Master's thesis

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Assessing the Impact of Sanctions Against Russia: An Analysis on Shipping Activity in Norwegian Waters

Master's thesis in Economics
Supervisor: Inga Heiland
June 2024

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Abstract

This master's thesis investigates how the sanctions imposed on Russia as a response to the invasion of Ukraine in 2022 has affected the shipping activity in Norwegian waters. Some of these sanctions affect the shipping industry, such as the implementation of a port ban against Russian vessels and a price cap of $60 per barrel on Russian crude oil. However, there is evidence suggesting that some shipping companies attempt to evade these sanctions through deceptive tactics. The thesis employs two primary approaches to assess the impact of the port ban on activity in Norwegian ports. The first approach utilizes linear regression models with and without multi-way fixed effects, focusing on a specific variable of interest. The second approach employs a DiD methodology to examine variations between the pre- and post-sanction period. Furthermore, the thesis explores changes in the shipping activity in Skagerrak following the implementation of a $60 price cap on Russian crude oil utilizing linear regression models with and without multi-way fixed effects. The analysis reveals that Russian vessels spend more time in port following the imposition of the port ban compared to vessels sailing under different flags. Additionally, the proportion of tankers with Russian and FOC origin has increased through Skagerrak following the implementation of the oil price cap. It is challenging to determine whether the observed changes in shipping activity are reliable indicators of deceptive behavior. Recent news articles report a rise in deceptive practices, which aligns with findings of the thesis and provides further indications of suspicious changes to the shipping activity in Norwegian waters. As previous literature emphasizes the importance of preventing sanction circumvention, detecting abnormal changes could provide valuable insights that enables policymakers to implement further measures to diminish Russia's ability to continue financing the war against Ukraine.

Sammendrag

Denne masteroppgaven undersøker hvordan sanksjonene mot Russland, innført som en respons på invasjonen av Ukraina i 2022, har påvirket skipsaktiviteten i norske farvann. Noen av disse sanksjonene har påvirket den maritime sektoren, blant annet havneforbudet mot russiske fartøy og et pristak på 60 dollar per fat på russisk råolje. Det finnes imidlertid bevis som tyder på at noen rederier forsøker å unngå sanksjonene gjennom ulovlige taktikker. Oppgaven benytter seg hovedsakelig av to empiriske metoder for å vurdere effekten av havneforbudet på skipsaktivitet i norske havner. Den første tilnærmingen benytter lineære regresjonsmodeller både med og uten multippel faste effekter med fokus på én interessevariabel. Den andre tilnærmingen benytter seg av en DiD-metode for å undersøke variasjoner mellom perioden før og etter sanksjonen. Videre undersøker oppgaven skipsaktiviteten i Skagerrak etter implementeringen av en pristaket på russisk råolje ved bruk av lineære regresjonsmodeller både med og uten multippel faste effekter. Analysen avslører at russiske fartøy bruker mer tid i havn etter havneforbudet ble innført sammenliknet med fartøy som seiler under andre flagg. I tillegg øker andelen tankskip med russisk og FOC opprinnelse etter introduksjonen av pristaket. Det er utfordrende å fastslå om observerte forandringer i skipsaktiviteten er pålitelige indikasjoner på ulovlig aktivitet. Nylige nyhetsartikler rapporterer en økning i illegale aktiviteter som er i tråd med funnene fra oppgaven og gir videre indikasjoner på mistenksomme forandringer i skipsaktiviteten i norske farvann. Tidligere litteratur understreker viktigheten av å avverge sanksjonsunngåelse, og oppdage unormale forandringer kan gi verdifull innsikt som politikere kan benytte til å iverksette ytterligere grep for å redusere Russland sin evne til å fortsette å finansiere krigen mot Ukraina.

Table of contents

1 Introduction *6*

1.1 Research question and paper outline 6

1.2 The concept of circumventing sanctions 6

1.3 Motivation 7

1.3.1 Consequences of sanction circumvention 7

1.3.2 Suspicious shipping activity along the Norwegian coast 8

2 Background *9*

2.1 Government Sanctions 9

2.2 AIS data 10

2.3 Deceptive Behavior 11

2.3.1 Shadow fleet 11

2.3.2 Flags of convenience 13

2.3.3 "Spoofing" 15

2.3.4 Ship-to-Ship transfers 16

2.3.5 Research vessels 16

2.3.6 Ship characteristics 17

2.3.7 Time in port 18

3 Previous literature *18*

3.1 Economic effects of sanctions 19

3.2 Political effects of sanctions 20

3.3 Sanction circumvention in practice 21

4 Data *22*

4.1 Dataset: Arrivals/Time in port 22

4.1.1 Outcome variable 23

4.2 Dataset: Arrivals/Sea-web 23

4.2.1 Outcome variables 24

4.3 Dataset: Crossings Skagerrak 24

4.3.1 Outcome variables 25

4.4 Data source 25

4.5 Data coverage 26

4.5.1 Arrivals/Time in Port 26

4.5.2 Arrivals/Sea-web 27

4.5.3 Crossings Skagerrak 27

4.6 Strengths and weaknesses of the data 28

5 Descriptive statistics and empirical evidence *28*

5.1 Activity at Norwegian ports 29

5.1.1 Descriptive statistics: Number of vessels and vessel types 29

5.1.2 Descriptive statistics: Vessel characteristics and time in port 31

5.1.3 Empirical evidence 33

5.2 Activity in Skagerrak 46

5.2.1 Descriptive statistics: Number of vessels and vessel types 46

5.2.2 Descriptive statistics: Vessel characteristics 48

5.2.3 Descriptive evidence: Evolution of crossings 49
5.2.4 Empirical evidence 50

6 Discussion ***56***

6.1 The impact of economic sanctions on the maritime industry **56**

6.2 Relevant extensions **60**

7 Conclusion ***61***

Bibliography ***63***

1 Introduction

1.1 Research question and paper outline

This master's thesis contributes to the existing literature on utilizing satellite data on ship positions (AIS) with the purpose of detecting sanction circumvention. Sanctions are implemented to influence a country's behavior by imposing economic incentives or limiting their ability to engage in unwanted activities. In response to the Russian invasion of Ukraine in February 2022, Norway has imposed restrictive sanctions on Russia, including trade restrictions on Russian crude oil (Prop. 69L (2020–2021), p. 9). However, there is evidence suggesting that some shipping companies attempt to evade these sanctions through deceptive tactics aimed at concealing the origin and destination of the goods they transport (Windward, n.d.-b). The main research question of this thesis is: How do the sanctions on Russia affect the shipping activity in Norwegian waters? Using data from AIS and New Ship Rep, the thesis aims to identify an increase in irregular port calls, route deviations and other deceptive practices following the implemented sanctions against Russia. There is limited research available on identifying deceptive shipping practices after the imposition of the sanctions. Therefore, this thesis aims to make a valuable contribution to the literature with the aim to detect deviating shipping activities within Norwegian waters.

The structure of this master's thesis is as follows: Chapter 2 provides relevant background information on three topics: The Norwegian government's sanctions against Russia, AIS data, and deceptive behavior. Chapter 3 reviews previous literature focusing on economic and political effects of sanctions, and how sanctions are circumvented in practice. Chapter 4 describes the data applied in the analysis. Chapter 5 introduces the specifications used in the analysis, presents descriptive statistics, and discusses empirical results. Chapter 6 discuss the results, limitations, and potential extensions of the analysis. Finally, Chapter 7 concludes the findings from the thesis.

1.2 The concept of circumventing sanctions

In response to Russia's invasion of Ukraine, the EU and other western countries, including Norway, have imposed various sanctions on trade with Russia. Some of these sanctions specifically affect the shipping industry. (Sanksjonsforskrift Ukraina (territoriell integritet mv.), 2014, §19a). Despite the enforcement of these sanctions, there has been an increase in illicit shipping activity, as reported by Windward (Windward, n.d.-b). It is reasonable to assume that this also applies to Norwegian territory as the findings from Braw (2024) reports that there are on average 12 shadow vessels sailing through Norwegian waters every day.

It is suspected that some Russian vessels deactivate their AIS transmitter while engaging in illicit activities, allowing them to operate undetected during illicit ship-to-ship transfers and continue trading sanctioned or embargoed goods (Windward, n.d.-b). Another evasion tactic involves sailing under flags of open registries to appear non-sanctioned, which allows vessels to carry sanctioned goods and engage in deceptive practices (Windward, n.d.-a). A wide known concern is that these vessels do not follow standard maritime safety rules, thus causing a higher risk of accidents at sea (Aalberg et al, 2022). Huish (2017) highlights how the use of evasion tactics, such as flags of convenience, allowed the continuation of marine traffic to North Korean ports despite the imposition of sanctions against North Korea. Furthermore, there have been observations of changes in the ship characteristics of vessels departing Russian ports through the Baltic Sea, particularly between April and September of 2022. It is believed that these changes are related to illicit behaviors conducted by Russian firms or their allies. (Braw, 2024). Therefore, the thesis will not only focus on activity in Norwegian ports and waters but also investigate irregular changes in ship characteristics, such as size and age.

1.3 Motivation

1.3.1 Consequences of sanction circumvention

On 24 February 2022, Russia invaded Ukraine. Consequently, international sanctions were imposed on Russia to de-escalate the conflict. The sanctions aim to target Russia's economy and limit their access to weapons and resources to finance the war against Ukraine (Ozili, 2022). Sanctions have become an important tool to correct unwanted behavior by countries. Previous research has shown that sanctions imposed on Russia following the annexation of Crimea in 2014 effectively altered trade flows to and from Russia. It is likely that when sanctions are imposed on Russia, the country seeks alternative non-sanctioning nations for trade opportunities. Therefore, the effectiveness of sanctions depends on coordination among the sanctioning counties. (Flach et al., 2023). For instance, Windward reports that Russia's trade flow of crude oil has shifted to third countries, such as India and China, following the invasion of Ukraine. (Windward, n.d.-a). When Russia is able to evade the sanctions, it undermines the intended impact, rendering them as a merely symbolic gesture of disapproval

(Huish, 2017). Additionally, this raises concerns regarding Russia's ability to effectively undermine the sovereignty of other nations.

1.3.2 Suspicious shipping activity along the Norwegian coast

There have been numerous reports from newspapers of suspicious shipping activity along the Norwegian coast and waters. One of these articles highlights how Russian fishing vessels are frequently appearing over oil and gas fields or near military drills. Using AIS data, they reveal that over the past 10 years, at least 50 ships have had opportunities to gather information from the Nordic regions undetected (Eriksen et al., 2023). In a separate article, "Bergens Tidende" (BT) reports that Russian research vessels have been spotted along the Norwegian coast following the outbreak of the war. Tracking data from Marine Traffic shows these vessels sailing across gas pipes in Norwegian territory and through Skagerrak (Johansen et al., 2022). Law enforcement warnings have been issued regarding Russian vessels with deviating sailing patterns along the coast and instances of AIS manipulation. Inspections revealed that these ships were absent from the indicated locations. Additionally, it is stated that similar concerns may apply to vessels from other nations with a relatively large share of Russian citizens among their crew (Strand, 2023). Further, in December 2022 it was reported that approximately 400 oil tankers had been bought by unknown buyers and newly established companies, which could suggest that these are used to smuggle Russian crude oil or other sanctioned goods. There has also been a shift in flag registries, with a decrease in ships registered under European countries and an increase in ships registered in Panama and Liberia (Peachey, 2022). The presence of ships sailing under flag of convenience through the Baltic Sea has significantly increased after the Russian invasion of Ukraine, potentially indicating that they are engaging in illegal activities while passing through Skagerrak. (Braw, 2024).

The rise of the so-called shadow fleet to carry Russian crude oil and other sanctioned goods not only enables Russia to continue financing the war against Ukraine, but also poses safety and environmental risks, such as collisions and oil spills (Aalberg et al., 2022). It is crucial to detect deceptive shipping practices by firms affiliated with the shadow fleet, as it enables policy makers to implement further sanctions to impede such illicit behavior. There is currently limited research available which aims to detect how the sanctions affect the shipping activity in Norwegian ports and waters. However, numerous articles and papers suggest that there has been an increase in deceptive shipping practices conducted within Norwegian territory after the invasion of Ukraine. Consequently, using two main approaches, linear regression models with and without multi-way fixed effect, and a difference-in-difference approach, this thesis aims to identify unusual changes in the shipping activity following the implementation of sanctions against Russia.

2 Background

This chapter starts by presenting the Norwegian government's imposition of sanctions against Russia with particular focus on the maritime industry. Then, it proceeds to give a general introduction to AIS data. Finally, the chapter presents an overview of deceptive behavior employed by shipping companies to conceal illicit activities at sea.

2.1 Government Sanctions

The Norwegian sanctions against Russia aim to reduce Russia's ability to finance the ongoing war against Ukraine. Recently the sanctions have been intensified, thereby further restricting the opportunity to conduct trade with Russia. On 29 April 2022, the Norwegian government decided that Russian vessels are prohibited to enter Norwegian mainland, and by 08 May 2022 the ban was in effect. Furthermore, Russian vessels that are re-registered under a different flag after 24 February 2022 will also be included in the port ban. The ban includes commercially operated vessels weighing 500 gross tons or more that engage in international traffic, as well as yachts, and certain leisure crafts. Russian fishing vessels calling at Tromsø, Båtsfjord and Kirkenes are specifically exempt from the port ban as of 14 October 2022. However, if the fishing vessel is owned by listed individuals, the other sanctions may still be applicable (Sanksjonsforskrift Ukraina (territoriell integritet mv.), 2014, §19a). On 5 December 2022, the Norwegian Government adopted a price cap of $60 per barrel on Russian crude oil (Sanksjonsforskrift Ukraina (territoriell integritet mv.), 2014, §17k). The sanction corresponds to the price cap implemented by the EU and G7 countries. In a press release by the Norwegian government, it is reported that the aim of the sanction is to reduce Russia's income from oil exports to third countries (Norwegian Government, 2022a).

On the 23 June 2023, the European Union (EU) officially adopted its eleventh sanctions package against Russia. The primary goal of this package was to effectively prevent any attempts to circumvent the existing sanctions, and thereby strengthening their impact. Among these sanctions is the ban on granting port access to vessels participating in ship-to-ship transfers suspected of violating the ban on oil importation or exceeding the price cap. The ban also includes vessels that fail to notify authorities about STS-transfers, and vessels that manipulate or disable the navigation tracking system while transporting Russian oil. (European Commission, 2023a). On the 13 December 2023, the EU adopted its twelfth sanctions package. This package aims to impose additional bans on trade with Russia, as well as measures to reduce sanction circumvention. Tankers will be closely monitored to investigate how they are used to evade the oil price cap and regarding sale of tankers to third countries. Additionally, it includes stricter measures targeting third-country companies involved in circumventing the sanctions. (European Commission, 2023b). Subsequently, on the 23 February 2024, the EU implemented its thirteenth sanctions package to further combat the issue of sanction circumvention by third-country companies (European Commission, 2024). As of 19 March 2024, the Norwegian government has implemented additional sanctions, which aligns with these sanction packages. (Sanksjonsforskrift Ukraina (territoriell integritet mv.), 2014, §§ 19aa, 19ab, 19g).

