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Internationalisation in Road Transport of Goods in Norway: Safety Outcomes, Risk Factors and Policy Implications

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Abstract: The European Union (EU) promotes a gradual lifting of restrictions on foreign hauliers involved in domestic road transport of goods (cabotage), and liberalization of the current road cabotage rules may further increase the proportion of foreign heavy goods vehicles (HGVs) on Norwegian roads. The aims of the present study are to: (1) Examine the safety outcomes of increasing internationalisation in (Norwegian) road transport of goods; and (2) Discuss the importance of potential risk factors related to increasing proportions of foreign HGVs on Norwegian roads. We use four data sources to shed light on the aims. Results show that foreign HGVs account for 6% of the average domestic transport in Norway, and 11% of the HGVs involved in personal injury accidents. Additionally, foreign HGVs have a three times higher risk of single vehicle accidents, and twice the risk of head-on collisions. Foreign HGV drivers also seem more likely to trigger fatal accidents. We conclude that two risk factors seem to be important: (1) experience with/competence on Norwegian roads and (2) winter driving. Thus, the safety challenge is not that the drivers are foreign, but that they to some extent lack experience with, and competence on, the Norwegian road networks and the challenges that these roads may pose (e.g., narrow roads with high gradients, many curves, snow and ice). Previous research from other countries has also found that lacking experience with national road networks is an important risk factor. Given our results on risk factors, we may hypothesize that if foreign HGV drivers get more experience and education on Norwegian driving conditions, then increased internationalization could perhaps be of less concern in road safety. When discussing the higher accident risk and lower experience of foreign HGV drivers in Norway, it is important to note that the reason for foreign HGV drivers, working for foreign hauliers, to drive in Norway is that there are customers of the goods in Norway. Interviewees stressed that the foreign driver is often the last link in a long and complex chain of actors involved in the transport. Although these actors have a legal responsibility to "contribute to safety," interviewees stated that this responsibility is vague and not clearly enforced. We therefore suggest the clarification of, and an increase in, the responsibilities of the different parties involved in goods transport, especially the transport buyers. This means to both ensure the experience and training of the drivers (e.g., preparing them properly to drive on winter roads), and to positively influence their transport safety in other ways (e.g., reducing stress and time-pressure).

Keywords: heavy goods vehicles; accident risk; cabotage; foreign and domestic; risk factors

1. Introduction

European market pressures have brought forth an increase in the proportions of foreign hauliers in the Norwegian road transport sector in recent years, and today about six percent of the kilometres

driven by heavy goods vehicles (HGVs) is done by foreign hauliers [1]. The vast majority of this is international transport, in and out of Norway. The involvement of foreign hauliers in domestic transport of goods within Norway (cabotage) is profoundly limited by Norwegian regulations. However, liberalization of existing rules for cabotage can further increase the proportion of foreign heavy goods vehicles (HGVs) on Norwegian roads.

Cabotage, meaning the national carriage of goods for hire or reward carried out by non-resident hauliers on a temporary basis in a host Member State, is governed by EU-Regulation (EC) 1072/2009 as of 14 May 2010. The purpose of this regulation was to reduce empty trips after the unloading of international transport operations. According to the regulation, every haulier may perform up to three cabotage operations within a seven-day period starting the day after the unloading of the international transport.

Since the 1980s the European Union (EU) has introduced measures to deregulate the goods transport market. As part of the implementation of the common market, the European Commission has been pushing to remove market barriers to liberalize EU-Regulation (EC) 1072/2009 and allow cabotage. Consequentially, a major deregulation of domestic road transport of goods in the EU/EEA area was scheduled to take place in January 2014.

After protests from several member states facing competition from new EU-countries with lower labour costs, the planned liberalization of the cabotage legislation was first postponed to 2015, when a newly elected EU-commission would be in place. After that, the liberalization was postponed again. The exploitation of the lower wage and benefit expectations of foreign workers (social dumping) and national competitiveness were the main concerns raised by member states, while little attention was given to the issue of transport safety (cf. [2]). While EU Directives have been introduced in an attempt to harmonise and improve road safety standards across EU countries (e.g., 2008/96/EC on road safety management, 2003/59/EC on heavy vehicle driver training), the effects of increased cabotage for the road safety of individual countries remain far from clear. It should also be mentioned that several reports of the European Traffic Safety Council (ETSC) examine work-related road safety and recommend that transport organisations should include transport safety as an important part of their Health, Safety and Environment (HSE) work [3–5]. In 2008, more than 5200 people were killed in accidents involving HGVs in 23 EU countries [6].

