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**Summary:**

## **Accident risk of Norwegian-operated cargo ships in Norwegian waters**

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*This study surveys the sailed distance of Norwegian and foreign actors involved in transport of cargo at sea in Norway, and matches the results with accident data from the Norwegian Maritime Authority, in order to calculate and compare the accident risk of ships operated from Norway. The results show that ships sailing under Norwegian flag (NIS/NOR) have about three times higher risk of reported ship accidents of all damage rates than vessels with foreign flag with Norwegian operator. We find no statistically significant difference between the groups, when we compare the risk of ship accidents with serious damage. The key hypothesis that we originally were going to examine was whether foreign actors have higher accident risk than Norwegian actors. The data have not been good enough to answer this question. The foreign ships that we compare with are operated from Norway, even though they are sailing under foreign flags with foreign crews. We recommend increased efforts to ensure that accidents involving foreign ships are reported to the Norwegian authorities, to make accident statistics as complete as possible. To explain why Norwegian-registered ships have higher risk, we discuss five factors: 1) size of vessels, 2) age of vessels, 3) sailing patterns and number of port calls, 4) staff/fatigue and 5) accident type. The results should be interpreted with some caution, as we only have AIS-data for 2012, as the accident statistics lack information on operator state and as we assume that Norwegian operated ships report accidents to Norwegian authorities to the same extent.*

### **Background and aims**

Transport of goods by sea has long been open to foreign actors, and port statistics show that the number of internationally registered ships engaged in domestic and international transport of goods in Norway have increased the past decade (SSB 2012).

The purpose of the present study is therefore to:

- 1) Identify sailed distance of Norwegian and foreign actors in cargo transport by sea in Norway.
- 2) Match these results with accident data in order to calculate and compare the ship accident risks of Norwegian and foreign actors in cargo transport by sea in Norway.

The original hypothesis we were going to examine was whether foreign actors have higher accident risk than Norwegian actors in transport of goods by sea. The basis for the hypothesis was research indicating that foreign actors are exposed to unique risk factors that make them more prone to ship accidents than Norwegian actors. Previous research indicates the importance of safety culture and framework conditions (Håvold 2003, 2005; Bjørnskau and Longva 2009; Hovi and Hansen 2011; Størkersen et al 2011). Unfortunately, the data has not been good enough to answer this question, and we have therefore chosen to compare the ship accident risk of ships that are operated by Norwegian companies, but sailing under different flags.

The study is part of a research project aiming to assess the effect on accident risk of the increasing shares of foreign actors in road and sea transport of goods in Norway; and to provide a scientific knowledge base that Norwegian authorities can use to develop measures to reduce any increased risk identified. Information about the project: «Safe Foreign Transport» (SAFT) can be obtained from the website: [www.toi.no/saft](http://www.toi.no/saft). The project is funded by the TRANSIKK program of the Norwegian Research Council and lasts for three years (2013-2015).

## **Data sources and methods**

The study is based on Statistics Norway's (SSB) quarterly port statistics covering the years 2003-2012, The Norwegian Coastal Administration's (NCA) AIS-data (Automatic Identification System) from 2012 and accident data from The Norwegian Maritime Authority (NMA), for the period 1981-2012.

The port statistics include information about number of port calls, tonnes loaded and unloaded, product type and the ships' flag states for public traffic ports with an annual cargo of at least 1 million tons or at least 200,000 passengers. There are about 30 such ports in Norway, and the port statistics comprise about 90 % of all cargo loaded and unloaded in Norwegian ports.

In addition to using port statistics as a measure of exposure, we use AIS data to analyse the sailed distance (in km) of ships sailing along the Norwegian coast. These data contain information on both the operating state and flag state, but they are only available for 2012. The data set contains static data like ship id, vessel type, size and flag, as well as dynamic data such as time and location.