2.2 AIS data

The empirical analysis utilizes satellite data on ship positioning obtained from Norway's national Automated Identification System (AIS) and is provided by the Norwegian Coastal Administration (NCA). The data gives a continuous overview of the positioning of vessels along the Norwegian coast and waters, as it enables vessels to send out signals identifying themselves to other vessels and coastal authorities. The information provided includes details regarding identity, ship type, position, and other voyage-related information. (Adland et al., 2017). The International Maritime Organization (IMO) requires all international voyaging vessels of 300 gross tonnage or more, non-international voyaging cargo vessels of more than 500 gross tonnage, and all passenger ships to have an AIS transmitter (International Maritime Organization, n.d.). Consequently, the AIS has achieved extensive global coverage. (Ford et al., 2018)

AIS was initially developed to prevent ships from colliding, but over time it is increasingly used to monitor vessels activities, both at sea and in ports. (Ford et al., 2018). The Norwegian government use AIS data as a measure to enhance maritime safety and emergency preparedness in Norwegian waters. Surveilling the maritime traffic with AIS contributes to uncover deviations and enable authorities to implement necessary measures to reduce the risk of accidents and monitor potential high-risk vessels. (Norwegian Coastal Administration, n.d.). However, there are some disadvantages of using AIS. Firstly, although the transmissions should occur with consistent intervals, the AIS data may have transmission gaps. There are three reasons why this happens. 1) there is a high density of vessels in one location, 2) poor quality transmission due to the equipment being faulty or poor quality, and 3) intentional disabling of AIS transmissions. Another possible concern with AIS is whether the transmissions are an accurate representation of the vessel's position, bearing, and speed. (Ford et al., 2018). Although the AIS provide information regarding the whereabouts of the vessel and its activity, it does not provide insight on movement of the cargo itself. This means that knowledge about the actual shipment route remains uncertain. (Heiland et al., 2023).

2.3 Deceptive Behavior

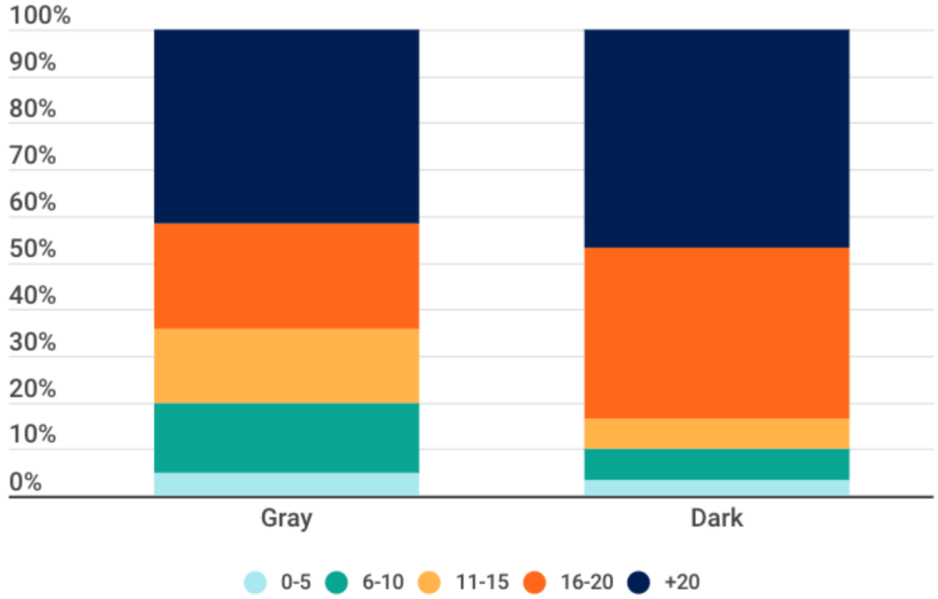
In recent years private firms have started to offer services to search for suspicious shipping behavior, such as Windward and Lloyd's List Intelligence. Bad entities engage in illicit activities by avoiding detection, sanctions, and regulations while executing oil smuggling and illegal trading. Windward states that after the implementation of Russian sanctions, there have been an increase in deceptive shipping practices. Specifically, a combination of dark activities, such as location manipulation and ship-to-ship transfers. (Windward, n.d.-b)

2.3.1 Shadow fleet

Windward showcases how the war between Russia and Ukraine has created a shadow fleet to evade sanctions, for example to conduct illicit oil smuggling. Windward identifies a three-tiered system of vessels to show how Russia exploit AIS data. 1) Cleared fleet – Tankers who do not exhibit any suspicious behavior. 2) Gray fleet – New phenomenon developed after the war. There were established overseas companies with the intention of obscuring the origin and ownership of vessels to appear non-sanctioned. A significant number of gray fleet vessels also participate in frequent "flag hopping". It is difficult to determine the legality and sanction compliance in the case of gray fleets. 3) Dark fleet – Vessels who engage in "dark activities" to move cargo, such as disabling the AIS transmitter or manipulation of ID and location. (Windward, n.d.-c)

The shadow fleet mostly consists of older ships that fail to meet the requirements of the industry's standard western insurance. These vessels frequently alter their name and flag registration. Figure 1 provides a visual representation of the age distribution of grey and dark fleet vessels. It is evident from the figure that older vessels dominate the representation of both fleets. (Windward, n.d.-c)

Figure 1: From Windward (n.d.-c). Age distribution of gray and dark fleet vessels



Since the sanctions were imposed against Russia in 2022, there have been a significant increase in the number of vessels joining the shadow fleet. 12 months into the war, 400 crude-oil vessels had joined the dark fleet, accounting for approximately 20 percent of the world's total crude-oil fleet. In October 2023 it was estimated that the size of the shadow fleet had increased from 1100 vessels to 1400. However, it is reasonable to believe that there are dark numbers in this estimation, and it may not reflect the true extent of the shadow fleet's presence (Braw, 2024). Additionally, Braw (2024) reports that an analysis conducted by the NCA suggest that the average number of journeys by crude-oil tankers from Russia through the Baltic Sea increased significantly between 2020 and 2023. The author states that, on average, twelve shadow vessels pass through Norwegian waters each day.

Androjna et al. (2024) states that the existence of the shadow fleet holds considerable significance due to its non-compliance with established maritime regulations. The disregard of standard safety protocols suggests that the dark vessels engaging in illicit activities are exposed to a higher risk of accidents. Further, the authors states that accidents involving shadow tankers have increased worldwide (Androjna et al., 2024). The Maritime Executive (2024) reports that 02 March 2024 a dark fleet tanker was involved in a collision off the coast of Denmark, as it reportedly was headed to a Russian port to load oil. The vessel's current owner is undisclosed, but its manager was launched in late 2022 and operate three Panama-flagged older tankers. (The Maritime Executive, 2024). In October 2023 it was observed that two-thirds of Russian vessels carrying crude oil were insured by "unknown" (Braw, 2024). The paper by Byrne et al. (2023) suggests that a lack of vessel ownership data is an indicator of high risk and finds that there is a 69.2% chance that these vessels carry a "Warning" or "Severe" compliance status. It is important to note that this is not official assessment criteria and is assigned by S&P Global Market Intelligence. However, the assessments imply that these vessels are involved in dark activities, such as STS-transfers, AIS manipulation or is included on watch-lists of sanctioned vessels. (Byrne et al., 2023)

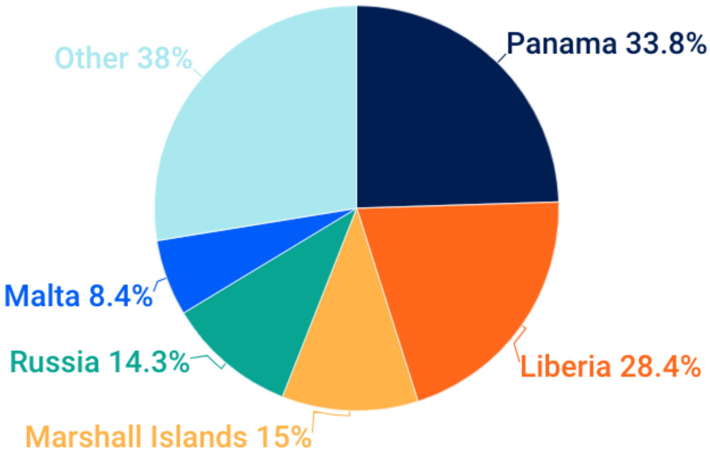
2.3.2 Flags of convenience

The term "flag of convenience" (FOC) refers to the situation where a vessel is registered in a different country than the country of ownership. Countries that do not impose requirements for nationality or residency are called "open registries". Shipowners can register vessels under these flags and adhere to the laws of that registry. A FOC then refers to the flag of an open registry country that is flown by a shipowner. There are several reasons why some shipowners opt for this practice. Using FOC is a tactic to hide illegal behavior, and some open registries allow shipowners to remain anonymous. This poses challenges when pursuing legal action against such firms and shipowners. By employing FOC, they can evade or bypass strict regulations and safety standard requirements by their home country. Additionally, it can reduce costs related to tax rates, and they are able to avoid laws that protect workers' conditions and wages. (Windward, n.d.-a). The International Transport Workers Federation lists more than 40 FOC countries, including Panama, Bahamas, Cyprus, and Liberia. (International Transport Workers Federation, n.d.)

Windward illustrates the distribution of flags with the highest number of dark fleet vessels. Figure 2 provides a visual representation of this distribution, revealing how 62% of dark fleet vessels are flagged under 5 countries. In addition to Russia, the other four countries are on the FOC list. Specifically, 33.8% of dark fleet vessels are registered under Panama, and 28.4%

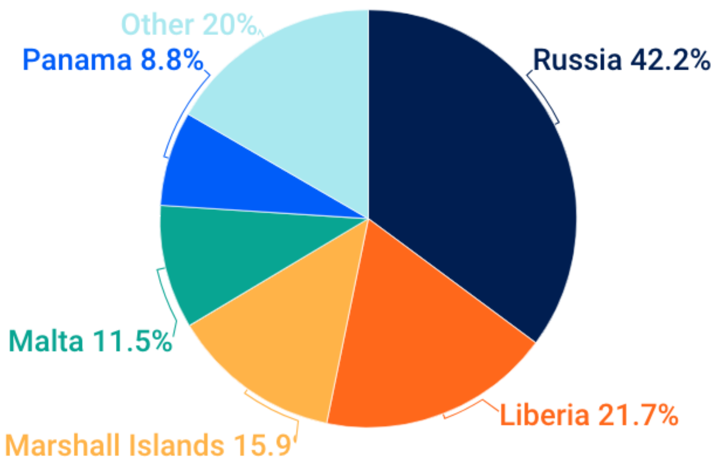
under the Liberian flag. Further, Windward also highlights that 11% of dark fleet vessels are flagged under European flags, where 8.4% is flagged under Malta. (Windward, n.d.-a)

Figure 2: From Windward (n.d.-a). Percentage distribution of dark fleet vessels



The distribution of flags for gray fleet vessels is depicted in Figure 3 by Windward. They point to the same top five flags as for dark fleet vessels, which make up 80% of the distribution. However, there are some notable differences in the percentage distribution. The chart shows that 42.2% of gray fleet vessels are registered under Russia, and 21.7% under the Liberian flag (Windward, n.d.-a).

Figure 3: From Windward (n.d.-a). Percentage distribution of gray fleet vessels



The study conducted by Miller et al. (2020) investigates how FOC are used in the context of illegal, unreported, and unregulated (IUU) fishing. The authors aim to empirically examine what makes a FOC desirable to foreign vessels. They find that shipowners who evade fisheries management rules to exert illegal behavior employ tactics such as adopting FOC. The most sought-after flags are those associated with countries that exhibit a lack of cooperation with international efforts to promote sustainable management of shared fish stocks and preventing IUU fishing. These flags are easily acquired, and many have fishing access in a high number of countries' exclusive economic zones (EEC) and areas managed by regional fisheries management organizations. (Miller et al., 2020)

In a report by Braw (2024) the author highlights how there have been an increase in flags of convenience vessels departing Russian ports through the Baltic Sea, and along the Norwegian western coast. Among these, the dominant flag state is Liberia, followed by Marshall Islands, Russia and Panama. As vessels not flagged by countries classified as FOC have a decreasing number of departures from Russian ports, the increase in vessels flagged by FOC could suggest a rise in shadow vessels operations. (Braw, 2024)

2.3.3 "Spoofing"

"Spoofing" is a method that involves disabling the AIS transmitter to avoid tracking. While the transmitter is inactive the firm engage in illegal activities, such as ship-to-ship (STS) transfers and illegal fishing. This suggests that shipping firms have the possibility to exploit the weaknesses of AIS data to conceal deceptive practices. (Androjna et al., 2021). According to Androjna et al. (2024), this vulnerability is due to the AIS data not being encrypted and that there are no mechanisms to perform authentication, timing, and validity checks. An example of spoofing is mentioned in the same study, as the authors became aware of a Russian vessel outside Greece that, according to the AIS system, nearly collided with another vessel. The AIS data showed that the vessel was on a collision course against another vessel before it seemingly performed a rapid change of course. Satellite images revealed that the Russian vessel was showing incorrect positioning while participating in an STS-transfer. (Androjna et al., 2024). In an earlier study conducted by Androjna et al. (2021) they examined an instance that occurred in July 2020 near the Galapagos Islands. According to AIS data the ships were located around New Zealand but had actually been observed 10,000 km away from the reported location. The ships were close to the Galapagos Islands, an area known for previous incidents of illegal fishing. The paper revealed that a significant number of fishing vessels had been deactivating their AIS transmitter for eight hours or more, presumably to engage in illicit activities within the territory of Galapagos Islands. (Androjna, 2021)

2.3.4 Ship-to-Ship transfers

A ship-to-ship (STS) transfer is a cargo transfer that occur at sea and is mostly performed to handle crude oil, petroleum products and liquified gas. This usually happens at anchorages outside territorial waters or further at sea where ships drift while conducting STS transfers. If the transfers are performed incorrectly, the process will induce a high risk of oil spills and accidents. Therefore, there are strict regulations and safety protocols to ensure safe and efficient transfers. Legitimate transfers are conducted in accordance with IMO regulations and other relevant regulations to ensure safe maritime trade. Illicit STS transfers are conducted to disguise the violation of sanctions and embargoes, smuggle goods, or to engage in other illegal trade. Such transfers have increasingly become a method of oil smuggling employed globally, operating beyond the traditional trade route (Androjna et al., 2024).

Since the Ukrainian war, Russian vessels and those affiliated with Russia have been banned from entering European Union ports. However, on 24 April 2022 an older Liberian-flagged crude oil tanker anchored off the Romanian coast. The ship did not move for several months and allegedly served as a storage tanker for transshipment of Russian oil. (Androjna et al., 2024). Furthermore, the Norwegian Coastal Administration (NCA) found a notable increase in transportation of crude oil, and that it was transported over longer distances. It is likely that some of the oil leaving Russia's Baltic ports is delivered to other tankers through STS transfers. Some vessels, monitored by the NCA, were found showing unexplained stops in the Mediterranean and Arabic Seas, which suggests likely STS activities. (Braw, 2024)

2.3.5 Research vessels

In a news article by "Aftenposten" it is reported that Russian research vessels are utilized for military purposes by the Russian government. It is stated that some Norwegian firms within the oil- and gas industry has reported observations of Russian research vessels seemingly engaging in surveillance and mapping of pipes in Norwegian territory ("*Angivelig russisk kartlegging",* 2021). A news article from "BT" states that according to data from Marine Traffic, there has been observations of multiple instances of Russian research vessels sailing above Norwegian gas pipes after Russia invaded Ukraine in February 2022. The data reveals that some of these vessels have been calling to Russian marine bases. Further, the article shows that many of these vessels have been sailing along the Norwegian coast from ports in Murmansk to ports in St. Petersburg and Kaliningrad (Johansen et al., 2022).