Because of the low wage level in the countries that recently joined the EU, it is likely that any possible lifting of cabotage restrictions will increase the proportion of Eastern European HGVs on Norwegian roads. Norway is not a member of the EU, but as a member of the European Economic Area (EEA), Norway is commited to implement EU legislation on economic competition. This includes potential removal of cabotage restrictions in the road sector.

Although the increasing proportion of foreign actors in road transport in Norway is well documented, little is known about the consequences for national road safety. A previous literature review conducted by Nævestad et al. [7] indicates that the HGV accident risk varies by a factor of up to ten in European countries (cf. [6,8]), and that the accident risk for foreign HGVs is approximately two times higher than it is for domestic HGVs in those European countries studied. There are, however, no studies systematically studying both the accident risk and potential risk factors for domestic and foreign HGVs in Norway. The aims of the present study are therefore to: (1) Examine the safety outcomes of increasing internationalisation in the (Norwegian) road transport of goods; and (2) Discuss the importance of potential risk factors related to increasing proportions of foreign HGVs on Norwegian roads. This paper is based on a larger study of the safety outcomes of the internationalization of road transport of goods, which is presented in Nævestad, Phillips, Levlin & Hovi [9]. Both the interview guide and the survey that the present study is based on are provided in this previous report. We use the following four data sources to shed light on the aims: (1) Personal injury accidents; (2) Fatal accidents; (3) Small-scale survey and (4) Qualitative interviews.

2. Previous Research

2.1. Previous Research on Accident Risk

The DaCoTa [6] study indicates that the risk of fatal HGV accidents is three times higher in eastern European countries than in Scandinavia. The risk in Poland and Slovakia is over 30 fatalities per million population, while it is substantially less than 10 per million in Denmark and Sweden [6]. Risk relations for fatal accidents involving all vehicle types are similar—in this case 102 and 68 fatalities per million population in Poland and Slovakia, respectively, compared with 46 and 38 fatalities per million population for Denmark and Sweden [10].

It is, however, relevant to question the suitability of population as an exposure measure. Accident risk estimates should ideally use measures of exposure focusing on HGV activity (e.g., vehicle distance travelled). Comparing the number of fatalities involved in HGV incidents per billion HGV km driven in each of the European countries, AECOM [8] finds that the risk of HGV related fatalities generally is higher in eastern European countries than it is in western European countries. The average risk for all EU member states is 31.5 fatalities involved in a HGV incident per billion HGV km. Romania had by far the highest HGV fatality risk, with 177.3 fatalities per billion HGV km driven. Poland had the second highest fatality risk (59.9), followed by Belgium, Greece, Finland, Austria, Denmark, Portugal and the Czech Republic.

Langeland and Phillips [11] provide a comparison of the HGV accident risk for every billion HGV kilometres travelled in European countries, and find that the HGV risk in Norway equals the European average of 23 fatalities per billion domestic HGV kilometres. The risk of an HGV being involved in fatal accidents in Norway based on this measure was lower than 12 other European countries and higher than eight other European countries. Belgium, Croatia and Finland had the highest risk of HGVs being involved in fatal accidents, and the risk was nearly twice that of Norway's. Luxembourg, The Netherlands and Ireland had the lowest risk in this comparison, and the HGV risk of being involved in fatal accidents in Norway was about twice the risk of these countries.

