problemi Rozvitku Ekonomiki Regionu* [The Actual Problems of Regional Economy Development], 1(17), pp. 8–22. doi: <https://doi.org/10.15330/apred.1.17.8-22>
The candidate's personal contribution includes a critical review and categorisation of the literature sources, and generalisation of observed trends. The co-author contributed by performing academic supervision and validation of the findings.
5. Zaidman, G. and Yakubovskiy, S. (2025) 'Modeling dynamics of oil tanker freight rates and market capitalization of oil tanker shipping companies', *Včeni Zapiski* [Scientific-Research Works], (38(1)), pp. 301–315. doi: https://doi.org/10.33111/vz_kneu.38.25.01.24.166.172
The candidate's personal contribution includes a correlation-regression analysis and evaluation of the dynamics of freight rates and shipping companies' market capitalisation in the oil tanker sector. The co-author contributed by performing academic supervision and validation of the findings.

Appendix B (continued)

6. Zaidman, G., Yakubovskiy, S. and Romanenko, S. (2025) ‘Modeling dynamics of dry bulk freight rates and market capitalization of dry bulk shipping companies’, *Kiivs'kij Ekonomičnij Naukovij Žurnal* [Kyiv Economic Scientific Journal], (8), pp. 52–59. doi: <https://doi.org/10.32782/2786-765X/2025-8-7>

The candidate's personal contribution includes a hypothesis formulation, correlation-regression analysis, and evaluation of the dynamics of freight rates and shipping companies' market capitalisation in the dry bulk sector. The first co-author, S. Yakubovskiy, contributed by performing academic supervision and validation of the findings. The second co-author, S. Romanenko, contributed by providing a methodological support.

**2) Papers in scientific periodicals indexed in
Web of Science Core Collection and/or Scopus databases**

7. Zaidman, G. *et al.* (2021) ‘Containership charter rates: analysis of unprecedented growth after COVID-19 pandemic outbreak’, *Journal of Global Policy and Governance*, 10(2), pp. 21–38. doi: <https://doi.org/10.14666/2194-7759-10-2-002> (*indexed in the Scopus database*)

The candidate's personal contribution includes a hypothesis formulation, correlation-regression analysis, and evaluation of the dynamics of charter rates in the container sector. The first co-author, G. Dominese, contributed by providing a conceptual support. The second co-author, S. Yakubovskiy, contributed by performing academic supervision and validation of the findings. The third co-author, T. Rodionova, contributed by providing a methodological support.

*Appendix B (continued)***Publications that substantiate the validation of the PhD research material**

8. Zaidman, G. (2021a) ‘Covid-19 pandemic’s impact on shipping industry: quickly recovered dry sector and stagnating tanker fleet’, *Sotsialno-ekonomichni ta politychnyi rozvytok v umovakh yevropeiskoi intehtatsii, zbirnyk naukovykh prats mizhnarodnoi naukovo-praktychnoi konferentsii* [Socio-economic and political development in the context of European integration, collection of scientific reports of the international scientific and practical conference]. Odesa, June 2021. Odesa: Odesa I. I. Mechnikov National University, pp. 64–65.
9. Zaidman, G. (2021b) ‘Dry bulk carriers and containerships move the post-Covid shipping industry’, *Materialy Mizhnarodnoi naukovo-praktychnoi internet-konferentsii “Tendentsii ta perspektyvy rozvytku nauky i osvity v umovakh hlobalizatsii”*, *zbirnyk naukovykh prats* [Proceedings of the international scientific and practical online conference “Trends and prospects for the development of science and education in the context of globalization”, collection of scientific papers], (77). Online, December 2021. Pereiaslav: Hryhorii Skovoroda University in Pereiaslav, pp. 77–80.
10. Zaidman, G. (2022) ‘Shipping industry in 2022: new disruption after recovery’, *Sotsialno-ekonomichni ta politychnyi rozvytok krain u suchasnykh umovakh, zbirnyk naukovykh prats mizhnarodnoi naukovo-praktychnoi konferentsii* [Socio-economic and political development of countries in modern context, collection of scientific reports of the international scientific and practical conference]. Odesa, May 2022. Odesa: Odesa I. I. Mechnikov National University, pp. 61–62.
11. Zaidman, G. (2025b) ‘Rol morskoho transportu v zovnishnii torhivli Ukrainy’ [‘The role of maritime transport in the foreign trade of Ukraine’], *Ekonomika sohodennia ta mizhnarodne spivrobitnytstvo, materialy Vseukrainskoi naukovo-*

Appendix B (continued)

praktychnoi konferentsii [Modern economy and international cooperation, proceedings of the All-Ukrainian international scientific and practical conference]. Odesa, November 2025. Odesa: Odesa I. I. Mechnikov National University, pp. 151–155. doi: <https://doi.org/10.36059/978-966-397-558-0-38> [in Ukrainian].

12. Zaidman, G. and Yakubovskiy, S. (2021c) ‘Shipping industry in bounce back after pandemic, with containership sector leading the way’, *Economic trends: new opportunities and threats, international scientific conference*. Le Mans, November 2021. Riga, Latvia: Baltija Publishing, pp. 9–12. doi: <https://doi.org/10.30525/978-9934-26-158-9-3>

The candidate’s personal contribution includes an analysis of the COVID-19’s impact on global shipping and post-pandemic development of the industry. The co-author contributed by performing academic supervision.

13. Zaidman, G. and Yakubovskiy, S. (2023) ‘World seaborne trade in 2023: new recovery after disruption’, *Tvorchyi vnesok profesora Antona Filipenka u navchalno-naukovyi protses ekonomichnykh spetsialnostei vyshchykh navchalnykh zakladiv Ukrainy, materialy naukovooho sympoziumu* [Professor Anton Filipenko’s scholarly contribution to the educational and research development of economic disciplines in higher education institutions of Ukraine: proceedings of the academic symposium]. Kyiv, December 2023. Kyiv: Educational and Scientific Institute of International Relations of Taras Shevchenko National University of Kyiv, pp. 57–58.