2.3.6 Ship characteristics

Braw (2024) suggests that the activity of tankers departing Russian ports through the Baltic Sea can give good indications of the shadow fleet's activity. Still, she mentions the importance of recognizing that not all tankers departing these ports are dark ships. If there are significant and surprising changes to the characteristics of vessels sailing under the Russian flag or FOC, this could also be potential indicators of irregular deviations in their behavior or activities at sea. This includes changes in the average size and age of vessels, particularly those flagged under Russia or FOC.

Braw (2024) finds that between 2020 and 2022 the total deadweight of crude oil tankers sailing from Russian ports through the Baltic Sea had increased considerably and highlights how this increase began in April 2022. Further, if there are highly irregular changes to the size of Russian or FOC vessels, this could be an indicator of deceptive behavior. Such changes might be due to firms and owners replacing their ships with either larger or additional vessels that are able to transport relatively more cargo. Thus, they are able to transport larger amounts of Russian crude oil or other illegal goods than they did prior to the imposition of the sanctions.

According to Tradewinds, the age profile of vessels transporting Russian oil changed significantly in 2022. They found that 28% of the vessels carrying Russian crude oil in January 2022 was 15 years or older, while by December 2022 this number had increased to about 50% (Coyne, 2023). The latest report by Equasis provides an overview of the world merchant fleet from 2022 and displays tables of the age distribution of the fleet based on age, size and ship type. Thus, the report can be used to compare the age distribution of the shadow fleet to the average age distribution of the world fleet. Most notably, a significant share of oil and chemical tankers is reported to be under the age of 25 years, while a prominent share of fishing vessels is above the age of 25 years (Equasis, 2022, p. 6-11). This implies that larger vessels, e.g. tankers, typically are relatively new compared to smaller ship types, such as fishing vessels. However, this suggests that the age distribution of the shadow fleet as illustrated in Figure 1 does not align with the age distribution of the world fleet. This is important to note as there are different risks associated with higher age of vessels, especially for tankers carrying crude oil or other potentially hazardous materials. The research conducted by Aalberg et al. (2022) and Aalberg and Bye (2018) reveals that age can serve as a significant risk indicator associated with navigation accidents, thereby implying that older vessels exhibit a higher likelihood of being involved in such incidents.

2.3.7 Time in port

Another interesting factor to examine is whether the imposition of a port ban against Russian vessels have caused an increase in irregular port calls or unusual changes to how much time vessels spend in Norwegian ports. This is particularly relevant given the exemption of Russian fishing vessels from the port ban. It is possible that these vessels secretly engage in prohibited trade, potentially with other goods than fish. Thus, this could affect whether they stay longer or shorter at port. Further, when the Norwegian Government expanded the port ban to only allow port calls by Russian fishing vessels to the ports of Tromsø, Båtsfjord and Kirkenes, it was also required inspections of all Russian vessels calling to these ports. It was seen as a necessary measure to reduce the possibility of Norway being used as a transit country to transport illegal goods to Russia. (Norwegian Government, 2022b). It is reasonable to assume that more frequent inspections of Russian vessels will result in an increase in the time these vessels spend in port. However, the expansion of the port ban and more frequent inspections of Russian vessels might have led to a decrease in illegal behavior to avoid detection by Norwegian authorities. This could suggest that Russian vessels spend less time in port following the implementation of the sanction.

3 Previous literature

Sanctions is a policy tool used to promote behavioral changes from sanctioned countries and entities (Flach et al., 2023). Many have investigated whether sanctions work, and the consequences of implementing sanctions and embargos. The thesis investigates whether the sanctions implemented against Russia have affected the shipping activity in Norwegian waters, and thus how sanctions from the Norwegian government have incentivized Russia and their collaborators to utilize different evasion tactics. As mentioned in papers like Huish (2017) and Sang-Hoon (2020), sanctions may not have the intended effect because of sanction circumvention. The related literature on maritime evasion tactics is limited, and especially surrounding “new” tactics that has surfaced following Russia’s invasion of Ukraine in 2022. Therefore, the focus of this thesis is to provide indications of sanction circumvention in Norwegian territory.

Chapter 3 present related literature on how sanctions can affect several aspects of an economy. Therefore, the chapter is divided into three sections. Section 3.1 presents economic effects of sanctions, while section 3.2 discusses political effects. In section 3.3, different aspects of sanction circumvention are presented. This includes related literature on what constitutes effective maritime sanctions, different evasion tactics, and how this has affected the efficiency of previously imposed sanctions on regimes like Russia and North Korea.

3.1 Economic effects of sanctions

From an economic perspective, sanctions are deemed “effective” if they reduce economic activity in sanctioned countries and sectors. Flach et al. (2023) measures the effects of the sanctions imposed on Russia in response to the annexation of Crimea between 2014 and 2019. The results show that Russia had a loss in real income of 0.3% and suggests that a full decoupling by the EU and its allies from Russia would amplify this effect to over 4%. Further, they argue that deep and coordinated sanctions would significantly increase the economic burden on Russia. The authors observed a shift in Russia’s trade flow as a response to the sanctions, with increasing exports to third countries and developing countries, and reduced imports from the G7 countries. (Flach et al, 2023). Gaur et al. (2023) supports this claim, as the authors find that India’s import of Russian oil increased from 1 percent to 35 percent after the implementation of the oil price cap in 2022.

Similarly, Demertzis et al. (2022) studied the impact of EU sanctions on Russia’s economy following the invasion of Ukraine in 2022. Their findings support the notion that greater coordination among the sanctioning countries is necessary to effectively limit the Russian economy, aligning with the conclusions from Flach et al. (2023). Additionally, Mahlstein et al. (2022) examines the impact of a trade embargo by 40 allied countries against Russia, highlighting a significant deterioration in Russia’s terms of trade. The authors states that the sanctioning countries that are most integrated in Russia’s economy stands to experience the greatest loss, while some resource-rich allies experience welfare gains. Further, in support of the economic efficiency of sanctions, Iikka Korhonen (2019) studied the aftermath of western sanctions and Russia's countersanctions considering their invasion of Crimea in 2014. Like previous studies, the author highlights how the sanctions negatively affected the Russian economy. Notably, the author suggests that most of the sanctions' efficiency stems from restricting the access of Russian companies' finances, thereby reducing investments in Russia.

3.2 Political effects of sanctions

The paper by Felbermayr et al. (2018) studies the link between the economic effects of sanctions and political outcomes, thereby the likelihood of sanctions' success. Earlier findings indicate contradictive results, where political scientists' assessment is that the sanctions do not work while economists' states that the sanctions are effective and impactful. Whether the sanctions are a success or not, depends on the foreign policy goals and the efficiency of the sanctions in achieving them. Additionally, the study emphasizes how the economic sanctions could affect political decisions in the country and influence the government's domestic political power (Felbermayr et al., 2018). Mazaheri (2010) investigates the sanctions imposed on Iraq and revealed how the sanctions have strengthened rather than weakened the sanctioned government. By utilizing a comprehensive program with high demands on the leader and a prolonged duration of the program, the sanction produced opposite effect on domestic politics and strengthened Saddam Hussein's government. Drury and Peksen (2009) find that economic sanctions may weaken the level of political freedoms in the sanctioned countries.

Gould-Davies (2018) looked at the sanctions' effectiveness on Russia considering their invasion of Crimea, revealing limited success in inducing political settlement. Despite reducing an escalation, sanctions failed to moderate Russia's policy due to their importance of influence over Ukraine. To circumvent the sanctions, in the long run Russia may adopt closer ties with China, undermining western leverage. Ellitott et al. (1990) suggests caution against overstating the efficiency of sanctions due to limited success in achieving major policy changes in target countries across various cases.

The evidence from chapter 3.1 suggests that economic sanctions have previously been effective in terms of a negative impact on the economy of the sanctioned country, while studies like Gould-Davies (2018) and Mazaheri (2010) suggests the sanctions' influence on country's policies is ineffective. Gaur et al. (2023) supports this, where they find short-run negative economic costs to Russian firms following the invasion of Ukraine in 2022. However, over time their economy improves, suggesting they develop a robust strategy to deal with any potential negative consequences of sanctions. Further, the authors conclude that the Russian invasion in 2022 demonstrates how economic sanctions have limited effect on the foreign policy of a sovereign state.

3.3 Sanction circumvention in practice

A reason why sanctions may not have the intended effects is sanction circumvention. There is currently limited academic evidence on how sanctions are circumvented in practice, particularly in the maritime sector. Yet, papers like Huish (2017) and Schott (2023) identifies different circumvention tactics in the maritime sector, employed by countries like Russia and North Korea. Moreover, it is provided suggestions of alternative approaches to limit sanctioned countries' trade opportunities more effectively.

Huish (2017) evaluates the effectiveness of maritime sanctions against North Korea. Huish identifies four circumvention tactics that allows marine traffic to North Korean ports to continue: flags of convenience, false identification, offshore ownership, and shell-firm owners, managers and insurers. The findings from Huish (2017) suggests that the North Korean regime has the means to circumvent many of the sanctions, thereby highlighting the inefficiency of the maritime sanctions. Similarly, Grant et al. (2020) argues how vessels that engage in maritime sanction evasion are largely flagged by open registries and have been associated with violations of various sanction regimes, including those against North Korea. Another example of how sanctions are circumvented in practice is related to the accession process for WTO membership. Javorcik and Narcisco (2017) suggest that tariff evasion was an unintended consequence of the accession process. Importers and customs officials' ability to misrepresent import prices was restricted after joining the WTO. However, the authors find evidence of alternative evasion tactics, such as underreporting of quantities, smuggling, and product misclassification. They argue that the overall level of evasion remained unaffected.

Sang-Hoon (2020) analyzes the conditions for effective maritime sanctions against North Korea and refers to the failure of early economic sanctions. He argues how this led to the use of "smart sanctions", which target supporters of the regime by limiting North Korea's trade opportunities. Sang-Hoon describes the importance of preventing the regime's maritime circumvention tactics as one of three conditions for effective sanctions. This supports the findings from Huish (2017), which suggests that instead of solely sanctioning the North Korean regime, a more effective measure would be to impose restrictions on capital flow that allows the continuation of marine traffic to North Korea. The findings from Huish (2017) and Sang-Hoon (2020) corresponds to the EU's latest sanction packages, which aim to reduce Russia's possibility of evading the sanctions, as outlined in chapter 2.1.

Schott (2023) highlights how Russia's efforts to circumvent sanctions after the invasion of Ukraine in 2022 only have had small-scale success regarding transshipping goods through middle eastern and Asian countries. The author argues that, over time, costs related to the sanctions will be an increasing liability for the Russian economy and their ability to finance the war. Furthermore, the author argues that the G7 price cap on Russian oil has not blocked Russia's export of oil and products, and references articles that state how some oil companies underreport prices and store money in offshore trading companies, which Russia likely has access to.

4 Data

This chapter provides an overview of the data and variables applied in the analysis, along with explanations of the different datasets. Chapter 4.1 outlines the setup of the dataset *Arrivals/Time in port,* as well as its key variables. In chapter 4.2, the structure of the dataset *Arrivals/Sea-web* is explained, along with essential variables for the analysis. Additionally, chapter 4.3 describes the structure of the dataset *Crossings Skagerrak.* Furthermore, chapter 4.4 provide information regarding the sources from which the datasets were extracted, and chapter 4.5 explains the coverage of the different datasets. Lastly, chapter 4.6 describe the strengths and weaknesses of the data used in the analysis.

4.1 Dataset: Arrivals/Time in port

The main dataset utilized in the analysis is derived from the "Arrivals and Departures for each port" (*Arrivals*) and has been obtained from the Norwegian Coastal Data Center (NCDA) provided by the NCA. The dataset contains variables that display MMSI, IMO, ship name, ship type, ETA, GT and location. Specifically, the ship types considered in this dataset are fishing vessels and tankers[1]. The data includes all ports in Troms and Finnmark. Each observation in the dataset corresponds to a vessel's arrival to one of these ports. In order to ascertain the duration of time that vessels spend in these ports, it is essential to include another dataset, *Time in Port*. The *Time in Port* dataset comprises variables such as ship name, ship type, ETA, time in port, location, and location type. Similarly to the *Arrivals* dataset, an observation is perceived when a vessel arrives at a port. However, while the *Arrivals* dataset enables identification of a vessel's origin, it does not register the duration of time spent by each vessel in port. Conversely, the *Time in Port* dataset it is possible to observe the duration of time a vessel spends in port. However, the dataset is unable to identify the flag under which a vessel is registered, which is essential for the analysis. The two datasets combined, *Arrivals/Time in port*, is thereby able to provide valuable information regarding shipping activity at Norwegian ports.

4.1.1 Outcome variable

The outcome variable is a logarithmic transformation of the duration (in hours) that each vessel spends in a port. This is used in a difference-in-difference framework to examine how much time vessels spend in port compared to other vessels after the implementation of the port ban. The primary objective of this analysis is to demonstrate the impact of the sanction on shipping activity in Norwegian ports and assess whether Russian and FOC vessels exhibit unusual changes in their duration spent in port. These findings have the potential to provide valuable insights into possible illicit behavior.

4.2 Dataset: Arrivals/Sea-web

To obtain additional information about the vessels beyond what the NCDA can provide, data from *Sea-web* have been incorporated with the Arrivals dataset from chapter 4.1. The dataset *Arrivals/Sea-web* primarily aims to acquire data regarding the age of ships. The dataset provides variables such as MMSI, IMO, ship name, ship type, flag, and when the vessels are built. This enables the merged data to provide information regarding age and size distributions before and after the sanctions were introduced. The dataset includes the same ports and ship types as in section 4.1.

[1] Tankers include crude oil tankers, crude/oil products tankers, products tankers, chemical/products tankers, chemical tankers, LPG tankers, LNG tankers, and asphalt/bitumen tankers

The dataset sums the number of Norwegian, Russian and FOC vessels, respectively. Further, it provides mean statistics for the variables Sanction, Age, and GT for all vessels. The mean and summary statistics is aggregated by port and month.

4.2.1 Outcome variables

Using three different outcome variables, this study aims to analyze how the sanction variable affects each one individually. Thus, it is possible to investigate how the sanction has affected the shipping activity in Norwegian ports. The first outcome variable is the share of a country i. The second outcome variable is the average age of the proportion of vessels from country i. Finally, the third outcome variable is the average gross tonnage of the proportion of vessels from country i. It is likely that the implementation of the sanction will affect the shipping traffic in different aspects, thereby using various outcome variables the results will give an overall depiction of the effect.