The main strength of AECOM [8] and Langeland & Phillips [11] is that they estimate accident risk based on vehicle km. However, these studies compare HGV accident risk across countries instead of examining the risk of national groups of HGV drivers within countries. Nævestad et al. [1] study the vehicle kilometres of Norwegian and foreign HGVs in Norway 2007–2012, and analyses these results in light of data on personal injury accidents to calculate and compare the accident risk of Norwegian and foreign HGVs in Norway. This study defines accident risk as the number of personal injury accidents per million vehicle km. The average accident risk of all HGVs in Norway was 0.34 accidents per million vehicle km. Norwegian (0.32) and Danish (0.35) HGVs had the lowest accident risk. The accident risk of HGVs from the rest of the EU15 (0.91) was over 2.5 times higher than the accident risk of Norwegian vehicles. Polish and Baltic vehicles (0.68) had the second highest accident risk, followed by Swedish vehicles and vehicles from other EU27 countries. The accident risk for all national groups were statistically significantly different from that of Norway, except in case of Denmark and other EU27 countries. Among the HGVs involved in personal injury accidents in the period, 2957 vehicles were Norwegian, 117 Swedish, 49 Danish, 99 from other EU15 countries, 93 Polish or Baltic, 17 HGVs from other EU27 countries, 21 were from other countries, and 363 HGVs had unknown nationality. Nævestad et al. [1] did not calculate the risk for HGVs from countries outside the EU (N = 22), because they lacked data on their vehicle kilometres in Norway.

A study conducted by Leviäkangas [12] shows that the accident risk for Russian HGVs on one of the roads in the study was double the risk of Finnish HGV drivers. Although this study is limited by the fact that it relies on a limited empirical base, it is one of few studies comparing the accident risk of foreign and domestic HGV drivers based on vehicle km. Additionally, this study is relevant for Norwegian conditions, as it is one of few studies of HGV accident risk that discusses foreign drivers' lacking experience with winter conditions as a risk factor.

2.2. Previous Research on Risk Factors

Research has identified several important risk factors commonly associated with serious road accidents involving HGVs, including high speed, drink-driving, distraction and fatigue (e.g., [13,14]). Such factors are most often assigned to drivers of vehicles other than HGVs, who are more often responsible for triggering accidents in which HGVs are involved. Common risk factors for those accidents triggered by HGV drivers include speeding or unsuitable driving for the prevailing conditions, driver fatigue, and technical factors associated with the load or vehicle (e.g., [14,15]). What is not clear is the extent to which such risk factors vary across countries in Europe. In the remainder of this section we review existing research on risk factors for accidents involving foreign HGV drivers.

Training, competence and experience represent important risk factors for foreign HGV drivers. Research indicates that foreign HGV and car drivers are more vulnerable than domestic drivers, as they are unfamiliar with the existing road environment [16,17]. This indicates the importance of experience and competence with the national road network. Accordingly, winter driving and steep roads represent a crucial safety challenge in Norway and several other European countries [12,18,19] Leviäkangas [12] points to winter driving as a risk factor, and concludes that the winter season is especially risky for foreign drivers. He suggests that this is due to lack of winter driving skills and inadequate winter equipment. Unlike Finland, it is not mandatory with winter tires or winter training during licensing in Russia. This indicates the importance of training, especially winter driving training, as a potential risk factor. In contrast with Norway, winter training is not required in European countries further south, making it even harder for foreign drivers to cope with Norwegian winter conditions. Contrary to this, however, Vlavkeld, Stipdonk & Bos [20] conclude that poor driver training is unlikely to represent a risk factor for foreign HGV drivers, as international research has not proved a relationship between the quality of driver training and accident risk, as the EU Directive 2006/126/EC and 2003/59/EC establishes common minimum requirements for driver training in all European countries.

Technology and equipment also make up a potential risk factor. Some studies suggest that haulier companies in Eastern European countries do not have the same strict standards applying to the technical state of vehicles as Norwegian hauliers [18,19]. The Norwegian Public Roads Administration (NPRA) conclude, however, that they did not find substantial differences between the technical state of Norwegian and foreign HGVs after controlling 17,000 HGVs from January to August 2013 [21]. According to Safetec [18], however, foreign (European) HGVs generally used on flat European roads often are less suitable to Norwegian conditions (e.g., smaller engines, two-axle tractors) than Norwegian HGVs. A further risk factor related to technology and equipment that varies across EU countries is HGV combination length, although current Norwegian regulations are restrictive relative to Sweden, for example [22].