The candidate’s personal contribution includes an identification of contemporary trends in the development of international seaborne trade. The co-author contributed by performing academic supervision.

14. Zaidman, G. and Yakubovskiy, S. (2024a) ‘Influence of Covid-19 shock and Ukrainian war on international seaborne trade’, *Actual problems of international*

Appendix B (continued)

relations, collected papers, (159/2). Kyiv, May 2024. Kyiv: Educational and Scientific Institute of International Relations of Taras Shevchenko National University of Kyiv, pp. 7–9.

The candidate's personal contribution includes an evaluation of response of global maritime trade on the COVID-19 pandemic and the war in Ukraine. The co-author contributed by performing academic supervision.

15. Zaidman, G. and Yakubovskiy, S. (2024b) 'Shipping industry after Ukrainian war outbreak: quantitative and qualitative changes', *Sotsialno-ekonomichnyi ta politychnyi rozvytok krain v umovakh hlobalnoi nestabilnosti, materialy druhoi mizhnarodnoi naukovo-praktychnoi konferentsii* [Socio-economic and political development of countries under conditions of global instability, proceedings of the second international scientific and practical conference]. Odesa, May 2024. Odesa: Odesa I. I. Mechnikov National University, pp. 30–31.

The candidate's personal contribution includes an analysis of high-level transformations in dry bulk and tanker international seaborne trade caused by the war in Ukraine. The co-author contributed by performing academic supervision.

Appendix C

Table C.1

Structural market data for the BDI, LIBOR, the S&P 500 index, crude oil Brent price and iron ore price

Year	BDI	LIBOR, %	SP500	P_OIL, USD per barrel	P_IRON_ORE, USD per metric tonne
2005	2497	4.03	1,207.23	54.43	28.11
2006	4539	5.33	1,310.46	65.38	33.45
2007	7949	5.12	1,477.18	72.73	36.63
2008	872	3.09	1,220.04	97.57	61.57
2009	3140	1.57	948.50	61.86	79.99
2010	1519	0.92	1,139.97	79.63	146.72
2011	1347	0.83	1,267.64	111.08	167.79
2012	760	1.01	1,379.61	111.96	128.53
2013	1512	0.68	1,643.80	108.84	135.36
2014	709	0.56	1,931.38	98.94	97.39
2015	429	0.79	2,061.07	52.40	56.14
2016	963	1.38	2,094.65	44.05	58.57
2017	1371	1.79	2,449.08	54.40	71.13
2018	1169	2.76	2,746.21	71.07	70.14
2019	774	2.37	2,913.36	64.03	93.62
2020	1606	0.77	3,217.86	42.30	108.07
2021	2289	0.3	4,273.41	70.83	158.16
2022	1130	3.4	4,097.49	99.00	120.70
2023	2110	5.47	4,283.73	82.32	120.32

Note: P_OIL – crude oil Brent price; P_IRON_ORE – iron ore price. The BDI values as of the end of each year. The S&P 500 index values present the average closing price. LIBOR, prices of crude oil and iron ore are average annual values.

Source: Compiled by the author based on data from Macrotrends LLC (2025), Trading Economics (2025), Triami Media BV (2025), Federal Reserve Bank of St. Louis (n.d.)

Appendix C (continued)

Table C.2

**Structural market data for coal price, wheat price, corn price, rice price and
aluminium price**

Year	P_COAL, USD per metric tonne	P_WHEAT, USD per metric tonne	P_CORN, USD per metric tonne	P_RICE, USD per metric tonne	P_ALUM, USD per metric tonne
2005	50.82	129.67	98.51	287.81	1,900.51
2006	52.73	169.14	121.65	303.52	2,573.06
2007	70.09	231.18	163.61	332.39	2,639.86
2008	138.02	292.97	223.36	700.20	2,577.92
2009	76.16	192.11	165.63	589.38	1,668.49
2010	104.60	195.23	185.96	520.49	2,172.99
2011	129.61	280.28	291.85	551.71	2,400.64
2012	101.44	276.33	298.44	580.24	2,022.80
2013	90.13	265.69	258.98	519.31	1,846.68
2014	75.73	242.90	192.94	426.48	1,867.42
2015	62.69	185.87	169.84	380.05	1,664.68
2016	70.08	143.20	159.22	388.26	1,604.18
2017	94.14	145.29	154.60	399.07	1,967.65
2018	113.23	186.13	164.51	403.08	2,108.47
2019	82.19	163.26	170.17	396.51	1,794.49
2020	61.98	185.51	165.58	477.84	1,704.10
2021	143.99	265.79	259.40	441.96	2,472.95
2022	384.17	360.18	318.36	419.06	2,706.99
2023	188.15	272.33	251.46	528.57	2,256.08

Note: P_COAL – coal price; P_WHEAT – wheat price; P_CORN – corn price; P_RICE – rice price; P_ALUM – aluminium price. Prices of all commodities are average annual values.

Source: Compiled by the author based on data from Federal Reserve Bank of St. Louis (n.d.)

Appendix C (continued)

Table C.3

**Structural market data for the market capitalisation of Star Bulk Carriers,
Golden Ocean Group, Genco Shipping & Trading, Eagle Bulk Shipping,
Seanergy Maritime**

Year	STAR_BULK_ MCAP, USD bn	GOLDEN_ OCEAN_ MCAP, USD bn	GENCO_ MCAP, USD bn	EAGLE_ MCAP, USD bn	SEANERGY_ MCAP, USD bn
2005	N/A	0.45	N/A	0.53	N/A
2006	0.28	0.4	N/A	0.62	N/A
2007	0.54	0.41	N/A	1.24	N/A
2008	0.14	0.26	N/A	0.31	0.12
2009	0.17	0.23	N/A	0.3	0.15
2010	0.16	0.55	N/A	0.31	0.11
2011	0.05	0.33	N/A	0.05	0.03
2012	0.03	0.15	N/A	0.02	0.01
2013	0.38	0.27	N/A	0.07	0.02
2014	0.71	0.37	0.83	0.55	0.02
2015	0.13	0.32	0.1	0.13	0.06
2016	0.28	0.5	0.05	0.28	0.04
2017	0.71	1.21	0.45	0.33	0.04
2018	0.84	0.93	0.32	0.32	0.02
2019	1.13	0.8	0.44	0.32	0.01
2020	0.84	0.81	0.3	0.23	0.06
2021	2.15	1.79	0.64	0.56	0.14
2022	1.97	1.85	0.65	0.68	0.09
2023	2	2	0.71	0.55	0.13

Note: N/A – not available. As the companies initiated public listing in different years, some historical MCAP data are unavailable. Values as of the end of each year.