The statistics for accidents at sea are collected from the NMA, which annually records accidents and near misses along the Norwegian coast, both with Norwegian and foreign vessels. This statistic distinguishes between ship accidents and personal accidents. We have associated data on the vessels' sailing distance with accident data from NMA, to get a measure of ship accident risk. Risk is measured both as the number of accidents per tonnes and number of km sailed.

## **Considerable differences in the reporting of accidents**

When we compare ship accidents with little or no damage between the flags states, we see that there has been a significant increase in the number of accidents with little or no damage reported by vessels flying the Norwegian flag from 2006. This trend is not found for ships with foreign flags. Based on information from the NMA we have reason to believe that this indicates differences in the reporting of accidents between flag states, rather than in risk.

Previous studies also pinpoint the existence of different reporting rates. Studies by Psarros, Skjong, & Eide (2009) and Hassel, Asbjørnslett, & Hole (2011) find significant under reporting of accidents and near accidents at sea for several nations. It is proposed that under reporting could be due to different methods and procedures for accident reporting between states, fear of loss of reputation, different perceptions of how to characterize an accident and criteria for reporting accidents. Such conditions can lead to different rates of reporting between flag states, and give a distorted picture of their accident risk. Research also shows that there are

differences in safety culture levels between national groups at sea (Håvold 2003), and that reporting is a key element of good safety culture (Reason 1997).

One general hypothesis according to under reporting of accidents is that it is harder to hide serious accidents, so these will be a better reflection of the true story than less severe accidents. We have, however, gotten inputs indicating that also serious maritime accidents with ships sailing under foreign flag can be reported directly to their respective flag states and not to the NMA. Also, as there are few serious incidents per year, comparing the risk of accidents between ships sailing under Norwegian and foreign flags may give a false impression of the differences in accident risk. As a result we have chosen to restrict ourselves to compare the accident risk of Norwegian operated ships, separating between Norwegian and foreign flags. Here we assume that ships flying foreign flags, but which are operated from Norway report accidents to the NMA to the same extent as NOR/NIS-ships do.

## **Analysis of accidents and accident risk**

We conduct three different analyses of accidents and risk. First, we examine the number of accidents with cargo ships in Norwegian waters during the period 2003-2012. We have included all reported ship accidents, both Norwegian and foreign vessels in our study. However, in this report we primarily present the results for ships flying the Norwegian flag, but in some cases we also present results for other groups of flag states. We have categorized the various flag states into five groups: 1) Norway, 2) Nordic countries, 3) EU countries 4) countries with the right to sail under flags of convenience and 5) a group of other states. We present the number of accidents in the period 2003-2012 for these groups, but we do not calculate and compare their accident risk, since we assume that there are considerable differences in their reporting of accidents to the Norwegian authorities. The same five groups are used in the analyses of trends in the port statistics from 2003 to 2012.

Second, we analyse trends in the accident risks of ships flying the Norwegian flag in the period 2003-2012. The number of accidents is compared to the number of tonnes (millions) transported, from Statistics Norway's port statistics. We would prefer to compare risk for operator state, but this is not recorded in the port statistics.

Third, we look at the accident risk for Norwegian operated ships sailing along the Norwegian coast based on the number of million kilometres, from NCA's AIS data. By Norwegian operated ship we mean: 1) ships registered in Norwegian International Ship Register (NIS) and Norwegian Ordinary Ship Register (NOR) and 2) ships sailing under a foreign flag but which are operated from Norway. We look at Norwegian operated vessels because of the presumed differences in reporting and because a significant proportion of the ships sailing under foreign flags have Norway as operator state.

## **Transport of cargo**

Port statistics show an increase in the number of tonnes transported by ships to and from Norwegian ports during the period 2003-2012. Figure S.1 shows the trend for different flag states.