Road characteristics represent a potential risk factor. Langeland and Phillips [11] find that Norway has 37% more fatalities per inhabitant involving heavy vehicles than the average of 23 other European countries. They attribute this to economic prosperity in Norway, leading to a relatively high level of goods transport on Norwegian roads. Additionally, Norway has a high proportion of its heavy vehicle transport on roads with a poor standard, partly due to a dispersed population and industry in the outskirts of the country. First, less than 10% of the total kilometres driven in Norway are on roads with central barriers. This is the lowest proportion among the 13 other European countries that the authors compare—70% of the fatalities involving HGV accidents in Norway occur in head-on accidents. The second road characteristic which contributes to HGV related fatalities in Norway is slippery, narrow roads with many curves. About half of the HGV accidents occur on curves, which often are tight. Slippery and narrow roads are prevalent risk factors in these curve accidents with HGVs [11].

National culture may constitute a potential risk factor [23]. It is likely that foreign drivers are influenced by the road safety culture in their home country, influenced, for example by traffic rules, how police enforce the rules, road user interaction, driver licensing and driver education [24–28].

Leviäkangas [12] suggests that the risk the difference he found between foreign and domestic drivers in Finland can be explained by differences in traffic culture, which he defines as the sum of all factors affecting the skills, attitudes and behaviors of drivers as well as the equipment (i.e., vehicles).

Finally, framework conditions such as the economy, competition and rules/enforcement influence the safety level in HGV transport. Research has found that EU-Regulation (EC) 1072/2009, on cabotage, is interpreted and enforced differently in different EU countries [2,29,30]. Moreover, it has been claimed by some interviewees in a former study that foreign HGV drivers have higher proportions of performance-based pay [31]. These interviewees also argued that performance pay systems in the road transport sector for instance may increase drivers' stress, motivate them to speed, drive while fatigued, and thus behave negatively with regard to transport safety [31].

3. Methods

3.1. Analysis of Personal Injury Accident Data

In this study, we define HGV risk on Norwegian roads as the number of police reported injury accidents per million vehicle km. We use two data sources to calculate risk. The first data source is Statistics Norway's Lorry surveys' data on the vehicle kilometres of Norwegian HGVs in Norway. This is a quarterly survey of domestic and foreign traffic with Norwegian-registered HGVs. The second data source is traffic to/from Norway and cabotage within Norway with foreign HGVs. This is based on European studies similar to the Lorry survey. Eurostat's statistics directive commits each member state to conduct such surveys, which means that Statistics Norway gets information on all trips in and out of Norway from EU-countries. Combined, the national Lorry Survey in Norway and Eurostat data from similar surveys in European countries cover all foreign and domestic lorry trips between municipalities and counties that are conducted within, to, and from Norway. The following categories have been used in the analyses: (1) Norwegian HGVs; (2) Swedish HGVs; (3) Danish HGVs; (4) HGVs from other EU15 countries; (5) Baltic and Polish HGVs and (6) HGVs from other EU27 countries.

The study is based on accident data from Statistics Norway. Data from all personal injury accidents are collected by Statistics Norway. The units in the data file are mainly involved persons, i.e., people with injuries and the unharmed drivers of involved vehicles. The accident statistics include data on the countries in which the involved vehicles are registered, and ten different types of HGVs. Our analyses of accidents and accident risk focus on the number of HGVs that have been involved in personal injury accidents in the period 2007–2012. The accident data include 3531 police reported road accidents with personal injuries in Norway in the period 2007–2012. The accidents involved 3716 HGVs distributed among different groupings of vehicle registration countries. 2957 vehicles were Norwegian, 117 Swedish, 49 Danish, 99 from other EU15 countries, 93 Polish or Baltic, 17 HGVs from other EU27 countries, 21 were from other countries, and 363 HGVs had unknown nationality. The latter are added to the Norwegian HGVs in the calculations of accident risk.