Source: Compiled by the author based on data from CompaniesMarketcap.com (2024)

Appendix C (continued)

Table C.4

**Structural market data for crude oil Brent price, LIBOR, the S&P 500 index,
market capitalisation of International Seaways and Euronav**

Year	P_OIL, USD per barrel	LIBOR, %	SP500	INSW_ MCAP, USD bn	EURONAV_ MCAP, USD bn
1998	13.13	5.54	1,085.50	N/A	N/A
1999	18.11	5.71	1,327.33	N/A	N/A
2000	28.85	6.87	1,427.22	N/A	N/A
2001	24.71	3.83	1,192.57	N/A	N/A
2002	25.12	2.21	993.93	N/A	N/A
2003	28.78	1.36	965.23	N/A	N/A
2004	38.23	2.12	1,130.65	N/A	N/A
2005	54.68	4.03	1,207.23	N/A	N/A
2006	65.60	5.33	1,310.46	N/A	N/A
2007	72.65	5.12	1,477.18	N/A	N/A
2008	97.33	3.09	1,220.04	N/A	N/A
2009	61.58	1.57	948.50	N/A	1.1
2010	79.81	0.92	1,139.97	N/A	0.84
2011	111.54	0.83	1,267.64	N/A	0.24
2012	112.01	1.01	1,379.61	N/A	0.3
2013	108.96	0.68	1,643.80	N/A	0.63
2014	99.35	0.56	1,931.38	N/A	1.65
2015	53.02	0.79	2,061.07	N/A	2.21
2016	45.08	1.38	2,094.65	0.41	1.27
2017	54.89	1.79	2,449.08	0.54	1.45
2018	71.61	2.76	2,746.21	0.49	1.56
2019	64.20	2.37	2,913.36	0.87	2.65
2020	43.33	0.77	3,217.86	0.46	1.64
2021	70.83	0.3	4,273.41	0.73	1.78
2022	99.00	3.4	4,097.49	1.82	3.46
2023	82.32	5.47	4,283.73	2.22	3.55

Note: N/A – not available. As the companies initiated public listing in different years, some historical MCAP data are unavailable. P_OIL – crude oil Brent price. Price of crude oil and LIBOR are average annual values. The S&P 500 index values present the average closing price. Market capitalisation values as of the end of each year.

Source: Compiled by the author based on data from Macrotrends LLC (2025), Triami Media BV (2025), CompaniesMarketcap.com (2024), Federal Reserve Bank of St. Louis (n.d.)

Appendix C (continued)

Table C.5

**Structural market data for the market capitalisation of TORM, Frontline,
Teekay, Scorpio Tankers, Nordic American Tankers**

Year	TORM_ MCAP, USD bn	FRONTLINE_ MCAP, USD bn	TEEKAY_ MCAP, USD bn	SCORPIO_ MCAP, USD bn	NAT_ MCAP, USD bn
1998	N/A	0.0655	N/A	N/A	0.11
1999	N/A	0.23	N/A	N/A	0.1
2000	N/A	1.16	N/A	N/A	0.19
2001	N/A	0.78	N/A	N/A	0.13
2002	N/A	0.68	N/A	N/A	0.13
2003	N/A	1.88	N/A	N/A	0.15
2004	N/A	3.32	N/A	N/A	0.51
2005	N/A	2.84	N/A	N/A	0.61
2006	N/A	2.38	N/A	N/A	0.92
2007	N/A	3.59	0.55	N/A	0.98
2008	0.74	2.31	0.32	N/A	1.16
2009	0.68	2.13	0.27	N/A	1.27
2010	0.48	1.98	0.64	0.25	1.22
2011	N/A	0.33	0.22	0.15	0.57
2012	0.22	0.25	0.24	0.45	0.46
2013	0.17	0.32	0.33	2.34	0.73
2014	0.0321	0.28	0.57	1.43	0.9
2015	0.91	2.34	1.07	1.41	1.39
2016	0.56	1.21	0.35	0.79	0.86
2017	0.53	0.78	0.39	0.86	0.35
2018	0.5	0.94	0.25	0.9	0.28
2019	0.83	2.53	0.81	2.29	0.72
2020	0.56	1.23	0.37	0.65	0.45
2021	0.65	1.44	0.37	0.77	0.32
2022	2.55	2.70	1.04	3.31	0.64
2023	2.74	4.46	1.70	3.23	0.88

Note: N/A – not available. As the companies initiated public listing in different years, some historical MCAP data are unavailable. Values as of the end of each year.

Source: Compiled by the author based on data from CompaniesMarketcap.com (2024)

Appendix C (continued)

Table C.6

Correlation analysis of inflation, crude oil Brent price and global oil production

	INFLATION	P_OIL	GLO_OIL_PROD
INFLATION	1		
P_OIL	-0.255	1	
GLO_OIL_PROD	-0.517	0.726	1

Note: INFLATION – global inflation (consumer prices), percentage change year-on-year; P_OIL – crude oil Brent price in USD per barrel; GLO_OIL_PROD – global oil production in million barrels per day.

Source: Compiled by the author based on analysis in Microsoft Excel using data from Clarksons Research (n.d.)