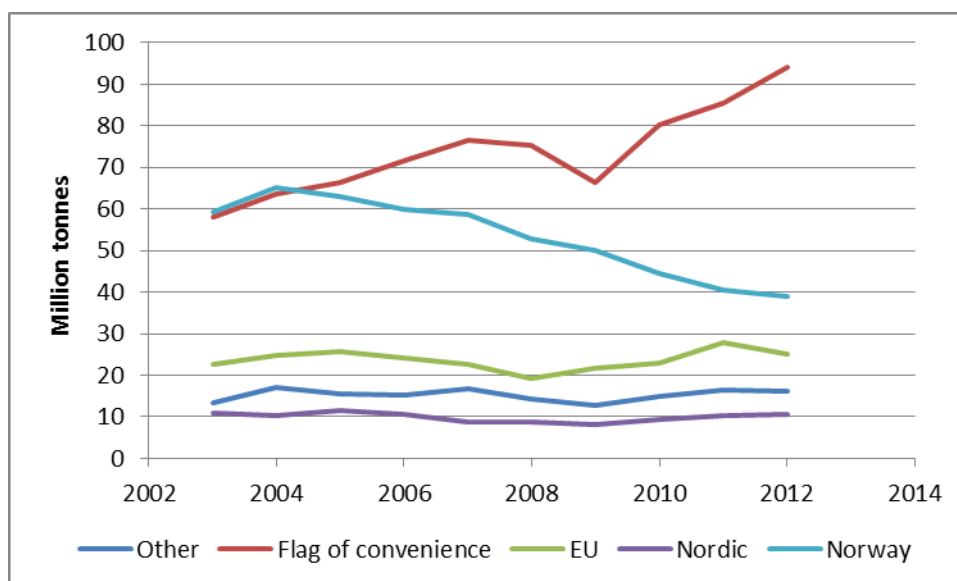


Figure S.1. Distribution of loaded/unloaded cargo in the largest ports in Norway, for flag states, in the period 2003-2012. Data: Quarterly Port statistics (SSB).

The figure shows two particular trends in the port statistics. One is a sharp reduction in cargo carried by Norwegian registered vessels (registered in NIS and NOR), and the other is a large increase in goods transported by ships flying flags of convenience. Vessels flying flags of convenience have accounted for the largest proportion of transported goods in the 30 largest ports in Norway in recent years. The trend is evident both for domestic- and international transport. This indicates a phase-out of Norwegian registered ships to ships with flags of convenience.

We used the AIS-data for 2012 to closer examine the flags and operator for ships along the Norwegian coast. We found that 52 % of the cargo ships that sailed the Norwegian coast in 2012 (2032 of 3924) were registered in a state with a flag of convenience. In comparison, only 6.7 % of these were operated by actors from the state of convenience themselves. EU operated most ships under flags of convenience, while Norway operated 8.2 %.

Shipping companies from the EU accounted for the operation of most vessels in Norwegian waters in total in 2012, and was registered as operator of 1387 cargo vessels. Norwegian actors operated 563 ships. If the distribution for 2012 is representative, and trends in the port statistics continue, it is likely that the amount of goods transported by NOR/NIS-registered ships will continue to fall. As these trends also were present for domestic transport, there is reason to expect increased cabotage in the future.

Examining which transports that were flagged out, we found that Norwegian companies have their strongest position among the smaller vessels, i.e. vessels under 5000 GT. We also found results indicating that it is primarily ships between 1.000 and 24.999 Gross Tonnes (GT) that are flagged out of Norway, particularly to states with flags of convenience. Looking at sailing distance, we found that flags of convenience accounted for the largest sailing distance in Norwegian waters, followed by Norwegian registered ships. When it comes to operating states, on the other hand, Norwegian operators accounted for the longest sailing distance along the Norwegian coast, followed by states from the EU.