We conduct tests of the significance level of the differences in accident risk between the national groups that we compare to examine the probabilities that the differences are due to statistical chance. The calculations take into account uncertainty in both accident- and exposure data. It is usually assumed that the coincidental variation in accident numbers are in accordance with the Poisson distribution [32]. This distribution is approximately equal to the normal distribution when applied to large numbers [32]. In the Poisson distribution, the standard deviation equals the square root of the number. A 95% confidence interval for an accident number is therefore:

$$n \pm \left(1,96\sqrt{n}\,\right)$$

We assume that the numbers for vehicle kms follow the normal distribution when we estimate the standard deviation and the confidence intervals for them. We use the following formula:

$$R \pm 1,96\sqrt{\left(\frac{S_e}{e}\right)^2 + \left(\frac{S_s}{s}\right)^2}$$

In this formula, the following abbreviations are used: R = risk number, Se = standard deviation of vehicle kms, Ss = standard deviation of injury number, e = vehicle kms, s = injury number. If the confidence intervals of two risk numbers are so different that they do not overlap, we assume that they are significantly different. They may, however, also be significantly different although they overlap. We use the following formula to examine whether the difference between risk numbers is statistically significant:

$$|D| \pm 1,96\sqrt{(s_1)^2 + (s_2)^2}$$

In this formula, the following abbreviations are used: $|D|$ = the absolute difference between risk number 1 and 2, S1 and S2 = standard deviation of risk numbers 1 and 2.

3.2. Analysis of Fatal Accident Data

All fatal road accidents are investigated by the NPRA in the form of regional Accident Analysis Groups (AAG). Since 2005 every fatal accident has been documented by means of in-depth reports describing the course of the accident, road and weather conditions and relevant aspects of involved road users and vehicles [33,34]. The reports are based on a common template and use different data sources, such as print-outs from police interviews with the road users, or technical reports from accident sites and on the vehicles involved [34]. For the vast majority of fatal accidents, there thus exists a separate report that can be reviewed to investigate its triggering or contributing factors. Certain variables from the in-depth reports are included in an AAG-database. This database can be used to quantitatively analyse fatal accidents and accident factors [33]. The AAG refers to direct causes as "triggering factors" and underlying causes as "situational factors".

Phillips & Meyer [35] made use of AAG-data to study the prevalence of fatal accidents involving drivers at work. The original AAG-database does not contain variables on work-related driving, although AAG-reports provide relevant and often indirect information about this [31]. For instance, the reports often mention road users' travel purpose. On the basis of travel purposes, among other things, it can be deduced whether the various road users involved in the accident were driving at or to/from work. Based on all AAG reports from the period 2005–2010, Phillips and Meyer added a new variable on driving during working hours to the AAG-database Nævestad & Phillips [31] use and update Phillips & Meyer [35] for mapping and analysing serious work-related road accidents (2005–2011). The difference is that Nævestad & Phillips focus on fatal accidents triggered by drivers at work, rather than hose involving drivers at work. For the present report, we have updated the database developed during the two previous projects. We have updated for the last available year (i.e., 2012). We used and updated the variables on drivers at work that we developed in the above projects, but this time we focus on the driver and the vehicle's nationality.

3.3. Small-Scale Survey

The project was carried out in line with our institute's ethics policy (www.toi.no). Interviews and survey participants were recruited directly (independently of their employers) and participation was voluntary, they were free to withdraw from participating at any time and their anonymity was guaranteed. Drivers were informed that the purpose of the research project was to study HGV drivers in Norway, focusing on safety, working conditions, winter driving etc. This was done in the participants' mother tongue, or in some cases in English for drivers who were fluent in English.

3.3.1. Recruitment of Foreign HGV Drivers

The respondents were recruited in two different ways. The main reason for this is that previous experiences have shown that it may be difficult to recruit foreign HGV-drivers in Norway to participate in surveys, e.g., through foreign HGV companies operating in Norway. Additionally, we wanted to ensure that we recruited foreign drivers who actually were driving in Norway. Thus, we chose to recruit foreign drivers directly, while they stayed in their vehicles in Norwegian parking lots and resting areas etc. This is, however, a resource-demanding method of getting survey responses. The Norwegian respondents were therefore recruited by means of a web-based survey distributed on websites. We chose this method rather than recruiting through Norwegian companies, as we wanted Norwegian HGV drivers from several different companies, to make them comparable to the foreign HGV drivers, who also were from several different companies.