Table C.7

Additional information about Scorpio Tankers, TORM, International Seaways, Euronav, Teekay, Frontline, Nordic American Tankers

Company	Headquarters	Years publicly traded as of the end of 2023	MCAP in 2023, USD bn	Fleet size as of 2024, vessel units
Scorpio Tankers	Monaco	14	3.23	107
TORM	Denmark	16	2.74	86
International Seaways	the USA	8	2.22	73
Euronav	Belgium	15	3.55	40
Teekay	Canada	17	1.70	42
Frontline	Cyprus	26	4.46	82
Nordic American Tankers	Norway	27	0.88	20

Source: Compiled by the author based on CMB.TECH nv (2024), CompaniesMarketcap.com (2024), International Seaways, Inc. (2024), Scorpio Tankers (2024), Teekay Corporation Ltd. (2024), TORM (2024), Nordic American Tankers (2022), Frontline (2018)

Appendix C (continued)

Table C.8

Correlation analysis of tanker freight indicators

	EARNINGS	BDTI	BCTI
EARNINGS	1		
BDTI	0.856	1	
BCTI	0.807	0.936	1

Note: EARNINGS – average earnings for all tankers in USD per day.

Source: Compiled by the author based on analysis in Microsoft Excel using data from Clarksons Research (n.d.)

Table C.9

Structural data for Singapore, Hong Kong and Los Angeles container throughput

Month	SP CT, TEU	HK CT, TEU	LA CT, TEU
Jan-20	3,182,599.25	1,425,000	806,143.75
Feb-20	2,898,686.75	1,160,000	544,037.30
Mar-20	3,197,879.25	1,515,000	449,568.30
Apr-20	2,843,484.25	1,462,000	688,999.00
May-20	2,806,720.50	1,515,000	581,664.75
Jun-20	2,907,671.75	1,533,000	691,475.40
Jul-20	3,016,320.00	1,588,000	856,389.15
Aug-20	3,174,695.50	1,573,000	961,832.75
Sep-20	3,207,671.75	1,538,000	883,624.80
Oct-20	3,238,693.75	1,499,000	980,728.55
Nov-20	3,134,646.50	1,529,000	889,748.15
Dec-20	3,261,834.50	1,634,000	879,186.05
Jan-21	3,156,021.75	1,538,000	835,516.20
Feb-21	2,881,586.75	1,019,000	799,315.40
Mar-21	3,270,574.75	1,557,000	957,599.25
Apr-21	3,091,280.75	1,517,000	946,966.35
May-21	3,216,904.25	1,592,000	1,012,047.85
Jun-21	3,114,506.50	1,485,000	876,430.35
Jul-21	3,123,559.50	1,566,000	890,799.80
Aug-21	3,182,281.00	1,508,000	954,377.35

Note: SP CT – Singapore port container throughput; HK CT – Hong Kong port container throughput; LA CT – Los Angeles port container throughput.

Source: Compiled by the author based on data from Hong Kong Maritime and Port Board (2021), Maritime and Port Authority of Singapore (2021), Port of Los Angeles (2021)

Appendix C (continued)

Table C.10

**Structural market data for the market capitalisation of Maersk, Hapag-Lloyd,
Orient Overseas Container Line**

Month	M MCAP, USD bn	H-L MCAP, USD bn	OOCL MCAP, USD bn
Jan-20	24.22	15.06	2.96
Feb-20	20.25	14.47	2.76
Mar-20	17.92	14.45	2.45
Apr-20	19.89	26.63	2.61
May-20	19.21	17.56	2.45
Jun-20	22.5	10.53	2.7
Jul-20	23.39	9.42	2.78
Aug-20	27.73	9.88	2.76
Sep-20	27.54	9.37	2.63
Oct-20	29.51	10.88	2.7
Nov-20	36.94	13.23	4.76
Dec-20	39.39	18.65	6.24
Jan-21	36.52	18.89	5.43
Feb-21	38.31	24.72	6.17
Mar-21	42.56	26.87	9.38
Apr-21	44.54	30.71	10.31
May-21	48.96	34.4	8.32
Jun-21	67.7	39.39	13.78
Jul-21	50.47	36.66	11.72
Aug-21	51.15	41.03	15.01
Sep-21	56.67	44.85	16.18

Source: Compiled by the author based on data from CompaniesMarketcap.com (2024)

Appendix C (continued)

Table C.11

Granger causality test results in containership segment (extended)