4.3 Dataset: Crossings Skagerrak

As an additional analysis, “Crossing line” from the NCDA is used. The dataset consists of a crossing line, “Skagerrak”, which extends across the North Sea between Mandal in Norway and Hanstholm in Denmark. Whenever an AIS signal from a vessel is detected crossing this line, it is recorded as an observation in the dataset. The dataset provides vessel-related information such as MMSI, ship name, ship type, crossings, date of crossing and GT. The ship types included in this dataset are fishing vessels, tankers[2], and research vessels.

The dataset is included in the analysis to investigate whether there are changes in sailing patterns or other suspicious behavioral changes for vessels of Russian or FOC origin passing through Skagerrak. By utilizing a crossing dataset, it is possible to investigate ships that do not call to Norwegian ports but may exploit Norwegian seas as a transit route for smuggling illegal goods. It is reasonable to assume that this dataset can provide additional insights into the hypothesis that the shipping activity in Norwegian waters has been affected by the sanctions against Russia. This is because Russian and FOC vessels are more likely to pass through Skagerrak than to enter Norwegian ports, enabling a more accurate comparison of how their behavioral changes following the imposition of sanctions. Additionally, Russian and FOC

[2] Tankers include crude oil tankers, crude/oil products tankers, products tankers, chemical/products tankers, chemical tankers, LPG tankers, LNG tankers, asphalt/bitumen tankers

vessels passing Skagerrak are likely more risk prone, as they are subject to less frequent inspections than if they were to enter Norwegian ports. This suggests that the vessels sailing through Skagerrak could be more likely to engage in illicit behavior, such as transportation of sanctioned oil from Russia.

The dataset summarizes Norwegian, Russian and FOC vessels, including tankers and research vessels. Additionally, it provides mean statistics for the variables Sanction and GT for all vessels. The dataset is aggregated by ship type and month.

4.3.1 Outcome variables

Using the same argument presented in chapter 4.2.1, the investigation focuses on three different outcome variables: the share of country *i*, the proportion of tankers from country *i*, and the proportion of research vessels from country *i*. Employing alternative outcome variables to those presented in chapter 4.2.1 enables an expansion of the analysis on the impact of the sanctions. Additionally, investigating the activity in Skagerrak demands a more detailed examination of various ship types as this region exhibit greater diversity in ship types compared to ports in Troms and Finnmark.

4.4 Data source

The Coastal Data Center contains data from AIS, Njord, SafeSeaNet and Skipsregisteret. The data extracted can be grouped into two, depending on the data they are based on: 1) *Data from New Ship Rep*. This data derived from arrival notices and compulsory voyages. Vessels over 300 GT report to SafeSeaNet before arriving at a port in Norway. The datasets *Arrivals* and *Time in port* is based on data from New Ship Rep. 2) *Data from AIS***.** The data contains information about vessels from the ship registry. The data is a full-resolution AIS signal that has been "cleaned" by removing positions of vessels that are unambiguously likely to be incorrect. The data gives an overview of all ships, except for leisure crafts under 45 meters length and fishing vessels under 15 meters length. The dataset *Crossings Skagerrak* is based on AIS data. (Norwegian Coastal Data Center, n.d.). The dataset *Sea-web* is obtained from S&P Global Market Intelligence. They run the world's largest maritime ships database, Sea-web Ships (S&P Global Market Intelligence, n.d.-b). This includes information regarding shipowners, companies, operators, movements, casualties and more (S&P Global Market Intelligence, n.d.-a).

4.5 Data coverage

All three datasets consist of panel data, which means that the data follow the same individuals or entities over a specific period of time rather than being a randomly selected sample. In this analysis, the panel data follow the population of ships sailing through Norwegian waters and ports at a certain point in time. The data is then able to compare differences between the ships included in the sample.

4.5.1 Arrivals/Time in Port

In the dataset *Arrivals/Time in port* the sanction variable activates on 01 May 2022, as the initial port ban against Russian vessels was introduced on 08 May 2022. The sample period is therefore from 01 May 2021 to 01 May 2023, providing a two-year dataset. The decision for not using a wider sample by including additional years is due to the impact of the COVID-19 pandemic between 2020 and 2022. According to the European Maritime Safety Agency, the maritime sector experienced an overall decrease of 10.2% in port calls from 2019 to 2020 (European Maritime Safety Agency, n.d.). Including this period in the analysis could potentially distort the estimates, as there is likely to be a relatively high increase in shipping activity and trade after all pandemic-related restrictions were lifted in 2022.

The dataset *Arrivals/Time in port* includes 76 ports, 14 anchorages and 18 sea locations included. The dataset reports observations of tankers and fishing vessels in Troms and Finnmark. Windward's AI technology suggest that tankers, specifically oil and oil product tankers, are the most prevalent ship type in Russia's shadow fleet (Windward, n.d.-c). Since most Russian vessels that call to Norwegian ports are fishing vessels, they have also been included in the analysis. Additionally, their inclusion is justified by the assumption that, following the port ban, there may be an increased risk of fishing vessels engaging in deceptive practices such as IUU, espionage or transportation of sanctioned goods through Norwegian ports and waters. The Norwegian Government (2022b) stated in a press release that the fishery agreement between Norway and Russia allows cooperation to ensure sustainable management of the Barents Sea fish stocks. This is the reason why Russian fishing vessels were exempt from the initial port ban. However, as of 14 October 2022, Russian fishing vessel are only permitted access to the ports of Tromsø, Båtsfjord and Kirkenes to reduce the risk of Norway being used as a transit country for illegal transportation of goods to and from Russia. These ports have the highest number of port calls from Russian fishing vessels in Norway (Norwegian

Government, 2022b). Additionally, it is reasonable to assume that many Russian fishing vessels usually are located around the coast of Troms and Finnmark, as this is relatively close to the Barents Sea. This justifies the choice of including ports from northern Norway in the analysis, as it allows comparisons of the amount of time vessels spend in the ports before and after the imposition of the sanction.

4.5.2 Arrivals/Sea-web

In the dataset *Arrivals/Sea-web* there are 102 locations[3] included. The sample from this dataset contains the same ports and time period as in section 4.5.1. Thereby, the sanction variable switches on 01 May 2022. Further, the dataset contains 882 observations, which presents a potential challenge as attainment of statistically significant results becomes more problematic with lower numbers of observations. This is because the insufficiency of observations hinders the model to control for the random noise.

4.5.3 Crossings Skagerrak

In the dataset *Crossings Skagerrak*, the sanction variable switches on 01 December 2022, as the $60 price cap per barrel of Russian crude oil was introduced on 08 December 2022. This differs from the two prior analyses as vessels crossing the Skagerrak line do not necessarily enter Norwegian ports, and therefore, are not affected by the port ban. The decision to utilize this particular sanction is due to many tankers carrying Russian crude oil passing through Skagerrak to enter Russian ports like Primorsk and St. Petersburg, which are located near Russian-dominated oil pipelines (Janicek et al., 2010). Consequently, the inclusion of the price cap is deemed more appropriate as it is likely to have a larger impact on changes in behavior and potential circumvention tactics employed by Russian oil smugglers sailing through Skagerrak. In the analysis of share as an outcome variable the dataset contains 96 observations, while in the analysis of tankers and research vessels as outcome variables, the dataset consists of 24 observations. This presents a similar challenge regarding insufficient observations, as discussed in chapter 4.5.2.

[3] "Locations" include ports, sea locations and anchorages. Not possible to differentiate between ports, sea locations and anchorages in this dataset.

4.6 Strengths and weaknesses of the data

The main advantage of using data from the NCA is the extensive coverage of shipping activity in Norwegian ports and waters over time. Additionally, the data can be filtered locally after choosing an overall selection of data (Norwegian Coastal Administration, n.d.). This allows exclusion of irrelevant information regarding the research question. However, if vessels disable the AIS transmitter while sailing through Skagerrak, this could potentially lead to missing observations. Thereby, the data would not be able to capture the true effect of the sanctions. Additionally, when investigating the activity in Norwegian ports the dataset is not able to provide information regarding the cargo they transport or the vessels' intention with the port call. It is possible that this could provide additional insights on how the activity and goods they transport have changed after the sanctions were implemented.

Moreover, it is important to be aware that when the datasets *Arrivals/Sea-web* and *Crossings Skagerrak* were collapsed, some information about the variables might have disappeared. Thereby, the reliability and unbiasedness of the analysis may be affected. At the same time, this approach allows the datasets to be more manageable and easier to handle. Consequently, it can provide simple regressions and clear depictions of how the shipping activity in Norwegian waters has been impacted by the implementation of the sanctions.

5 Descriptive statistics and empirical evidence

The regression models are estimated in an attempt to identify the causal effect of the implementation of sanctions against Russia. The main hypothesis, which builds on the theoretical framework from chapter 2 and 3.3, is that the implementation of the sanctions led to an increase in deceptive shipping activity. Assuming that some Russian firms and allies will try to circumvent the sanctions, there is a possibility that there will be irregularities in the shipping activity in Norwegian ports and waters.

To analyze how the activity at the Norwegian ports is affected by the port ban, two main approaches are used. The first approach involves using linear regression models with and without multi-way fixed effects. These models focus on one variable of interest without additional control variables. Given the limited prior research on this topic, starting with a simple approach is deemed appropriate. Additionally, incorporating fixed effects should be able to account for noise that may distort the estimates. The second approach involves using a

DiD specification, which is a stricter specification compared to the linear regression models. The DiD specification examines not only the differences before and after the sanction was implemented but also the differences between Russian/FOC vessels and non-Russian/FOC vessels.

To investigate potential irregular changes in shipping activity in Skagerrak following the implementation of the price cap on Russian oil, linear regression models with and without multiway fixed effects are utilized. These models aim to illustrate any changes in the characteristics of the Russian and FOC fleets, as well as their sailing patterns through Skagerrak.

Chapter 5.1 examines the shipping activity in Norwegian ports. Chapter 5.1.1 and 5.1.2 present relevant descriptive statistics, such as the number of vessels, vessel types and characteristics. In chapter 5.1.3 empirical evidence for the linear specifications are introduced before presenting the results. The DiD specifications are presented and accompanied by the results. Chapter 5.2 investigates the shipping activity in Skagerrak. Similar to chapter 5.1, chapter 5.2.1 and 5.2.2 presents relevant descriptive statistics. Chapter 5.2.3 introduces the linear specifications and presents the results from the analysis.

5.1 Activity at Norwegian ports

The datasets *Arrivals/Sea-web* and *Arrivals/Time in port* are used when analyzing the activity at Norwegian ports. As mentioned, the port ban implemented on 08 May 2022 is used as the sanction variable to investigate whether there has been changes in the shipping activity at Norwegian ports.

5.1.1 Descriptive statistics: Number of vessels and vessel types

Table 1 displays the number of vessel observations before and after the implementation of the sanction. Additionally, the table includes observations of vessels in the post-sanction period that can be considered new[4]. The percentage of new post-sanction vessels have been included to make a more meaningful comparison between the countries. These numbers are presented

[4] The term "new" denotes the number of vessels only observed in the post-sanction period. However, it is important to note that they may have been in Norwegian ports prior to May 2021, but in this analysis, it is assumed that they are completely new.

for Norwegian, Russian and FOC vessels, respectively, and for all flags combined[5]. Observing Table 1, the proportion of new Norwegian and Russian vessels are 11% and 7%, respectively. This is consistent with the number of new vessels for all flags, which constitute a proportion of 14%. However, new FOC vessels constitute 74% of the observations in this period, which is exceptionally high compared to the other countries. This can be a possible indicator of these countries conducting illicit activities at Norwegian ports, as the increase is suspiciously high. However, it is important to note that the number of FOC vessels was relatively low prior to the sanction, which can make any increase appear disproportionately high.

Table 1: Descriptive statistics of vessel observations pre- and post-sanction

Variable	Freq.	Percentage
Norwegian:		
Pre-sanctions	2351	49.12
Post-sanctions	2435	50.88
New	275	11.29
Russian:		
Pre-sanctions	764	48.82
Post-sanctions	801	51.18
New	56	6.99
Flags of convenience:		
Pre-sanctions	71	30.74
Post-sanctions	160	69.26
New	118	73.75
All flags:		
Pre-sanctions	3638	48.34
Post-sanctions	3888	51.66
New	549	14.12

Table 2 illustrate the frequency and percentage of fishing vessels and tankers for each country before and after the sanction. It can be observed a relatively minor increase in the frequency of Norwegian and Russian fishing vessels after the sanction. For FOC vessels, the proportion of fishing vessels have increased relatively much in comparison. However, the number of observations for FOC fishing vessels constitute a relatively small share of the sample. For tankers, the overall change has increased slightly for all flags combined and for Norway specifically. It was only observed one Russian tanker in the pre-sanction period, while the sample contains no Russian tankers in the post-sanction period. This is presumably a result of

[5] "All flags" include observations of vessels flagged by all flags included in the dataset.

the port ban, but it is apparent that Russian tankers usually did not call to these ports before the sanction was implemented either. Further, FOC vessels have a considerably higher proportion of tankers post-sanction, constituting 72% of the total number of FOC tankers over the sample period.

Table 2: Descriptive statistics of fishing vessels and tankers pre- and post-sanction

	Fishing vessels		Tankers	
Variable	Freq.	Percentage	Freq.	Percentage
Norwegian:				
Pre-sanctions	1488	49.22	655	49.55
Post-sanctions	1535	50.78	667	50.45
Russian:				
Pre-sanctions	763	48.79	1	100.00
Post-sanctions	801	51.21	0	0.00
Flags of convenience:				
Pre-sanctions	22	39.29	49	28.00
Post-sanctions	34	60.71	126	72.00
All flags:				
Pre-sanctions	2436	49.13	994	46.73
Post-sanctions	2522	50.87	1133	53.27

5.1.2 Descriptive statistics: Vessel characteristics and time in port

Table 3 presents descriptive statistics regarding vessel characteristics and the duration of their stay in Norwegian ports before and after the port ban was implemented. The table reveals a decline in the average time spent by Norwegian vessels in ports between the pre- and post-sanction periods. Conversely there is a noticeable increase in the number of hours spent in port by Russian and FOC vessels after the implementation of the sanction. Additionally, the table offers an overview of the changes in average GT and average age for each flag. Notably, FOC vessels exhibit a substantial rise in average GT during the post-sanction period in comparison to the pre-sanction period. This may be attributed to the significant increase in FOC tankers, which are generally characterized by their relatively large size in contrast to fishing vessels. Furthermore, both Russian and FOC vessels have experienced a decrease in average age. However, it is worth mentioning that the average age of Russian vessels remains notably higher in comparison to vessels under other flags.

Table 3[6]: Vessel characteristics and time in port (means)[7]

Variable	Obs	Time in port	GT	Age
Norwegian:				
Pre-sanctions	2351	138.606	1447.799	24.509
Post-sanctions	2435	110.32	3480.689	24.767
Russian:				
Pre-sanctions	764	136.868	1661.416	31.674
Post-sanctions	801	171.054	2005.483	31.228
Flags of convenience:				
Pre-sanctions	71	30.103	9652.183	23.254
Post-sanctions	160	46.81	49563.838	16.163
All flags:				
Pre-sanctions	3638	128.666	2427.125	25.344
Post-sanctions	3888	114.079	6126.614	24.744

Table 4 provides an overview of the age distribution before and after the sanction for each country, as well as the age distribution of the entire sample. The distribution is specified in percentage for both the pre- and post-sanction period for each flag. Overall, there is not any evident changes to the age distributions before and after the sanction was introduced. However, Russian vessels exhibit a relatively high proportion of vessels over the age of 30 compared to other flags. Specifically, more than 64% of observations by Russian vessels entering Norwegian ports fall within this age group. Although the increase is not significant when comparing the pre- and post-sanction period, it remains a noteworthy finding. However, it is almost exclusively observed Russian fishing vessels. Chapter 2.3.6 reports that the average age of fishing vessels is relatively high compared to other ship types, which could explain the high age distribution of Russian fishing vessels.