## Analysis of accidents

A total of 675 accidents with cargo ships were registered along the Norwegian coast between 2003 and 2012. This represents just about 38 % of all of the recorded accidents in the period, making cargo ships the category with the highest number of accidents. We find an increase in the number of accidents involving cargo ships from 2006 to 2012. Much of this increase is due to an increase in the number of accidents with little or no damage to vessels, which has more than doubled between 2006 and 2009 (an increase from 23 to 61 accidents). If we distribute the accidents with little or no damage over flag states and years, we see that this is explained by an increase in the number of accidents registered by Norwegian ships (NIS/NOR). This made us check if there have been any changes affecting the scope of accident reporting in the period. A request to the Norwegian Maritime Authority made it clear that there hadn't been any direct change in the requirements for reporting accidents. However, in 2006 internal changes were made, and greater focus were put on accident recording. This may have influenced the number of accidents reported, especially for Norwegian actors, involving an increase in less serious incidents reported by Norwegian shipping companies.

## Analysis of accident risk based on transported goods

We have analysed accident risk for ships flying Norwegian flag in the period 2003-2012, with respect to the amount of goods transported, in million tonnes. We only focus on ships flying the Norwegian flag, as we have indications of significant differences in reporting between the various flag states.

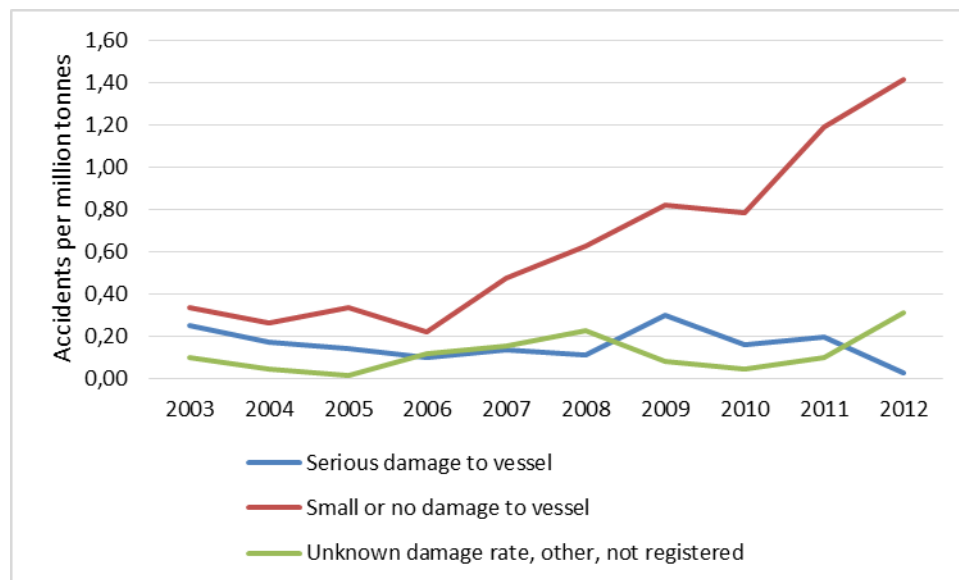


Figure S.2 Number of accidents per million tonnes of transported goods for Norwegian ships, distributed according to different degrees of damage, in the years 2003-2012. Data sources: The statistics of ship accidents (NMA) and SSB port statistics.

Figure S.2 shows that the risk of accidents with little or no damage has increased substantially from 2006 for Norwegian ships, also compared to accidents with severe or unknown damage. This underlines the result that Norwegian ships have been affected by the changed focus of accident reporting. The risk of serious accidents with Norwegian cargo ship decreased in the period 2003-2012. There were 15 serious

accidents in 2003 and 1 in 2012. The numbers vary from year to year, but the pattern for these accidents is different from that of the less serious accidents.

### Analysis of accident risk based on sailed km

We also calculate the accident risk for Norwegian operated ships sailing along the coast of Norway on the basis of million kilometres sailed. By Norwegian-operated ships we mean: 1) vessels flying NOR/NIS flags, or 2) vessels that fly foreign flags, but which are operated from Norway. We assume that all ships operated from Norway report accidents to the NMA to the same extent, regardless of flag state.

Figure S.3 shows a comparison of accidents per mill km for the average number of accidents in the period 2003-2012 divided by sailed km in 2012 for NOR/NIS and foreign ships, all operated by Norwegian operators.