Indicators	Lagged variables												
	CC rate	CS SP	CS NP	US IP	CH IP	SK IP	TW IP	SP	BP	M MCAP	SP CT	HK CT	LA CT
CC rate		8.7 (0.02) ^b L=2 +	12.82 (0.005) ^a L=3 +	5.52 (0.02) ^b L=1 +	742 (0.00) ^a L=3 +	2.82 (0.09) ^c L=1 +	SNS	9.97 (0.000) ^a L=3 +	SNS	24.69 (0.000) ^a L=2 +	8.38 (0.08) ^c L=4 +	SNS	8.63 (0.07) ^c L=4 +
CS SP	6.3 (0.04) ^b L=2 +		13.28 (0.004) ^a L=3 +	SNS	SNS	5.86 (0.05) ^c L=2 +	SNS	77.29 (0.00) ^a L=2 +	11.8 (0.008) ^a L=3 +	19.07 (0.000) ^a L=2 +	SNS	SNS	SNS
CS NP	SNS	SNS		SNS	44.58 (0.00) ^a L=2 -	SNS	10.6 (0.00) ^a L=2 +	SNS	73.9 (0.00) ^a L=3 +	SNS	47.1 (0.00) ^a L=2 +	32.5 (0.00) ^a L=2 +	SNS
US IP	SNS	SNS	93.98 (0.000) ^a L=2 +		117 (0.00) ^a L=4 +	SNS	SNS	21.2 (0.00) ^a L=4 +	11.5 (0.00) ^a L=2 +	29.2 (0.00) ^a L=5 +	SNS	SNS	5.26 (0.02) ^b L=1 +
CH IP	57.17 (0.000) ^a L=3 +	SNS	SNS	SNS		83.4 (0.00) ^a L=5 +	SNS	12.2 (0.03) ^b L=5 +	SNS	SNS	17.31 (0.00) ^a L=5 +	SNS	SNS
SK IP	5.13 (0.02) ^b L=1 +	8.93 (0.02) ^b L=2 +	88.88 (0.00) ^a L=3 +	27.5 (0.00) ^a L=1 +	24.4 (0.00) ^a L=5 +		SNS	2.76 (0.09) ^c L=1 +	34.2 (0.00) ^a L=3 +	27.6 (0.00) ^a L=5 +	SNS	SNS	34.0 (0.00) ^a L=5 +
TW IP	11.27 (0.04) ^b L=5 +	15.5 (0.00) ^a L=2 +	SNS	SNS	22.6 (0.00) ^a L=4 +	5.27 (0.02) ^b L=1 +		SNS	21.1 (0.00) ^a L=3 +	SNS	SNS	SNS	4.2 (0.04) ^b L=1 +
SP	SNS	5.41 (0.07) ^c L=2 +	13.67 (0.001) ^a L=2 +	50.63 (0.00) ^a L=3 +	65.4 (0.00) ^a L=5 +	SNS	6.73 (0.03) ^b L=2 +		SNS	SNS	131 (0.00) ^a L=5 +	25.1 (0.00) ^a L=5 +	SNS
BP	SNS	SNS	SNS	6.38 (0.04) ^b L=2 +	18.9 (0.00) ^a L=4 +	SNS	SNS	30.9 (0.00) ^a L=5 +		13.4 (0.00) ^a L=1 +	SNS	2.78 (0.09) ^c L=1 +	7.11 (0.00) ^a L=1 +
M MCAP	SNS	SNS	6.53 (0.011) ^b L=1 +	29.3 (0.00) ^a L=5 +	18.6 (0.00) ^a L=5 +	SNS	13.6 (0.02) ^b L=5 +	19.8 (0.00) ^a L=4 +	SNS		SNS	17.2 (0.00) ^a L=5 +	3.8 (0.06) ^c L=1 +
SP CT	30.4 (0.000) ^a L=4 +	SNS	SNS	SNS	10.99 (0.06) ^c L=5 +	SNS	SNS	SNS	SNS	SNS		SNS	6.62 (0.01) ^b L=1 +
HK CT	17.57 (0.004) ^a L=5 +	SNS	SNS	SNS	87.49 (0.000) ^a L=3 +	SNS	SNS	22.5 (0.00) ^a L=5 +	SNS	SNS	SNS		SNS
LA CT	SNS	SNS	SNS	SNS	7.99 (0.005) ^a L=1 +	SNS	SNS	SNS	SNS	SNS	SNS	SNS	

Note: SNS – statistically non-significant. For statistically significant relationship, the information in the cells includes Chi-squared, followed by p-value in parentheses; ^a, ^b and ^c represent 1, 5 and 10% significance levels respectively; L represents lag; the + and - symbol denote direct and indirect causality respectively. CC rate – containership time-charter rates; CS SP – containership secondhand price; CS NP – containership newbuilding price; US IP – U.S. industrial production;

*Appendix C (continued)**Table C.11 (continued)*

CH IP – Chinese industrial production; SK IP – South Korean industrial production; TW IP – Taiwanese industrial production; SP – steel ship plate price; BP – crude oil Brent price; M MCAP – market capitalisation of Maersk; SP CT – Singapore port container throughput; HK CT – Hong Kong port container throughput; LA CT – Los Angeles port container throughput.

Source: Compiled by the author based on analysis in EViews

Appendix D

Table D.1

Structural data for world GDP in current prices, purchasing power parity

Year	Advanced economies GDP, bn of international dollars	Emerging market and developing economies GDP, bn of international dollars	World GDP, bn of international dollars
2000	29,156.16	20,907.99	50,064.16
2001	30,295.01	22,147.07	52,442.08
2002	31,262.15	23,452.77	54,714.92
2003	32,518.55	25,312.05	57,830.59
2004	34,471.19	27,965.21	62,436.40
2005	36,552.46	30,812.89	67,365.34
2006	38,835.18	34,196.88	73,032.06
2007	40,975.94	37,929.06	78,905.00
2008	41,891.48	40,782.91	82,674.39
2009	40,715.62	41,925.31	82,640.93
2010	42,470.61	45,448.28	87,918.89
2011	44,097.69	49,013.03	93,110.72
2012	45,419.64	52,449.71	97,869.35
2013	46,872.07	55,930.69	102,802.76
2014	48,686.42	59,524.51	108,210.93
2015	50,291.49	62,555.19	112,846.68
2016	51,697.38	65,820.08	117,517.46
2017	53,980.05	70,150.36	124,130.42
2018	56,423.06	75,631.40	132,054.46
2019	59,278.19	80,596.27	139,874.46
2020	58,483.01	81,099.04	139,582.05
2021	64,632.25	91,546.63	156,178.88
2022	71,260.03	101,969.91	173,229.94
2023	75,069.89	110,505.91	185,575.80
2024	78,255.23	117,871.15	196,126.38
2025f	81,435.56	125,442.66	206,878.22
2026f	84,466.31	133,128.04	217,594.34
2027f	87,470.76	141,184.57	228,655.32
2028f	90,825.33	150,033.96	240,859.28
2029f	94,033.47	158,958.46	252,991.94
2030f	97,371.82	168,324.70	265,696.52

Note: f – forecasted value.

Source: Compiled by the author based on data from the IMF (2025a)

Appendix D (continued)

Table D.2

Structural data for global fleet's average age by vessel type

Age range	Bulk carriers	Container ships	General cargo	Oil tankers	Other types	Total
0–4 years	18	17	7	11	11	11
5–9 years	19	15	7	14	13	13
10–14 years	38	20	15	22	17	20
15–19 years	13	26	14	18	12	14
More than 20 years	12	22	57	35	47	42

Note: Data in % of vessel numbers as of 2024.