[6] In Table 3 the variables have been calculated using *Arrivals/Sea-web*, except for time in port which have been calculated using *Arrivals/Time in port*. Minor differences in the number of observations in the two datasets because of the merge in *Arrivals/Time in port* but does not make a significant difference.
[7] Some variables have relatively large standard deviations and min/max values, which might have affected the means and skewed the comparison of the pre- and post-sanction period.

Table 4: Age distribution in percentage pre- and post-sanction

Variable	0-4	5-9	10-14	15-19	20-24	25-29	30+
Norwegian:							
Pre-sanctions	7.44	11.06	16.84	2.47	16.76	10.68	34.75
Post-sanctions	9.03	11.29	13.06	5.71	17.21	12.11	31.58
Russian:							
Pre-sanctions	3.66	1.96	3.53	2.09	14.53	12.70	61.52
Post-sanctions	4.12	1.75	4.62	1.00	13.36	11.11	64.04
Flags of convenience:							
Pre-sanctions	0.00	4.23	7.04	23.94	32.39	4.23	28.17
Post-sanctions	16.88	15.62	4.38	33.75	14.37	1.25	13.75
All flags:							
Pre-sanctions	5.94	10.12	12.81	6.49	15.97	10.69	37.99
Post-sanctions	8.82	10.42	10.96	8.51	15.43	10.52	35.34

5.1.3 Empirical evidence

Testing for statistical significance. From the dataset *Arrivals/Sea-web* three linear regression models are estimated, with and without multi-way fixed effects. This approach allows testing for statistical differences in the outcome variables after the implementation of the sanction. The regression models are estimated with aggregated data by port and month of the year. The regression equations can be written as:

1a) $$Share_{pm}^{i} = \beta_0 + \beta_1 Sanction_m + \varepsilon_{pm}^{i}$$

1b) $$Share_{pm}^{i} = \beta_0 + \beta_1 Sanction_m + \alpha_p + \alpha_{moy} + \varepsilon_{pm}^{i}$$

2a) $$Age_{pm}^{i} = \gamma_0 + \gamma_1 Sanction_m + \varepsilon_{pm}^{i}$$

2b) $$Age_{pm}^{i} = \gamma_0 + \gamma_1 Sanction_m + \alpha_p + \alpha_{moy} + \varepsilon_{pm}^{i}$$

3a) $$GT_{pm}^{i} = \delta_0 + \delta_1 Sanction_m + \varepsilon_{pm}^{i}$$

3b) $$GT_{pm}^{i} = \delta_0 + \delta_1 Sanction_m + \alpha_p + \alpha_{moy} + \varepsilon_{pm}^{i}$$

$i - country\ (Norwegian, Russian\ or\ FOC)$

$p - port\ ID$

$m - month$

$\varepsilon - error\ term$

$$\alpha_p - port\ ID\ fixed\ effects$$
$$\alpha_{moy} - month\ of\ the\ year\ fixed\ effect$$

The sanction variable switches on 01 May 2022, corresponding to the imposition of the Norwegian port ban against Russian vessels. The parameter (β_1) from equation 1a) and 1b) is then interpreted as how the share of vessels is affected by the sanction compared to the pre-sanction period. Further, the outcome variable shows the share of vessels for country i. In specification 2a) and 2b), parameter (γ_1) signifies the sanction's impact on average age of the vessel share for each country *i*[8] compared to the pre-sanction period. The parameter (δ_1) from equation 5a) and 5b) signifies the impact on the average GT of the vessel share for each country i[9], compared to the pre-sanction period.

Chapter 2 documents a rise in Russian and FOC vessels leaving Russian ports, where some of these are potentially calling to Norwegian ports. This claim is supported by Table 1, where there is reported an increase in Russian and FOC vessels porting in Norway. Thereby, it is appropriate to examine how the sanction has affected the share of vessels from each country. Analyzing the share of vessels by country provides a more meaningful comparison, given the significantly higher number of Norwegian vessels compared to Russian and FOC vessels. This approach allows an easier comparison of relative changes. Additionally, it has been documented that the Russian shadow fleet primarily consists of older vessels. Therefore, it would be interesting to investigate whether there is a rise in older vessels following the implementation of the sanction. Moreover, there has been documented a notable increase in the size of crude oil tankers leaving Russian ports after April 2022. This raises the question of whether changes in size and age could indicate potential deceptive behavior. Hence, it would be interesting to include these variables in the analysis and investigate whether the implementation of the sanction has affected age and size of vessels at Norwegian ports.

The different outcome variables are expected to be affected by other factors unrelated to the imposition of the sanction. To address this concern, fixed effects are incorporated into the second specification for each dependent variable. By including fixed effects, we can account for the differences between each port in each month of the year. The port fixed effect helps

[8] Henceforth referred to as average age for country *i*
[9] Henceforth referred to as average GT for country *i*

control for variations between ports that remain constant over time. These variations can be attributed to factors such as size of the ports, available facilities, geographical placement and port fees. Additionally, month of the year fixed effects are utilized to control for factors that vary across months but remain constant across ports. This allows us to account for seasonality, which can have an impact on the outcome variables. For instance, differences in sailing patterns by fishing vessels may be influenced by the availability of fish stocks, which can vary across different months of the year.

Using linear regression models with only *sanction* as an independent variable can contribute to identifying the direct effect of the implementation of the sanction. Additionally, such simple models will give incentive to conduct further analyses if the results provide significant effect. Specification 1b), 2b) and 3b) of the regression models contains fixed effects.

Results. Table 5 provides estimated results based on equation 1a) and 1b)[10]. Column (1) to (3) display the estimated coefficients from 1a) while column (4) to (6) present the estimated coefficients from 1b).

In column (1) it is reported that in the absence of fixed effects, the share of Norwegian vessels calling to port is expected to decrease by 5.26% after the sanctions. Column (3) reports that the share of FOC vessels is expected to increase by 3.22% following the sanctions. This finding aligns with the documentation provided in chapter 2.3.2, which suggests that firms might resort to using FOC to conceal illicit behavior. It is plausible to speculate that with the port ban on Russian vessels, the vessels may opt to sail under FOC to bypass the port ban and continue their trading activities. This could explain the statistically significant increase in the share of FOC vessels at Norwegian ports. However, when fixed effects are included, no statistically significant results are obtained. This is unexpected considering the documentation provided in chapter 2.3.2 where there are reports of increased sightings of FOC vessels through the Baltic Sea and along the Norwegian coast. It is worth noting that these sightings may not necessarily translate into calls to Norwegian ports, particularly ports in Troms and Finnmark, and therefore may not be detected in the dataset. Nevertheless, Huish (2017) finds a significant occurrence of FOC vessels in North Korean ports following the implementation of a trade embargo, which suggests the possibility of a similar increase in FOC vessel arrivals in Norwegian ports.

[10] Appendix 2, Table A.5 presents the same regression model with clustered standard errors.

Additionally, the lack of statistically significant estimates for FOC vessels may be attributed to consistent variation between ports or potentially seasonal effects, which are accounted for when including the fixed effects. It is possible that the overall activity of all ships increased in ports where FOC vessels are overrepresented. This could lead to a rise in overall arrivals by FOC vessels even though the share in a given port remains unchanged. Surprisingly, the reported coefficients for the share of Russian vessels lack statistical significance. It might be expected that Russian firms, in response to the port ban, would utilize fishing vessels to circumvent the sanction. However, in October 2022, the port ban was expanded to include Russian fishing vessels, except for ports in Tromsø, Båtsfjord and Kirkenes (Sanksjonsforskrift Ukraina (territoriell integritet mv.), 2014, §19a). It was anticipated that this expansion would amplify the effect, as the share of Russian vessels previously calling to ports in other regions of Norway would now only be able to call to these three ports.

In conclusion, the estimated results in Table 5 provide insights into the reported changes in the share of Norwegian, Russian and FOC vessels following the sanction. However, the lack of statistically significant estimates when incorporating fixed effects for the share of FOC and Russian vessels raises questions and highlights the need for further investigation.

Table 5: Share of Norwegian, Russian and FOC vessels

VARIABLES	(1) Share Norway	(2) Share Russia	(3) Share FOC	(4) Share Norway	(5) Share Russia	(6) Share FOC
Sanction	-0.0526**	0.00452	0.0322***	-0.0239	0.00719	0.00957
	(0.0237)	(0.0150)	(0.0122)	(0.0146)	(0.00893)	(0.00857)
Constant	0.792***	0.0694***	0.0374***	0.775***	0.0681***	0.0500***
	(0.0168)	(0.0106)	(0.00863)	(0.0102)	(0.00621)	(0.00595)
Observations	882	882	882	860	860	860
R-squared	0.006	0.000	0.008	0.695	0.711	0.616
portID FE	NO	NO	NO	YES	YES	YES
Month of the year FE	NO	NO	NO	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 presents the estimated results obtained from equation 2a) and 2b)[11]. Column (1) to (3) display the estimated coefficients from 2a) while column (4) to (6) present the estimated coefficients from 2b).

In the absence of fixed effects, the sanction variable for average age of Norwegian and FOC vessels is significant at a 10% significance level. Specifically, the average age for Norwegian vessels is reported to decrease by approximately two years after the imposition of the sanction. In contrast, the average age of FOC vessels is reported to increase with approximately half a year post-sanction. If Russian firms operate under FOC, this could impact the average age of FOC vessels as Table 4 indicates that Russian vessels tend to be older. However, Table 3 presents contradictory evidence, showing that the average age of FOC vessels has actually decreased by approximately 7 years after the imposition of sanctions. This suggests a negative trend. When fixed effects are included in the analysis, the coefficient for FOC vessels is no longer statistically significant. This could be attributed by the fixed effect controlling for seasonal trends, such as maintenance schedules or other factors that causes older vessels to dock in a particular month or port. This explanation could also be applied to account for the lack of statistical significance observed for Norwegian vessels, as reported in column (4).

Table 6: Average age of Norwegian, Russian and FOC vessels

VARIABLES	(1) Age Norway	(2) Age Russia	(3) Age FOC	(4) Age Norway	(5) Age Russia	(6) Age FOC
Sanction	-1.892*	0.208	0.463*	-0.947	0.306	0.00865
	(1.105)	(0.485)	(0.255)	(0.819)	(0.331)	(0.200)
Constant	21.72***	2.055***	0.789***	21.04***	2.004***	1.042***
	(0.780)	(0.342)	(0.180)	(0.569)	(0.230)	(0.139)
Observations	882	882	882	860	860	860
R-squared	0.003	0.000	0.004	0.549	0.623	0.519
portID FE	NO	NO	NO	YES	YES	YES
Month of the year FE	NO	NO	NO	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[11] Appendix 2, Table A.6 presents the same regression model with clustered standard errors.

Table 7 presents the models based on equation 3a) and 3b)[12]. Column (1) to (3) display the estimated coefficients from 3a) while column (4) to (6) present the estimated coefficients from 3b).

In the absence of fixed effects, the results show that both Norwegian and FOC vessels have statistically significant estimates for their average GT at a 1% significance level. Specifically, the average GT for Norwegian vessels increase by 1,712 GT post-sanction, while FOC vessels is reported an average increase by 2,338 GT post-sanction. When including fixed effects in the analysis, the results still report statistically significant estimates for average GT of Norwegian and FOC vessels, but at different significance levels. Norwegian vessels have a statistically significant estimate at a 5% significance level, with an average increase of 880 GT in the post-sanction period. FOC vessels have a statistically significant estimate at a 1% significance level, with an average increase of 1,050 GT. The decreasing effect may be attributed to the fixed effects accounting for variation in GT that is constant across ports or time.

There are no statistically significant results for the average GT of Russian vessels post-sanction. This finding is surprising, as it was anticipated that the estimation would provide more significant results, given the possibility that Russia may have utilized larger fishing vessels to transport illegal goods after the sanction was implemented. Additionally, chapter 2.3.6 provides documentation which noted observations of Russia utilizing larger vessels after the invasion of Ukraine in 2022. However, the increase of larger vessels consisted of tankers and considering that this dataset only includes one Russian tanker, it may not be that surprising that there is a lack of statistical significance.

[12] Appendix 2, Table A.7 presents the same regression model with clustered standard errors.

Table 7: Average GT of Norwegian, Russian and FOC vessels

VARIABLES	(1) GT, Norway	(2) GT, Russia	(3) GT, FOC	(4) GT, Norway	(5) GT, Russia	(6) GT, FOC
Sanction	1,712***	42.09	2,338***	879.8**	40.65	1,050***
	(459.1)	(43.49)	(500.9)	(390.5)	(36.49)	(336.4)
Constant	1,218***	151.0***	170.9	1,659***	152.0***	842.9***
	(323.9)	(30.68)	(353.4)	(271.3)	(25.35)	(233.7)
Observations	882	882	882	860	860	860
R-squared	0.016	0.001	0.024	0.438	0.438	0.653
portID FE	NO	NO	NO	YES	YES	YES
Month of the year FE	NO	NO	NO	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Extensions. In order to ensure the credibility of the results obtained from the regression analyses, this study includes Appendix 2, which presents the results of the models with clustered standard errors. The purpose of this appendix is to provide additional evidence and strengthen the findings presented in Table 5, 6 and 7. Table A.5 in Appendix 2 reports the same estimates as column (4) to (6) in Table 5 and Table A.6 reports the same estimates as column (4) to (6) in Table 6. These estimations strengthen the results obtained from the initial analyses. However, it is important to note that Table A.7 in Appendix 2 reports the same estimates as column (4) to (6) in Table 7, but the coefficients are no longer statistically significant.

Difference-in-difference (DiD). From the dataset *Arrivals/Time in port*, three Difference-in-difference specifications were used to investigate one outcome variable, time in port. The first specification does not contain fixed effects, while the second specification incorporated fixed effects. The third specification included an interaction term between the unit and time fixed effects. The DiD approach allows for investigating, not only for differences in the outcome variable, but also differences between Russian vessels and non-Russian vessels. The specification also investigates differences between FOC vessels and non-FOC vessels.