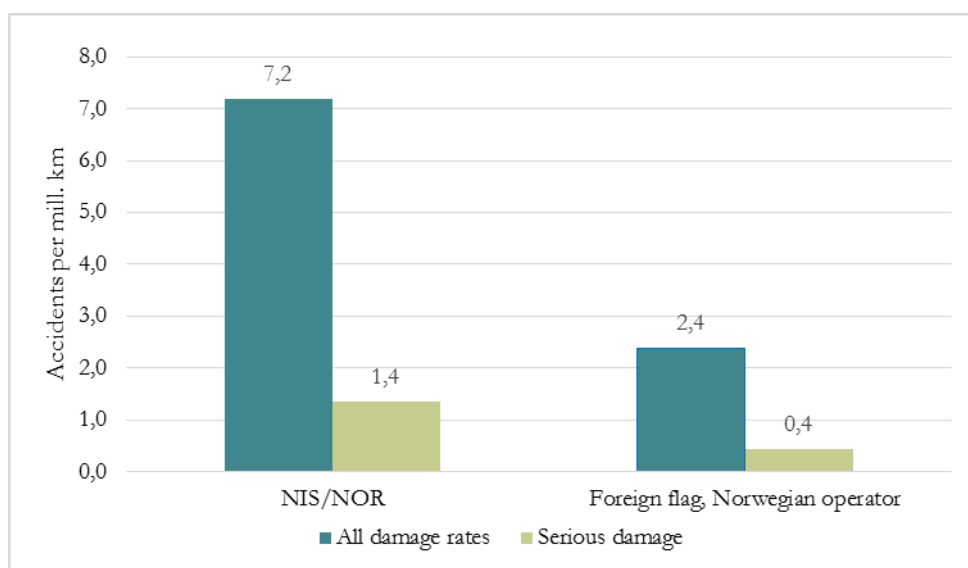


Figure S.3 accident risk per million km for NOR /NIS and foreign ships operated from Norway in Norwegian waters. (Average number of accidents in the period 2003-2012 divided by sailed km in 2012). Data sources: The statistics of accidents (NMA), and AIS data from the NCA.

Figure S.3 is based only on data on sailed distances from 2012, since we only have AIS data from this year. As there were few serious accidents in 2012, we use the average number of accidents per year in the period 2003-2012 as the basis for calculating risk. We see from Figure S.3 that NIS/NOR ships have about three times higher risk of reported ship accidents of all damage rates compared with foreign ships with Norwegian operators. This difference is statistically significant. The difference between risk of reported ship accidents with serious damage is smaller, and not statistically significant. Thus, we cannot conclude that NIS/NOR ships have higher risk of accidents with serious damage rate. We have also seen that the risk of serious accidents with Norwegian cargo ships have decreased in the period 2003-2012.

The risk estimates in figure S.3 should be interpreted with some caution, as they are based on several assumptions, for instance that ships sailing under foreign flag, but which are operated from Norway report accidents to the NMA to the same extent that NIS/NOR ships do. Nevertheless, the estimates indicate a topic that should be examined in future research.

## **Conditions that may explain the higher risk of NIS / NOR vessels**

From the comparison of accident risk we saw that Norwegian vessel in general have a higher accident risk than other vessels. This may be a result of different reporting cultures, and is associated with some uncertainty. We suggest five possible explanations, which we recommend to be investigated further in future research: 1) age of vessels, 2) size of vessels, 3) number of port calls and sailing patterns, 4) staff/fatigue and 5) accident types. We discuss NIS/NOR together here, but it is important to remember that NOR-registered ships sail between Norwegian ports while NIS-ships sail international trips.