Source: Compiled by the author based on data from UNCTAD (2024)

Table D.3

Structural data for Ukraine's foreign trade in goods

Year	Goods exports, USD mln	Goods imports, USD mln	Goods trade balance, USD mln
2005	32,184	34,377	-2,193
2006	36,174	42,220	-6,046
2007	46,168	57,753	-11,585
2008	63,188	80,640	-17,452
2009	37,134	42,477	-5,343
2010	47,299	56,896	-9,597
2011	62,383	80,414	-18,031
2012	64,427	86,273	-21,846
2013	59,106	81,234	-22,128
2014	50,552	57,680	-7,128
2015	35,420	38,875	-3,455
2016	33,560	40,502	-6,942
2017	39,701	49,364	-9,663
2018	43,341	56,055	-12,714
2019	46,091	60,352	-14,261
2020	45,143	51,921	-6,778
2021	63,113	69,755	-6,642
2022	40,899	55,551	-14,652
2023	34,678	63,813	-29,135
2024	38,888	69,291	-30,403

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.4

Structural data for Ukraine's foreign goods exports in absolute terms

Year	Total goods exports, USD mln	Agricultural products, USD mln	Mineral products, USD mln	Chemicals, USD mln	Timber and wood products, USD mln	Industrial goods, USD mln	Ferrous and nonferrous metals, USD mln	Machinery and equipment. USD mln	Other, USD mln
2005	32,184	4,264	4,144	3,386	804	399	13,784	4,307	1,096
2006	36,174	4,686	3,413	4,015	981	487	16,262	5,107	1,223
2007	46,168	6,132	3,693	4,943	1,289	643	20,565	7,563	1,340
2008	63,188	10,561	5,570	6,395	1,369	771	27,286	9,848	1,388
2009	37,134	9,510	3,033	3,317	1,169	472	12,605	6,007	1,021
2010	47,299	9,936	5,076	4,000	1,467	616	17,044	8,530	630
2011	62,383	12,804	6,951	6,041	1,855	795	21,836	10,722	1,379
2012	64,427	17,906	6,304	6,028	1,852	830	18,490	11,181	1,836
2013	59,106	17,040	6,306	5,070	2,004	846	16,793	8,537	2,510
2014	50,552	16,670	5,291	3,730	1,954	704	14,953	5,432	1,818
2015	35,420	14,478	2,672	2,436	1,540	503	9,164	3,339	1,288
2016	33,560	15,250	2,391	1,832	1,510	463	8,099	2,748	1,267
2017	39,701	17,739	3,517	2,052	1,647	575	9,890	2,862	1,419
2018	43,341	18,594	3,883	2,381	1,965	649	11,402	3,002	1,465
2019	46,091	22,123	4,405	2,171	1,780	697	9,994	3,426	1,495
2020	45,143	22,161	4,963	2,308	1,758	722	8,782	3,390	1,059
2021	63,113	27,687	7,874	3,173	2,491	946	15,719	3,819	1,404
2022	40,899	23,380	4,109	1,668	2,118	569	5,881	2,281	893
2023	34,678	22,001	2,262	1,329	1,719	557	3,888	2,150	772
2024	38,888	24,669	3,142	1,509	1,660	577	4,421	2,034	876

Source: Compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.5

**Structural data for Ukraine's foreign goods exports in shares of main
goods groups**

Year	Total goods exports, USD mln	Share of agricultural products, %	Share of mineral products, %	Share of chemicals, %	Share of metals, %
2005	32,184	13%	13%	11%	43%
2006	36,174	13%	9%	11%	45%
2007	46,168	13%	8%	11%	45%
2008	63,188	17%	9%	10%	43%
2009	37,134	26%	8%	9%	34%
2010	47,299	21%	11%	8%	36%
2011	62,383	21%	11%	10%	35%
2012	64,427	28%	10%	9%	29%
2013	59,106	29%	11%	9%	28%
2014	50,552	33%	10%	7%	30%
2015	35,420	41%	8%	7%	26%
2016	33,560	45%	7%	5%	24%
2017	39,701	45%	9%	5%	25%
2018	43,341	43%	9%	5%	26%
2019	46,091	48%	10%	5%	22%
2020	45,143	49%	11%	5%	19%
2021	63,113	44%	12%	5%	25%
2022	40,899	57%	10%	4%	14%
2023	34,678	63%	7%	4%	11%
2024	38,888	63%	8%	4%	11%

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.6

Structural data for Ukraine's foreign goods imports in absolute terms

Year	Total goods imports, USD mln	Agricultural products, USD mln	Mineral products, USD mln	Chemicals, USD mln	Timber and wood products, USD mln	Industrial goods, USD mln	Ferrous and nonferrous metals, USD mln	Machinery and equipment, USD mln	Other, USD mln
2005	34,377	2,635	9,925	5,085	1,132	1,650	2,407	9,903	1,640
2006	42,220	3,094	11,145	6,464	1,356	1,838	3,260	13,402	1,661
2007	57,753	3,905	14,768	8,757	1,791	2,129	4,662	19,079	2,662
2008	80,640	6,203	22,157	11,604	2,264	3,370	6,280	25,863	2,899
2009	42,477	4,936	14,306	7,969	1,545	1,894	2,587	8,453	787
2010	56,896	5,761	19,247	10,116	1,877	2,880	3,988	11,799	1,228
2011	80,414	6,347	26,514	12,505	2,094	2,951	5,522	19,208	5,273
2012	86,273	7,519	26,286	13,155	2,071	3,982	5,079	21,012	7,169
2013	81,234	8,181	21,180	13,042	2,199	3,881	4,552	18,154	10,045
2014	57,680	6,025	15,254	10,310	1,466	2,615	3,208	10,724	8,078
2015	38,875	3,412	11,186	7,541	934	1,749	1,897	7,504	4,652
2016	40,502	3,863	8,076	8,297	1,032	1,957	2,192	10,353	4,732
2017	49,364	4,267	11,973	9,576	1,147	2,127	2,878	13,569	3,827
2018	56,055	5,020	13,587	10,438	1,322	2,575	3,431	15,992	3,690
2019	60,352	5,696	12,638	10,872	1,253	3,108	3,516	19,361	3,908
2020	51,921	6,465	7,897	10,669	1,347	3,008	3,008	17,408	2,119
2021	69,755	7,666	13,999	14,392	1,484	3,671	4,221	21,845	2,477
2022	55,551	6,020	12,715	9,352	906	3,301	2,487	14,827	5,943
2023	63,813	6,930	10,376	11,151	969	3,188	3,273	19,586	8,340
2024	69,291	7,616	8,929	11,906	1,104	3,237	3,795	24,553	8,151