The regression model is a simple DID specification. It is a multi-way fixed effects structure, where port (unit) and month-year (time) fixed effects are included in equation 4b). Fixed effects interacted are included in equation 4c). The regression specifications can be written as:

4a) $Time\ in\ Port_{smp} = \beta_0 + \beta_1 Sanction_m + \beta_2 FOC_s + \beta_3 FOC_s * Sanction_m + \beta_4 RussianVessel_s + \beta_5 RussianVessel_s * Sanction_m + \varepsilon_{smp}$

4b) $Time\ in\ Port_{smp} = \beta_0 + \beta_1 Sanction_m + \beta_2 FOC_s + \beta_3 FOC_s * Sanction_m + \beta_4 RussianVessel_s + \beta_5 RussianVessel_s * Sanction_m + \alpha_p + \alpha_m + \varepsilon_{smp}$

4c) $Time\ in\ Port_{smp} = \beta_0 + \beta_1 Sanction_m + \beta_2 FOC_s + \beta_3 FOC_s * Sanction_m + \beta_4 RussianVessel_s + \beta_5 RussianVessel_s * Sanction_m + \alpha_{pm} + \varepsilon_{smp}$

$p - port\ ID$
$m - month$
$s - ship$
$\varepsilon - error\ term$
$\alpha_p - port\ fixed\ effects$
$\alpha_m - monthly - yearly\ fixed\ effects$
$\alpha_{pm} - fixed\ effects\ interacted$

The interaction variables indicates whether a vessel is sailing under Russia or FOC. The sanction variable switches on in the post-treatment period. The parameter in front of the six interaction variables (β_3 and β_5) is interpreted as the treatment effect of the sanction on the time in port by FOC or Russian vessels. The specification is estimated with five different approaches. The outcome variable is written in a logarithmic transformation due to the extremely high skewness in the distribution, as seen in Table 8.

To account for potential influence of unrelated variables and ensure the validity of the analysis, port and time fixed effects are included. The DiD specifications includes monthly-year fixed effects, allowing to control for factors that remain consistent across ports but vary across month and years. Consequently, the data can be used to compare differences across all months included in the sample. The fixed effects are included in 4b) and fixed effects interacted in 4c). The use of interacted fixed effects addresses the possibility that patterns of seasonality can vary for different ports. Furthermore, the specification in 4c) employs cluster-robust standard errors to address potential heteroskedasticity in the data. Specifically, the standard errors are clustered at the port level, and then further clustered at both the port and monthly-yearly levels. This approach is adopted to account for any potential heterogeneity in the data and ensure the robustness of the estimates.

A DiD strategy is a widely used methodology to examine the effect of a policy decision or other exogenous shocks on the population. This approach is particularly suitable for analyzing data derived from natural experiments. In this study, the exogenous shock is a government policy decision. The DiD approach employed here is a simple model specification with two time periods, and a control- and treatment group. The treatment group is directly affected by the policy change, while the control group is unaffected. The model is estimated using a linear regression framework with multiple fixed effects. Using two years of data, this approach allows for the control of systematic differences between the control and treatment groups, both before and after the policy change. For the treatment effect to be unbiased it is crucial that the parallel trends assumption is fulfilled. The assumption implies that, in the absence of the government policy, the treatment group and the control group will exhibit similar trends in their development (Wooldridge, 2019).

In this analysis, the treatment group consists of Russian and FOC vessels, while the control group consists of Norwegian and other remaining vessels. In order for the parallel trend assumption to be valid, it is assumed that in the absence of the government sanctions, the duration of time spent in port by Russian and FOC vessels (treatment groups) would exhibit a similar pattern to that of the other vessels (control group). It is reasonable to assume that, in the absence of the port ban, Russian and FOC vessels would not alter their behavior any differently than other vessels. This is because if the port ban was not implemented to restrict Russia's activities in Norwegian ports, Russian and FOC vessels would be able to continue their activities as they did prior to the sanction. Consequently, this implies that the duration of their port calls would develop in a parallel manner as Norwegian vessels. The fixed effects control for seasonality and other time varying effects in addition to differences between ports that remain constant over time. This approach helps isolate the treatment effect, where observed changes attributes to the treatment variable rather than pre-existing differences between the two groups. In the specification with interacted fixed effects the parallel trend assumption requires that, in the absence of the sanction, Russian/FOC ships would not have altered their behavior in a manner that differs from how other ships changed their behavior in a specific port at a given time.

Results. The regression models are based on equation 4a), 4b) and 4c), with equation 4c) further expanded to incorporate clustered fixed effects. The estimated results are depicted in Table 8. Column (1) displays the DiD regression without fixed effects, column (2) displays the regression model including fixed effects, and column (3) presents the model with fixed effects interacted. Column (4) and (5) present the same model with interacted fixed effects as column (3), but with clustered standard errors.

Column (1) reports a statistically significant increase of 9.36% in the duration of time in port during the post-sanction period. Furthermore, all model specifications report statistically significant and positive coefficients for Russian vessels. Column (2) reports that Russian vessels, regardless of the implementation of the sanctions, are generally expected to spend 61% more time in port compared to vessels sailing under other flags. This trend is amplified in column (3) to (5), where it is reported that Russian vessels are generally expected to spend 72.6% more time at ports compared to other vessels. Additionally, the treatment variable for Russian vessels exhibits a statistically significant estimate in column (2). This implies that Russian vessels are expected to spend 15.6% more time in port after the sanctions compared to other vessels. However, when fixed effects and fixed effects interacted are included, the treatment variable no longer exhibits any significant estimates. This suggests that there is no change in the duration of time spent in port for Russian vessels compared to vessels from other countries after the sanction. This finding is surprising given the results in Table 3, which reported a relatively high increase in the average time spent in ports by Russian vessels after the implementation of the sanction. With this knowledge, one would expect the treatment variable for Russian vessels to be statistically significant, indicating that they spend more time in port post-sanction. The lack of significant results for the Russian treatment variable suggests that there are other factors besides the implementation of the sanctions that account for the variation in the duration of time spent in port by Russian vessels.

The treatment variable for FOC vessels is not statistically significant across all columns, nor is the dummy variable for FOC vessels. This indicates that the duration of time spent in ports by FOC vessels is unaffected by the implementation of the port ban, or that they neither use more or less time compared to others. Additionally, it is likely that there are other factors than the implementation of the port ban against Russian vessels that explain the increase in the duration of time spent in port by FOC vessels, as observed in Table 3.

The variable for gross tonnage (GT) exhibits statistically significant effects when fixed effects and fixed effects interacted are included. Column (2) reports a relatively similar effect as column (3) to (5), indicating robust estimates. The results report that a 10 tonnage increase in a vessel's gross tonnage is expected to decrease the duration of time spent in port by 1.65%. From chapter 2.3.6, it is documented an increase in the size of Russian and FOC vessels entering Norwegian waters after the sanctions. This aligns with the findings in Table 3, which depict that the average GT for Russian and FOC vessels have increased in Norwegian ports. One could assume that larger vessels need to spend more time in port since they may carry more cargo, which would require longer time to unload. Further, it could be speculated the service of larger vessels at ports is more time-consuming compared to smaller vessels. With this knowledge, the results in Table 8 are unexpected. At the same time, fishing vessels may be more susceptible to damage due to their older average age compared to other types of ships. This could explain why it is reported that vessels of larger sizes are expected to spend less time in port.

The overall results from Table 8 are unexpected, considering the evidence provided in chapter 2 suggests a change in behavior for Russian vessels. It would be logical to assume that in the absence of suspicious behavior from Russian vessels, there would be a significant change in the treatment variable for FOC vessels. This assumption arises from the expectation that Russian firms might resort to utilizing FOC to conceal their activities, potentially leading to an increase in the presence of FOC vessels at Norwegian ports. These results may imply that the duration a vessel spends in port is not a suitable variable to employ when measuring or attempting to detect suspicious shipping behavior.

Table 8: Time in port for Norwegian, Russian and FOC vessels

	(1)	(2)	(3)	(4)	(5)
VARIABLES	logTimeinPort	logTimeinPort	logTimeinPort	logTimeinPort	logTimeinPort
Sanction	0.0936**				
	(0.0444)				
ConvenienceVessels	-0.0296	0.143	0.138	0.138	0.138
	(0.203)	(0.204)	(0.231)	(0.290)	(0.318)
ConvenienceInteraction	0.247	-0.216	-0.221	-0.221	-0.221
	(0.243)	(0.244)	(0.280)	(0.284)	(0.303)
RussianVessels	0.924***	0.610***	0.726***	0.726***	0.726***
	(0.0667)	(0.0770)	(0.0882)	(0.195)	(0.181)
RussianInteraction	0.0796	0.156*	-0.00714	-0.00714	-0.00714
	(0.0934)	(0.0906)	(0.121)	(0.164)	(0.155)
logGT	-0.00391	-0.165***	-0.166***	-0.166**	-0.166**
	(0.0178)	(0.0214)	(0.0230)	(0.0778)	(0.0772)
Constant	2.623***	3.922***	3.965***	3.965***	3.965***
	(0.131)	(0.159)	(0.171)	(0.602)	(0.595)
Observations	6,756	6,740	6,441	6,441	6,441
R-squared	0.061	0.150	0.205	0.205	0.205
portID FE	NO	YES	NO	NO	NO
Monthly-yearly FE	NO	YES	NO	NO	NO
portID*time FE	NO	NO	YES	YES	YES
Cluster1				portID	portID
Cluster2					Monthly-yearly

Standard errors in parentheses[13]
*** p<0.01, ** p<0.05, * p<0.1

Extensions. In Appendix 2, Table A.8 presents a similar regression model that includes ship type and monthly-yearly fixed effects. The table reports a statistically significant coefficient for the Russian dummy variable, confirming that Russian vessels tend to spend more time in port compared to other vessels regardless of the sanction. Specifically, the coefficient indicates a 52.7% increase in port time for Russian vessels. Furthermore, the regression model reports statistically significant coefficients for the Russian treatment variable, indicating that Russian vessels spend 19.7% more time in port than other vessels after the sanction implementation.

[13] Column (4)-(5) report robust standard errors in parentheses

Comparing the main results in Table 8 to A.8, it is reported that GT is not statistically significant when using clustered standard errors.

Additional regressions on time in port is presented in Table 9 and Table A.9 in Appendix 2, where only the ports in Tromsø, Båtsfjord and Kirkenes are included. As Russian fishing vessels only are allowed port calls to these three ports after 14 October 2022, this could provide valuable insight on how time in port has been impacted by the sanction. However, it is important to note that 24 Russian vessels were observed in other ports in Troms and Finnmark after this date. This is likely due to repairs, safety concerns or other exceptions, but could also indicate deceptive practices. In Table A.9 from Appendix 2, port and monthly-yearly fixed effects are used. The table reports roughly the same significance level and coefficients as in Table 8. However, column (1) reports that the sanction variable no longer has a statistically significant impact on how much time a vessel spends in port.

In Table 9, ship type and monthly-yearly fixed effects are used. The interacted fixed effect accounts for the variation in seasonality across different ship types. The inclusion of ship type as a unit fixed effect may be more relevant than port fixed effects in this specification, as it controls for constant differences between ship types across time. This implies that if tankers generally spend more time in ports than fishing vessels, ship type fixed effects will account for this difference. The relevance of port fixed effect may be weaker when considering only the ports in Tromsø, Båtsfjord and Kirkenes. These ports have relatively similar geographical placements and number of port calls, resulting in fewer constant differences over time. This may explain why the Russian interaction term now is significant at the 1% level, as Russian ships are primarily fishing vessels. Table 9 reports that Russian vessels are expected to spend 17.1% more time in port compared to other vessels after the implementation of the port ban, when applying clustered standard errors. The increase in time spent in port during the post-sanction period may be attributed to suspicious behavior, although further discussion is needed to confirm this. Notably, there was an increase in inspections of Russian vessels in Tromsø, Båtsfjord and Kirkenes in October 2022. This could contribute to the longer time spent in ports by Russian vessels compared to vessels that do not undergo inspections. Additionally, the variable for FOC vessels is now statistically significant, indicating that these vessels generally spend 65.3% less time in ports compared to other vessels. This aligns with the descriptive statistics presented in Table 3, which shows that the average time in port for FOC vessels is lower than the average time for Norwegian and Russian vessels.

Table 9: Time in port for Norwegian, Russian and FOC vessels in Tromsø, Båtsfjord and Kirkenes

	(1)	(2)	(3)	(4)	(5)
VARIABLES	logTimeinPort	logTimeinPort	logTimeinPort	logTimeinPort	logTimeinPort
Sanction	0.0344				
	(0.0602)				
ConvenienceVessels	-0.374	-0.536	-0.653*	-0.653***	-0.653***
	(0.363)	(0.361)	(0.381)	(0.0106)	(0.0170)
ConvenienceInteraction	-0.225	-0.199	-0.0598	-0.0598	-0.0598
	(0.466)	(0.462)	(0.478)	(0.129)	(0.119)
RussianVessels	0.563***	0.437***	0.401***	0.401***	0.401***
	(0.0736)	(0.0749)	(0.0772)	(0.00972)	(0.0102)
RussianInteraction	0.131	0.103	0.171	0.171***	0.171***
	(0.102)	(0.101)	(0.108)	(0.00435)	(0.0194)
logGT	-0.221***	-0.119***	-0.126***	-0.126	-0.126*
	(0.0311)	(0.0363)	(0.0370)	(0.0709)	(0.0683)
Constant	4.552***	3.861***	3.911***	3.911***	3.911***
	(0.236)	(0.271)	(0.277)	(0.527)	(0.507)
Observations	4,004	4,004	3,963	3,963	3,963
R-squared	0.057	0.094	0.114	0.114	0.114
portID FE	NO	YES	NO	NO	NO
Monthly-yearly FE	NO	YES	NO	NO	NO
ShipTypeID*time FE	NO	NO	YES	YES	YES
Cluster1				ShiptypeID	ShiptypeID
Cluster2					Monthly-yearly

Standard errors in parentheses[14]
*** p<0.01, ** p<0.05, * p<0.1

5.2 Activity in Skagerrak

The dataset *Crossings Skagerrak* is used when examining the activity in Skagerrak. The $60 price cap on Russian oil implemented on 8 December 2022 is used as the sanction variable to test for statistical differences in the shipping activity in Skagerrak.

5.2.1 Descriptive statistics: Number of vessels and vessel types

Table 10 displays descriptive statistics on the number of crossings for each flag and the total for all flags before and after the price cap was implemented. Additionally, the percentage distribution of crossings by new[15] vessels in the post-sanction period have been included to

[14] Column (4)-(5) report robust standard errors in parentheses
[15] The term "new" denotes the number of vessels only observed in the post-sanction period. However, it is important to note that they may have crossed the Skagerrak line prior to December 2021, but in this analysis, it is assumed that they are completely new.

make a more meaningful comparison between the countries. Observing Table 10, there is reported a decrease in crossings by Norwegian vessels, and a slight increase by Russian vessels. However, the number of crossings by FOC vessels have increased considerably. Additionally, the percentage of crossings in the post-sanction period by new vessels is about 42% and 45% for Russian and FOC vessels, respectively. This is a significant percentage, which corresponds to the findings from chapter 2.3.2 that suggests that there has been a significant increase in the number of journeys taken by vessels flagged under Liberia, Russia, Panama and Marshall Islands. This suggests that this could be possible indications of these vessels engaging in illicit activities when travelling from Russian ports through the Baltic Sea and Skagerrak.

Table 10: Descriptive statistics of vessel crossings pre- and post-sanction

Variable	Freq.	Percentage
Norwegian:		
Pre-sanctions	2836	46.92
Post-sanctions	2507	53.08
New	284	11.33
Russian:		
Pre-sanctions	111	39.08
Post-sanctions	173	60.92
New	73	42.20
Flags of convenience:		
Pre-sanctions	5475	42.05
Post-sanctions	7544	57.95
New	3457	45.83
All flags:		
Pre-sanctions	18640	47.94
Post-sanctions	20245	52.06
New	5872	29.01

Table 11 present the number of crossings by tankers, fishing vessels and research vessels for each country. For Russia, there is a high increase of both tankers and fishing vessels after the sanction, while the number of research vessels has decreased. For FOC vessels, there is a relatively high increase of crossings by all ship types after the implementation of the sanction.