1) *Vessels age*. We have not controlled for the age composition of the fleets, but when we look at accidents involving serious damage rates, we find that flags of convenience have more accidents with newer ships in both damage categories, while the opposite is true for Norwegian vessels. Further, the difference between accidents with ships flying the Norwegian flag and ships sailing under flags of convenience becomes smaller when we compare the number of accidents with ships built after 1980. We have not controlled for the distances sailed by vessels of different ages from different flag states. However, it seems that the NOR/NIS fleet is older than the fleet of ships with foreign flags, and that this may be an explanation for the higher accident risk of NIS/NOR-ships.

2) *Vessel size*. When looking at the distribution of accidents for size of vessels and flag states for cargo ships we find that most of the accidents are registered for the two smallest ship groups (<5000 GT), and that these largely are flying the Norwegian flag. We compared the risk of accidents of all damage rates for small vessels, flying Norwegian flags and Norwegian ships operating under foreign flags, and found that Norwegian cargo ship had higher accident risk than ships flying foreign flags when we controlled for size.

We have received input that the Norwegian cargo ships generally are smaller and older vessels sailing short distances in the inner fairway, with many ports of call. Foreign ships on the other hand, appears to be larger, newer vessels sailing long distances in the open sea, with fewer port calls in larger cargo ports<sup>1</sup>.

3) *Number of port calls and sailing patterns*. We would ideally have made a complementary accident risk estimation for cargo vessels calculated as the number of accidents per thousand port calls. We are however unable to do this since operating state is not registered in our data for port calls. We therefore recommend that operating state should be included in port calls data in the future. We also recommend that future research compare the accident risk between ships of different flag states/operator states in different zones, for example A) on the high seas and B) in inner coastal waters, so that the influence of flag states' different sailing pattern can be assessed against differences in accident risk.

4) *Staff/fatigue*. We have received suggestions indicating that NOR vessels tend to have relatively low staffing, combined with many port calls and a relatively high amount of administrative tasks on board. This provides a significant workload with the risk of fatigue (Størkersen et al 2011).

5) *Accident type*. Our research showed that NIS/NOR ships have about three times higher risk of reported ship accidents of all damage rates and accidents involving

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<sup>1</sup> This was mentioned in the reference group meeting, March 25.2014.

serious damage than foreign ships with Norwegian operators. However, the difference between the groups was only statistically significant for accidents of all damage rates. This difference is significant at the 5 % level, which means it is less than 5 % probability that the difference we observe between accidents of all the injuries is due to chance. The difference we saw between the accidents with serious damage is not statistically significant. In conclusion, we have no basis for claiming that the NIS/NOR ships are at higher risk for accidents with severe damage rates than vessels with foreign flags and Norwegian operators. The fact that the difference is not significant may to some extent be the result of few accidents involving serious damage, leading to substantial statistical uncertainty. However, the difference we see between the groups' risk of accidents of all damage rates may also reflect the fact that there are more accidents with less damage with NIS-NOR-ship because of the four reasons that we have mentioned above, given that these do not result in significantly more accidents with severe damage rates.

### **How important is flag state as an explanation of accident risk?**

The term "foreign actor" is complex in shipping, and it is timely to question how important flag state is when it comes to explaining differences in accident risk between cargo ships sailing along the Norwegian coast. We saw that NIS/NOR ships have about three times higher risk of reported ship accidents than foreign ships with Norwegian operators of accidents of all damage rates. Although the latter vessels sail under foreign flags with foreign crews, they are operated from Norway with Norwegian management systems on board and in the company offices. Additionally, NOR-registered ships sailing along the coast of Norway also have shares of foreign crew members due to lack of Norwegian seamen.

### **Need for improved data and topics for further research**

The data have not been good enough to answer whether foreign ships have higher accident risk than Norwegian ships. We recommend that operator state is included in the statistics of maritime accidents, and that work is done to ensure that accidents involving foreign ships are reported to Norwegian authorities, in order to make the ship accident statistics as complete as possible.

We recommend that future research should examine whether and to what extent the accident risk of NIS/NOR can be explained by vessel age, vessel size, sailing patterns, port calls and staffing/fatigue. Measures aiming to reduce Norwegian ship accidents should also focus on these issues.