Source: Compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.7

**Structural data for Ukraine's foreign goods imports in shares of main
goods groups**

Year	Total goods imports, USD mln	Share of agricultural products, %	Share of mineral products, %	Share of chemicals, %	Share of machinery and equipment, %
2005	34,377	8%	29%	15%	29%
2006	42,220	7%	26%	15%	32%
2007	57,753	7%	26%	15%	33%
2008	80,640	8%	27%	14%	32%
2009	42,477	12%	34%	19%	20%
2010	56,896	10%	34%	18%	21%
2011	80,414	8%	33%	16%	24%
2012	86,273	9%	30%	15%	24%
2013	81,234	10%	26%	16%	22%
2014	57,680	10%	26%	18%	19%
2015	38,875	9%	29%	19%	19%
2016	40,502	10%	20%	20%	26%
2017	49,364	9%	24%	19%	27%
2018	56,055	9%	24%	19%	29%
2019	60,352	9%	21%	18%	32%
2020	51,921	12%	15%	21%	34%
2021	69,755	11%	20%	21%	31%
2022	55,551	11%	23%	17%	27%
2023	63,813	11%	16%	17%	31%
2024	69,291	11%	13%	17%	35%

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.8

Structural data for Ukraine's goods exports by country in USD mln

Year	2018	2019	2020	2021	2022	2023	2024
Total	42,599	45,415	44,885	62,853	40,749	34,678	38,888
Poland	2,465	2,539	2,518	4,378	5,983	4,418	4,088
Spain	1,361	1,490	1,241	1,659	1,563	2,004	2,856
China	2,200	3,521	7,002	7,886	2,453	2,404	2,394
Germany	1,526	1,769	1,497	2,278	1,786	1,847	2,272
Turkey	2,332	2,585	2,383	4,016	2,900	2,368	2,195
Netherlands	1,434	1,713	1,619	2,116	1,450	1,479	1,966
Italy	2,495	2,286	1,856	3,340	1,581	1,521	1,898
Egypt	1,555	2,251	1,615	1,940	796	1,085	1,636
Romania	653	682	787	1,204	3,638	3,630	1,531
Bulgaria	511	468	496	807	1,417	905	1,130
India	2,164	1,960	1,936	2,482	889	543	991
Moldova	785	722	678	859	920	819	945
Slovakia	713	552	355	924	1,432	1,055	897
The USA	1,092	955	966	1,595	856	518	869
Belgium	570	650	526	614	442	353	831
Czech Republic	642	667	607	1,104	1,036	848	739
France	490	549	538	846	558	471	715
Lithuania	330	395	420	544	638	626	570
The UK	537	572	586	984	363	356	568
Austria	470	514	519	869	763	553	563

Note: Totals for some years vary compared to data in Tables D.3, D.4, D.5.

Source: Compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.9

Structural data for Ukraine's goods imports by country in USD mln

Year	2018	2019	2020	2021	2022	2023	2024
Total	53,924	57,646	51,438	69,223	52,891	61,649	68,410
China	7,297	8,908	7,992	10,476	8,258	10,133	13,996
Poland	3,191	3,725	3,815	4,622	5,230	6,347	6,762
Germany	5,514	5,576	4,956	5,890	4,305	4,842	5,195
Turkey	1,656	2,310	2,371	3,189	3,330	4,681	4,201
The USA	2,916	3,251	3,033	3,294	2,146	2,842	3,453
Italy	1,827	1,910	1,988	2,500	1,678	2,162	2,459
Czech Republic	924	1,085	888	1,326	1,339	1,682	2,362
Bulgaria	257	355	286	394	2,030	2,219	2,358
Greece	269	309	315	495	756	1,374	2,066
Slovakia	507	636	1,127	894	966	1,652	1,953
France	1,437	1,611	1,434	1,730	1,208	1,740	1,605
Romania	392	514	546	653	1,413	1,503	1,565
Hungary	861	894	1,066	1,225	740	1,089	1,300
India	602	733	713	949	1,676	1,871	1,291
The UK	869	754	717	1,104	754	1,083	1,260
Lithuania	873	1,139	809	1,281	1,315	1,294	1,188
Japan	703	936	1,053	1,200	623	892	933
Netherlands	756	745	726	980	1,056	1,015	897
Spain	620	830	722	958	690	875	840
Republic of Korea	406	433	484	674	509	652	760

Note: Totals for some years vary compared to data in Tables D.3, D.6, D.7.