Table 11: Descriptive statistics of fishing vessels and tankers pre- and post-sanction

Variable	Fishing vessel	Tanker	Research Vessel
Norwegian:			
Pre-sanctions	1417	1273	8
Post-sanctions	1267	1055	28
Russian:			
Pre-sanctions	54	21	23
Post-sanctions	75	74	13
Flags of convenience:			
Pre-sanctions	15	5349	13
Post-sanctions	50	7402	33
All flags:			
Pre-sanctions	6301	11845	89
Post-sanctions	5930	13800	139

5.2.2 Descriptive statistics: Vessel characteristics

Table 12 presents the mean statistics for vessels' gross tonnage, before and after the sanction for each country. Observing the table, both Russia and FOC have a relatively high increase of averages relative to Norwegian vessels. Especially Russia has an exceptionally high increase in averages of GT.

Table 12: Descriptive statistics for average gross tonnage (GT) pre- and post-sanction

Variable	Obs	GT
Norwegian:		
Pre-sanctions	2836	14145.337
Post-sanctions	2507	15501.106
Russian:		
Pre-sanctions	111	9041.649
Post-sanctions	173	15978.092
Flags of convenience:		
Pre-sanctions	5475	36773.934
Post-sanctions	7544	41118.773
All flags:		
Pre-sanction	18640	21371.502
Post-sanction	20245	24893.147

5.2.3 Descriptive evidence: Evolution of crossings

Figure 4 illustrates the evolution of crossings done by Norwegian, Russian and FOC vessels during the sample period, indicating the aggregated number of crossings by each country in each month. The vertical line marks the effective date of the implementation of the $60 price cap on Russian oil. This provides a valuable point of reference as it is the first moment when the price cap came into effect and a large number of vessels included in the dataset were affected by the price cap.

Further we observe a difference in trends of the three groups after the price cap was introduced. There exists a positive trend in crossings by FOC vessels after the price cap came into effect, whereas the number of crossings by Norwegian vessels is relatively more stable. The proportion of Russian vessels is low compared to Norwegian and FOC Vessels. This causes the changes in the line for Russian vessels to be minimal compared to the other vessels, and therefore Figure 4 do not give a clear visual of the Russian vessels' crossings. Figure 5 only accounts for crossings by Russian vessels, thereby depict a better visual. The number of crossings indicates a positive trend after the introduction of the price cap. It is important to remember that the lines represent overall group numbers and therefore hide differences in the trends within each group. The upward trend might be attributed to the imposition of the price cap. However, the positive trend for FOC vessels begins in November 2022, one month before the price cap's implementation. This suggests that another factor might be contributing to the positive trend. If the implementation of the price cap was announced in advance, it could have prompted the positive trend to start earlier. Another plausible explanation is that the reduced shipping activity observed in 2021 following the aftermath of the COVID-19 pandemic in 2020, led to an increase in crossings in 2022 as shipping activity began to normalize. However, Norway's consistent trend in the number of crossings indicates that the shipping activity had already stabilized. Despite the clear limitations of the presented graphical evidence, we can conclude that it is in favor of the main hypothesis, specifically that the implementation of the sanction has affected the shipping activity.

To make a more meaningful comparison between the countries, Table A.11 in Appendix 3 presents the evolution in percent of share for each country, and Table A.12 for Russian vessels. Similarly, in these graphs the evolution shows a positive trend for Russia and FOC countries, while it presents a more stable trend for the Norwegian vessels.

Figure 4: Evolution of crossings by Norwegian, Russian and FOC vessels

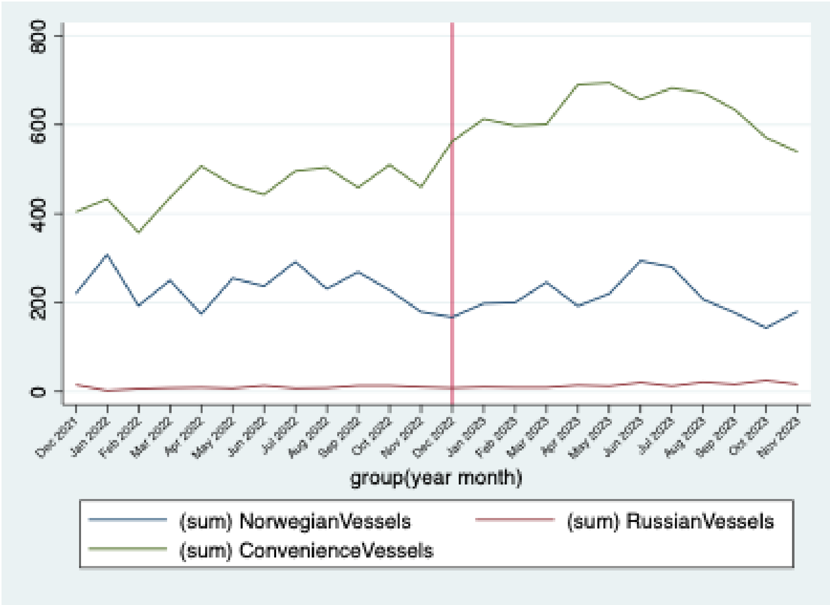
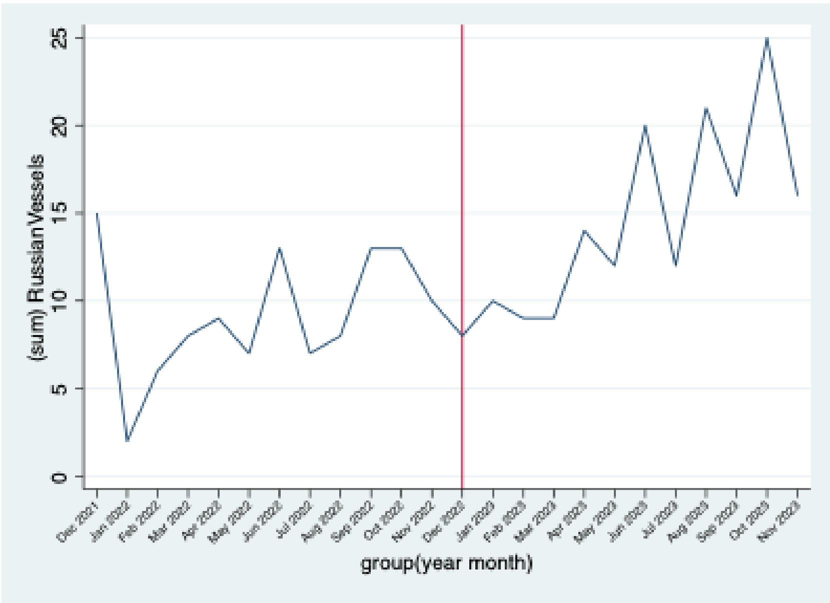


Figure 5: Evolution of crossings by Russian vessels



5.2.4 Empirical evidence

Testing for statistical significance. From the dataset *Crossings Skagerrak*, three linear regression models are specified, estimated with and without multi-way fixed effects. The models include ship type (unit) and month of the year (time) fixed effects. This means that the estimated regression models are aggregated by ship type and month. This approach allows testing for statistical difference in the outcome variable after the implementation of the price cap. The regression equation can be written as:

5a) $$Share_m^i = \theta_0 + \theta_1 Sanction_m + \varepsilon_m^i$$

5b) $$Share_m^i = \theta_0 + \theta_1 Sanction_m + \alpha_s + \alpha_{moy} + \varepsilon_m^i$$

6a) $$Tankers_m^i = \mu_0 + \mu_1 Sanction_m + \varepsilon_m^i$$

6b) $$Tankers_m^i = \mu_0 + \mu_1 Sanction_m + \alpha_s + \alpha_{moy} + \varepsilon_m^i$$

7a) $$Research\ vessel_m^i = \rho_0 + \rho_1 Sanction_m + \varepsilon_m^i$$

7b) $$Research\ vessel_m^i = \rho_0 + \rho_1 Sanction_m + \alpha_s + \alpha_{moy} + \varepsilon_m^i$$

$i - country\ (Norwegian, Russian\ or\ FOC)$

$p - port\ ID$

$m - month$

$\varepsilon - error\ term$

$\alpha_{moy} - month\ of\ the\ year\ fixed\ effects$

$\alpha_s - Shiptype\ ID\ fixed\ effects$

In this dataset, the sanction variable switches on after the implementation of the price cap. Therefore, the parameter θ_1 is interpreted as the share of crossings by country i is affected by the price cap compared to the pre-sanction period. Parameter μ_1 can be interpreted as how the price cap affects the proportion of tankers from country i that crosses Skagerrak, compared to the pre-sanction period. Parameter ρ_1 is interpreted as how the price cap affects the proportion of research vessels from country i that crosses Skagerrak, compared to the pre-sanction period.

The argument for utilizing share of country *i* as an outcome variable is presented in chapter 5.1.3. Moreover, the decision to employ the share of tankers for each country as an outcome variable is primarily based on several news articles and papers highlighting a significant increase in the number of tankers sailing through the Baltic Sea and Skagerrak (Braw, 2024). Additionally, using tankers as an outcome variable is based on the likelihood that transshipment and smuggling of Russian oil predominantly involve tankers. However, it is plausible to assume that other types of vessels are also utilized for transporting sanctioned goods, engaging in espionage, and other illicit activities. Consequently, based on this argument and recent news articles by NRK and BT, the share of research vessels for each country is also adopted as an outcome variable.

As indicated in the specification, fixed effects are incorporated for each outcome variable. In this case, the inclusion of fixed effects serves to account for differences between each ship type in each month. Given that the regression is conducted separately for each ship type, the fixed effect takes out the mean of the dependent variables for every ship type. Furthermore, the month of the year fixed effects controls for seasonality, as in chapter 5.1.3.

Results. Table 13 is based on the equations as presented in 5a) and 5b). In column (1) to (3) the coefficients are presented without fixed effects, while column (4) to (6) include fixed effects in the estimations.

Table 13 reports the impact of the price cap on Russian oil on the share of Norwegian, Russian and FOC vessels crossing the line in Skagerrak. When fixed effects are taken into account, the share of Norwegian vessels is reported to increase by 3.73% following the price cap. This rise in Norwegian vessel activity can be attributed to the EU's ban on oil imports from Russia, which has led to a shift towards Norwegian oil and subsequently encouraging greater activity by Norwegian vessels. However, the table does not report any statistically significant results for the share of Russian and FOC vessels. This lack of statistical significance appears to be inconsistent with the findings presented in chapter 2, which indicates increased activity by Russian and FOC vessels in Norwegian waters. One plausible explanation for the absence of statistically significant results could be AIS manipulation. If Russian and FOC vessels deactivate their transmitter when crossing Skagerrak line, they would not be captured in the dataset. However, Table 10 display a relatively high increase in crossings for both Russian and FOC vessels in Skagerrak, which contradicts this argument. Therefore, it appears that factors other than the implementation of sanctions account for the variation in the share of Russian and FOC vessels.

Table 13: Share of Norwegian, Russian and FOC vessels

VARIABLES	(1) Share Norway	(2) Share Russia	(3) Share FOC	(4) Share Norway	(5) Share Russia	(6) Share FOC
Sanction	0.0373	-0.0340	0.00813	0.0373*	-0.0340	0.00813
	(0.0313)	(0.0267)	(0.0453)	(0.0216)	(0.0206)	(0.0279)
Constant	0.196***	0.0774***	0.229***	0.196***	0.0774***	0.229***
	(0.0221)	(0.0189)	(0.0320)	(0.0153)	(0.0146)	(0.0197)
Observations	96	96	96	96	96	96
R-squared	0.015	0.017	0.000	0.601	0.501	0.677
ShiptypeID FE	NO	NO	NO	YES	YES	YES
Month of the year FE	NO	NO	NO	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 14 is based on the equations as presented in 6a) and 6b). In column (1) to (3) the coefficients are presented without fixed effects, while column (4) to (6) include fixed effects in the estimations.

Table 14 present the impact of the price cap on the proportion of tankers sailing under Norway, Russia and FOC, revealing statistically significant estimates across all columns. The proportion of Norwegian tankers is estimated to decrease by 3.12% in the post-sanction period. This decrease can be attributed to the trade ban against Russia, which might have reduced the numbers of Norwegian tankers venturing across Skagerrak. Conversely, the proportion of Russian and FOC tankers is reported to increase following the implementation of the price cap on Russian oil. The proportion of Russian tankers is reported to increase by approximately 0.34%. This is consistent with the findings in Table 11, which reveal a relatively high increase in crossings by Russian tankers during the post-sanction period. However, the reported increase in the proportion of Russian tankers is relatively low compared the overall discoveries outlined in chapter 2. This suggests that the relatively low increase may be due to the more frequent use of FOC tankers transporting Russian oil. This is supported by the results in column (3) and (6), which reports that the proportion of FOC tankers has increased with 8.49%. These findings align with the descriptive statistics in Table 10 and 12, which illustrates a significant increase in crossings by FOC vessels, particularly by tankers. Furthermore, the substantial increase in the proportion of FOC tankers correspond to the findings in chapter 2.3.2, which document a significant rise in FOC vessels departing from Russian ports through the Baltic Sea and Skagerrak. Notably, chapter 2.3.2 suggests that an average of approximately 12 shadow vessels passes through Norwegian waters each day. Therefore, the increase in both Russian and FOC vessels suggests that the results of this analysis correspond to the reports and articles mentioned in chapter 2.

Table 14: Proportion of Norwegian, Russian and FOC tankers

VARIABLES	(1) Tankers Norway	(2) Tankers Russia	(3) Tankers FOC	(4) Tankers Norway	(5) Tankers Russia	(6) Tankers FOC
Sanction	-0.0312***	0.00337***	0.0849***	-0.0312***	0.00337**	0.0849***
	(0.00375)	(0.000968)	(0.00816)	(0.00365)	(0.00114)	(0.00768)
Constant	0.108***	0.00189**	0.452***	0.108***	0.00189**	0.452***
	(0.00265)	(0.000684)	(0.00577)	(0.00258)	(0.000810)	(0.00543)
Observations	24	24	24	24	24	24
R-squared	0.759	0.355	0.831	0.886	0.549	0.925
Month of the year FE	NO	NO	NO	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 15 is based on the equations as presented in 7a) and 7b). In column (1) to (3) the coefficients are presented without fixed effects, while column (4) to (6) include fixed effects in the estimations.

Table 15 presents the impact of the price cap on the proportion of research vessels sailing under Norway, Russia and FOC crossing Skagerrak. The proportion of Norwegian research vessels is reported to increase by 13% in the post-sanction period. Conversely, Russian research vessels is reported to decrease by 14.4% after the price cap was implemented. This decline may be attributed to a potential alteration in travel patterns, as Russian research vessels might navigate from Murmansk through the Barents Sea and along the Norwegian coast, bypassing Skagerrak. Consequently, the dataset may not accurately capture a representative sample of Russian research vessels, thereby contributing to this negative effect. Nevertheless, as reviewed in chapter 2.3.5, it is suggested that Russian research vessels have been engaged in surveillance activities along the Norwegian coast and waters after the invasion of Ukraine in 2022. This implies that although the proportion of Russian research vessels have diminished, those crossing Skagerrak during the post-sanction period may still be involved in illicit activities.