Source: Compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.10

Structural data for Ukraine's foreign trade in services

Year	Services exports, USD mln	Services imports, USD mln	Services trade balance, USD mln
2010	18,327	12,712	5,615
2011	21,269	13,383	7,886
2012	22,089	14,589	7,500
2013	22,613	16,119	6,494
2014	14,884	12,362	2,522
2015	12,442	11,349	1,093
2016	12,448	11,959	489
2017	14,243	13,324	919
2018	15,836	14,500	1,336
2019	17,465	15,715	1,750
2020	15,564	11,164	4,400
2021	18,391	14,420	3,971
2022	16,618	27,703	-11,085
2023	16,602	25,346	-8,744
2024	17,226	22,749	-5,523

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.11

**Structural data for Ukraine's foreign services exports in absolute terms,
main service groups**

Year	Total services exports, USD mln	Manufac- turing services on physical inputs owned by others, USD mln	Transport, USD mln	Travel, USD mln	Telecomms, computer, and information services, USD mln	Other bus. services, USD mln
2010	18,327	1,326	7,991	3,788	719	2,456
2011	21,269	1,805	9,239	4,294	1,040	2,772
2012	22,089	2,077	8,717	4,842	1,321	2,951
2013	22,613	1,951	8,478	5,083	1,782	3,239
2014	14,884	1,278	6,231	1,612	2,042	2,495
2015	12,442	1,078	5,322	1,082	2,105	1,807
2016	12,448	1,126	5,348	1,078	2,310	1,643
2017	14,243	1,419	5,922	1,261	2,760	1,963
2018	15,836	1,698	5,949	1,445	3,473	2,264
2019	17,465	1,640	6,253	1,620	4,331	2,596
2020	15,564	1,354	5,089	356	5,181	2,685
2021	18,391	1,538	4,760	950	7,107	3,073
2022	16,618	971	3,832	774	7,521	2,541
2023	16,602	824	3,789	857	6,884	2,976
2024	17,226	805	4,111	1,047	6,610	3,263

Source: Compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.12

**Structural data for Ukraine's foreign service exports in shares of main
services groups**

Year	Total services exports, USD mln	Share of transport services, %	Share of travel services, %	Share of telecomms, computer and information services, %	Share of other business services, %
2010	18,327	44%	21%	4%	13%
2011	21,269	43%	20%	5%	13%
2012	22,089	39%	22%	6%	13%
2013	22,613	37%	22%	8%	14%
2014	14,884	42%	11%	14%	17%
2015	12,442	43%	9%	17%	15%
2016	12,448	43%	9%	19%	13%
2017	14,243	42%	9%	19%	14%
2018	15,836	38%	9%	22%	14%
2019	17,465	36%	9%	25%	15%
2020	15,564	33%	2%	33%	17%
2021	18,391	26%	5%	39%	17%
2022	16,618	23%	5%	45%	15%
2023	16,602	23%	5%	41%	18%
2024	17,226	24%	6%	38%	19%

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.13

**Structural data for Ukraine's foreign services imports in absolute terms,
main service groups**

Year	Total services imports, USD mln	Transport, USD mln	Travel, USD mln	Telecomms, computer, and information services, USD mln	Other bus. services, USD mln	Govt goods and services n.i.e., USD mln
2010	12,712	4,083	3,742	369	1,660	523
2011	13,383	3,722	4,461	437	1,911	624
2012	14,589	4,036	5,104	519	1,893	595
2013	16,119	4,041	5,763	763	2,056	581
2014	12,362	2,727	5,061	582	1,527	660
2015	11,349	1,947	5,101	627	1,132	964
2016	11,959	1,934	5,970	495	1,259	1,054
2017	13,324	2,109	7,121	508	1,325	917
2018	14,500	2,237	7,899	618	1,620	691
2019	15,715	2,516	8,517	701	1,621	811
2020	11,164	1,920	4,691	748	1,339	1,039
2021	14,420	2,834	6,251	934	1,588	1,036
2022	27,703	2,482	19,759	690	711	2,785
2023	25,346	2,939	17,202	958	789	2,167
2024	22,749	3,331	14,183	1,107	1,457	1,187

Source: Compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.14

**Structural data for Ukraine's foreign service imports in shares of main
services groups**

Year	Total services imports, USD mln	Share of transport services, %	Share of travel services, %	Share of other business services, %	Share of government goods and services n.i.e., %
2010	12,712	32%	29%	13%	4%
2011	13,383	28%	33%	14%	5%
2012	14,589	28%	35%	13%	4%
2013	16,119	25%	36%	13%	4%
2014	12,362	22%	41%	12%	5%
2015	11,349	17%	45%	10%	8%
2016	11,959	16%	50%	11%	9%
2017	13,324	16%	53%	10%	7%
2018	14,500	15%	54%	11%	5%
2019	15,715	16%	54%	10%	5%
2020	11,164	17%	42%	12%	9%
2021	14,420	20%	43%	11%	7%
2022	27,703	9%	71%	3%	10%
2023	25,346	12%	68%	3%	9%
2024	22,749	15%	62%	6%	5%

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

Table D.15

Ukraine's sea transport services trade by type, 2011–2018

Year	2011	2012	2013	2014	2015	2016	2017	2018
Sea transport services exports, USD mln	1,211	1,241	1,124	852	735	663	611	522
Passenger, USD mln	3	5	5	0	0	0	0	6
Freight, USD mln	50	38	54	34	14	32	43	28
Freight, % of sea transport services	4%	3%	5%	4%	2%	5%	7%	5%
Other, USD mln	1,158	1,198	1,065	818	721	631	568	488
Other, % of sea transport services	96%	97%	95%	96%	98%	95%	93%	93%
Sea transport services imports, USD mln	671	796	799	552	402	417	443	577
Passenger, USD mln	0	1	2	0	1	2	1	0
Freight, USD mln	537	696	579	442	340	348	347	477
Freight, % of sea transport services	80%	87.5%	72.5%	80%	85%	83.5%	78%	83%
Other, USD mln	134	99	218	110	61	67	95	100
Other, % of sea transport services	20%	12.5%	27.5%	20%	15%	16.5%	22%	17%

Source: Calculated and compiled by the author based on data from the NBU (2025)

Appendix D (continued)

НАПРЯМКИ УГОДИ ПРО АСОЦІАЦІЮ – ПРОГРЕС ВИКОНАННЯ*



* Показники системи оновлюються з урахуванням процесу реорганізації системи органів державної влади.

Fig. D.1. Areas of the Association Agreement – fulfilment progress [in Ukrainian]

Source: Cabinet of Ministers of Ukraine (n.d.)