Table 15: Proportion of Norwegian, Russian and FOC research vessels

VARIABLES	(1) Research Norway	(2) Research Russia	(3) Research FOC	(4) Research Norway	(5) Research Russia	(6) Research FOC
Sanction	0.130**	-0.144*	0.0274	0.130**	-0.144**	0.0274
	(0.0577)	(0.0821)	(0.101)	(0.0437)	(0.0520)	(0.0961)
Constant	0.0837*	0.268***	0.211***	0.0837**	0.268***	0.211***
	(0.0408)	(0.0580)	(0.0716)	(0.0309)	(0.0368)	(0.0679)
Observations	24	24	24	24	24	24
R-squared	0.187	0.123	0.003	0.767	0.824	0.551
Month of the year FE	NO	NO	NO	YES	YES	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Extensions. In Appendix 3, Table A.12 and A.13 presents additional regression analyses with clustered standard errors on the proportion of tankers and research vessels[16]. These regressions report no major differences for any of the outcome variables, thus strengthening the validity of the estimations.

Furthermore, Appendix 3 includes regressions on the share of fishing vessels and GT for each country as additional outcome variables. Table A.14 presents the impact of the price cap on the proportion of Norwegian, Russian and FOC fishing vessels. The table reports a 0.66% increase in the proportion of fishing vessels sailing under FOC following the sanctions, and a lack of statistically significant impact on the proportion of Russian and Norwegian fishing vessels.

Table A.15 present the impact of the price cap on the average GT to the share of Norwegian, Russian and FOC vessels. The table reports that the average GT of FOC vessels increased by 1,108 GT during the post-sanction period. This increase is likely attributed to the substantial rise in crossings by FOC tankers, as evidenced in Table 11. Chapter 2.3.6 suggests an increase in the size of vessels departing Russian ports through the Baltic Sea and Skagerrak. Therefore, this finding may imply that these vessels are engaging in deceptive practices.

[16] Not able to cluster share of country *i* due to insufficient observations.

6 Discussion

6.1 The impact of economic sanctions on the maritime industry

This master's thesis aims to investigate the extent to which economic sanctions imposed on Russia have contributed to an increase in deceptive shipping activities within Norwegian ports and waters. This is the main research question and requires further discussion. Through the applied empirical strategy, it is attempted to find possible indications of unusual changes in the shipping behavior in several aspects. The data cover the regions of Troms and Finnmark when examining the port activity, as well as the activity in Skagerrak.

The most interesting discoveries from the port activity in Troms and Finnmark is primarily revealed in the descriptive statistics. Notably, there has been a substantial increase in the number of port calls by vessels operating under flags of convenience (FOC), where 73% of vessels in the post-sanction period are considered new. This discovery raises the question of whether Russian firms more frequently utilize FOC vessels with the intent to circumvent the port ban and conceal illicit activities. Huish (2017) reveals that this was the case when studying the impact on the maritime sector in North Korea when subjected to similar sanctions. Furthermore, Table 4 illustrates how the age distribution of Russian vessels has remained relatively consistent through the pre- and post-sanction period. However, it is worth noting that Russian vessels generally tend to be of higher average age compared to Norwegian and FOC vessels. Following the implementation of the port ban, 64% of Russian vessels were 30 years or older, whereas the corresponding age of Norwegian and FOC vessels stand at 30% and 13%, respectively. As indicated by Windward, Russian shadow vessels tend to be of higher age, thereby prompting speculation regarding the potential that these Russian vessels have associations to the shadow fleet (Windward, n.d.-c). Additionally, Table 6 shows that the average GT of Russian vessels has increased from 1,661 GT to 2,005 GT. It is plausible that Russia utilizes bigger fishing vessels to transport larger volumes of illegal cargo after the port ban was implemented. The average GT of FOC vessels has increased from 9,652 GT to 49,563 GT. Despite the relatively low number of FOC vessels making the averages more susceptible to changes, the increase is still noteworthy. It is possible that Russian firms also utilize FOC vessels to smuggle sanctioned goods, which could imply the use of larger vessels to transport higher quantities.

In the multiway fixed effects analysis, the estimates for share of each country and average age lack statistical significance. These results were surprising given the substantial impact the port ban was expected to have as a sanction. It would be reasonable to expect the share of Russian vessels to decrease due to the restrictions of the port ban. However, the port ban exempts Russian fishing vessels calling to ports in Tromsø, Båtsfjord and Kirkenes. Consequently, one might anticipate an increase in the presence of Russian fishing vessels at these specific ports, thereby implying an increase in the estimated share. In relation to vessels operating under FOC, the findings from Huish (2017) suggests that it is plausible to anticipate that Russian firms will utilize FOC vessels to circumvent the port ban. This would enable Russian firms and allies to continue their shipping activities in Norwegian ports, consequently leading to an increase in the estimated share of FOC vessels. Conversely, illicit firms may refrain from escalating their number of port calls to avoid detection by Norwegian authorities. Thereby, enabling these vessels to perform illicit activities discreetly. Following the implementation of the sanction, the impact on the average age of Russian and FOC vessels in Norwegian ports was expected to increase. Braw (2024) reveals a rise in the number of older vessels within the Russian shadow fleet, which consists of vessels sailing under both Russia and FOC. If vessels associated with the shadow fleet enter Norwegian ports, this would imply an increase in the average age. However, the lack of statistically significant estimates suggests that the vessels referenced in Braw (2024) have not entered the ports in Troms and Finnmark during this time period. Furthermore, the analysis estimates that the average GT of FOC vessels is reported to increase with 1,050 GT in the post-sanction period. For Norwegian vessels, the average GT is reported to increase with 880 GT. Braw (2024) documents an increase in larger crude oil vessels from April 2022, which could suggest that some of the FOC vessels calling to Norwegian ports are affiliated with the Russian shadow fleet. However, it is challenging to determine whether the increase in average GT for FOC vessels is a credible indicator of potential involvement in illegal activities. The comparable increase in average GT for Norwegian vessels suggests that solely considering this factor does not necessarily imply that FOC vessels engage in illicit activities. Additionally, the relatively small number of FOC vessels makes the estimates more susceptible to fluctuations. Given that Braw (2024) documents that the increase in size of vessels primarily applies to crude oil tankers, it is unsurprising that there is a lack of statistically significant estimates regarding the average GT of Russian vessels. This is due to the dataset only including one Russian tanker, which calls to port before the sanction was implemented.

The DiD analysis reveals that Russian vessels generally spend longer time in port compared to other vessels regardless of the implementation of the port ban. The analysis report that the treatment variables for all the specifications did not yield statistically significant estimates. Windward (n.d.-b) and Braw (2024) documents an increase of the Russian shadow fleet, the use of FOC vessels and STS transfers following Russia's invasion of Ukraine. However, the referenced vessels may not be calling to Norwegian ports, suggesting that illicit shipping activity is not reflected by how much time vessels spend in port. However, one could question whether the lack of significant differences is due to Russian vessels also engaging in illicit behavior prior to the sanctions. Consequently, the implementation of the port ban may not have altered their behavior. Table 9 is an extension of the main model with ship type and month-year as fixed effects, and only considers the ports in Båtsfjord, Tromsø and Kirkenes. In this model, the Russian treatment variable becomes statistically significant, and the inclusion of clustered standard errors enhances the credibility. This implies that Russian vessels spend more time in port after the imposition of the port ban compared to vessels sailing under other flags. The ship type fixed effect is likely more relevant than the port fixed effect, given that the dataset only includes three ports. Additionally, if fishing vessels typically have longer durations at port than tankers, the ship type is more appropriate to control for this variation. Another extension of the main model with the ship type as a fixed effect, also report a statistically significant increase for the Russian treatment variable. This enhances the credibility of using ship type as a fixed effect. The significance of the Russian treatment variable may be attributed to increased inspections of Russian vessels, leading to longer port durations. Alternatively, it could suggest suspicious behavior. However, based on this analysis it is challenging to draw a definitive conclusion regarding whether the increased port duration for Russian vessels is due to illicit activities or other rational explanations. The absence of statistical significance estimates to the treatment variable for FOC vessels is unexpected given that Huish (2017) argues that there is an increase of utilizing FOC vessels when a country is imposed with sanctions.

The key finding from the analysis on activity in Skagerrak reveals that the proportion of tankers with Russian and FOC origin has increased following the implementation of the price cap on Russian crude oil. Specifically, the proportion of Russian and FOC tankers are reported to increase with 0.337% and 8%, respectively. The results align with the documentation provided in chapter 2.3.2 and 2.3.3, which suggests an increase in departures by Russian and FOC vessels from Russian ports through the Baltic Sea. Additionally, the results are consistent with the findings from the descriptive statistics in Table 11. The significant increase in FOC vessels, particularly the proportion of new vessels, may indicate that Russian firms are more frequently utilizing these flags to engage in illicit activities while sailing through Skagerrak undetected. This could also explain why the impact on FOC tankers is more pronounced. Braw (2024) suggests that the rise in number of FOC and Russian vessels contributes to the growth of the shadow fleet, and reports that on average 12 shadow vessels pass through Norwegian waters daily. If Russian firms are using tankers sailing under FOC to circumvent the sanction, it enables the sale of Russian oil exceeding the price cap. Thereby, undermining the intent of reducing Russia's revenues from oil sales. It is challenging to determine whether the results provide indications that Russian and FOC vessels are involved in deceptive practices while sailing through Skagerrak. However, several news articles and previous studies suggests that this may be the case. Nevertheless, there is a lack of empirical research papers which confirms these findings. Further, the absence of statistically significant effects of the price cap on the share of FOC and Russian vessels is unexpected. This is particularly surprising when considering the results presented in Table 10, which report a relatively high increase in the number of FOC vessels following the implementation of the sanction. Additionally, Figures 4 and 5 illustrate the distribution of vessel crossings from each country across the sample period, revealing an evident difference between the pre- and post-sanction period for both Russian and FOC vessels. It is reasonable to assume that this disparity would result in the sanction having a significant impact on the share of vessels from these countries. Another intriguing finding from the Skagerrak analysis is that the proportion of Russian research vessels has decreased by 14%. Although the estimate aligns with the results presented in Table 11, one could expect that Russia would utilize research vessels more frequently to engage in deceptive practices, such as espionage. However, it is plausible that many of these vessels sail through the Barents Sea and along the Norwegian coast, avoiding entry into Skagerrak. Thus, these vessels remain undetected in this dataset. Consequently, the relevance of analyzing how the share of Russian research vessels could be used to detect suspicious shipping behavior in Skagerrak is debatable. It may provide more useful when investigating activity along other crossing lines, such as across the gas pipelines between the Norwegian southwest coast and Shetland. This is due to recent news articles documenting Russian research vessels sailing across these pipes following the Russian invasion of Ukraine (Johansen et al., 2022).

The data obtained from the NCA provide information about vessels, such as where they port, their route and ship characteristics. Nevertheless, it is important to acknowledge that certain data may be compromised due to manipulation of the AIS transmitter or other illicit activities concealing their actions. One significant challenge associated with the data is the inability to detect whether a vessel's AIS transmitter has been deactivated. Additionally, details regarding the purpose of the vessels' travel and the cargo remains unknown in the dataset. This information could be of interest as it would enable further investigation of vessels transporting suspicious cargo or exhibiting unusual travel patterns.

Given the limitations of the analysis, it is not possible to draw a definitive conclusion regarding the impact of the sanctions on the overall level of deviations in the shipping activity in Norwegian waters. Insights from chapter 3.1 and 3.2 suggests that while sanctions do affect the economy of the targeted country, they fail to alter its policies. This raises questions regarding the efficacy and relevance of employing sanctions as a policy tool. Imposing sanctions on a country places a substantial economic burden on the sanctioning nations that engage in trade with said country. If the sanctions ultimately amount to nothing more than a symbolic gesture, the associated costs can be substantial. The findings from chapter 3.3 suggests that reducing Russia's ability to circumvent the sanctions is crucial for achieving the intended effects. This underlines the importance of policymakers continuously evaluating new strategies to prevent sanction circumvention. Detecting abnormal changes in the shipping activity in Norwegian ports and waters may provide valuable insights into exposing illicit behavior. This enables policymakers to prevent such activities and implement further measures to diminish Russia's ability to continue financing the war against Ukraine.

6.2 Relevant extensions

There are several relevant extensions that warrant consideration for further research on the topic. First, given the limited existing research on how the sanctions against Russia has affected the shipping activity in Norwegian waters, the current specifications employed in the thesis are relatively simplistic. Therefore, further research could potentially benefit from incorporating additional control variables or other outcome variables. Further, expanding the sample size by utilizing additional ports or extending the time period, or both, would enhance the reliability of the estimates. This would enable a more effective comparison of shipping activity in Norwegian ports and waters before and after the implementation of sanctions. Other relevant expansions include the utilization of other sanctions as a reference date, different ports, or exploring different crossing lines through the North Sea. Further, conducting a more qualitative analysis similar to the approach taken by Huish (2017) could yield valuable insights. This could include a more thorough investigation of specific ships, unknown ownership and insurance companies, as recent news articles suggests that certain vessels involved in illicit activities within Norwegian territory are also present in our dataset (Eriksen et al., 2023). Additionally, conducting further investigations into the sailing pattern of vessels over time could provide a more comprehensive understanding of potential deviations in their behavior. This, in turn, would likely offer more credible indications of illegal activity.

7 Conclusion

This thesis aims to the explore the impact of the economic sanctions imposed against Russia in response to the invasion of Ukraine in 2022 on shipping activity in Norwegian waters. Currently, there is limited research available within this field. Therefore, our master thesis represents one of the first studies that investigates the influence of the sanctions against Russia on the shipping activities within Norwegian territory.

The analysis reveals several notable findings. Firstly, Russian vessels are reported to spend 17% more time in port after the implementation of the port ban compared to other vessels. Moreover, descriptive statistics indicate a relatively high increase in vessels sailing under FOC calling to ports in Troms and Finnmark after the implementation of the port ban. Similarly, there has been a considerable increase in the number of crossings by Russian and FOC vessels after the price cap was implemented. Although these changes are not captured in the estimations of how the sanctions affect the share of each country, the descriptive statistics illustrate notable changes in the shipping activity in both Norwegian ports and Skagerrak. Specifically, 73% of observed FOC vessels in Norwegian ports are new, while in Skagerrak, 42% of observed Russian vessels and 46% of FOC vessels in the post-sanction period are new. Additionally, there has been a significant increase in the number of tankers sailing under FOC through Skagerrak following the implementation of the price cap on Russian oil. Specifically, the proportion of FOC tankers is reported to increase by 8%, while the proportion of Russian tankers crossing Skagerrak is reported to increase by 0.6%.

It is challenging to determine whether these findings provide feasible indications that vessels sailing under Russia and flags of convenience engage in illicit activities in Norwegian waters. However, previous literature on sanction circumvention and recent news articles reports a rise in deceptive behavior following the invasion of Ukraine in 2022. This aligns with the findings from the thesis, suggesting that there are indications of suspicious changes to the shipping activity in Norwegian waters.

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