The foreign drivers were recruited by a research assistant/student at rest stops, terminals and parking lots in the South-Eastern region of Norway in May 2014. Including introduction and closure of the interviews, most of the survey interviews with the foreign drivers lasted for about one hour. The research assistant spent a total of 105 h looking for foreign drivers over a period of 15 days in May 2014, and she drove a total of 1327 km. As each survey interview lasted for about one hour, she spent approximately 74 h talking to 69 foreign drivers and five Norwegian drivers in or outside their vehicles. Drivers were asked to answer the survey themselves by means of a tablet device connected to our online survey, or the research assistant would interview them using the tablet. In both cases, the tablet was used to access survey links with the survey in Norwegian, English, Polish, and Lithuanian (cf. [9]). There were introductory texts in the beginning of each web survey, explaining the purposes of the surveys and stressing that the surveys were confidential. Each time the research assistant approached a supposedly resting foreign driver, she said:

«Hi! I am a student writing a thesis on foreign drivers in Norway. I would like to ask you some questions on safety and working conditions. The survey is anonymous, and neither you, your vehicle or your company will be identified. I cooperate with the Institute of Transport Economics in Norway, which also will use the data from the survey. It will take about fifteen minutes to complete the survey».

The drivers who were unwilling to answer either could not answer because of their language, or because they did not have time, or they simply did not want to. According to her estimates, a total of 33% of the drivers that she approached were unwilling to answer the survey. Most of the drivers who were unwilling to answer were unwilling because she did not have the survey available in their language (19%). These languages were mainly: Russian, Latvian and Rumanian. Only 14% of the drivers that she asked were unwilling to answer for other reasons. Thus, this sample was shaped by the survey languages available.

3.3.2. Recruitment of Norwegian HGV Drivers

The Norwegian drivers in the sample were primarily recruited through a web link to the survey on the website of the Institute of Transport Economics. The web link was introduced on the website of the project "Work related transport accidents" which was a sub site on the Institute of Transport Economics website. A link to this site was also presented on the Facebook website to members of the "Norwegian cabotage study" which is a group for fans of a study attempting to map cabotage driving in Norway. We used this Facebook site, as we assumed that most of the members would be Norwegian HGV drivers. The website with the survey link was titled "Study of safety culture, winter driving and working conditions" which sums up the main themes in the survey. Moreover, on this website, respondents were informed that:

"If you are a HGV driver, we hope that you will participate in a study! The Institute of Transport Economics is conducting a survey aimed at HGV drivers in Norway. It will take you about fifteen minutes to answer the survey. The Institute of Transport Economics conducts the survey in conjunction with a research project financed by the Norwegian Research Council, LINK. Questions or comments can be directed to Tor-Olav Nævestad. Thank you very much in advance!"

The website with the survey link was placed on the website of a research project financed by the Norwegian Research Council, focusing on work related accidents in road, sea and air transport. We placed the link to the survey on this website, as we also intended to use the small-scale survey data in this research project, focusing on work-related transport accidents.

3.3.3. Challenges Related to Comparing Norwegian and Foreign HGV Drivers

An important methodological and ethical challenge related to surveys comparing Norwegian and foreign HGV drivers is that the issue of foreign HGV drivers in Norway at the time of the study was a politically debated issue, generating considerable incitement among the involved parties. The Norwegian drivers answering the survey are to some extent competing in the same market as the foreign drivers in the survey. As each group of drivers potentially would have interest in giving strategic answers in order to score better than the other group, they were only informed in the survey introduction that the study concerned "HGV drivers in Norway" in general (i.e., both Norwegian and foreign). The fact that the Norwegian drivers generally did not "score better" than the foreign drivers, except when it comes to winter driving, seem to indicate that they did not give strategic answers.

3.3.4. Description of the Sample

In Table 1 we present proportions for driver nationality, their vehicle registration countries and their employment countries, distributed according to three geographical regions and one category for unknown.

Table 1. Nationality of drivers, vehicle registration country and driver employment country.

Region	Driver Nationality		Vehicle Reg. Country		Driver Employ. Country	
Norwegian:	47%	61	49%	64	49%	63
Western European Countries:	13%	17	15%	20	15%	19
Central/Eastern European countries:	40%	52	28%	37	31%	40
Unknown:	0%	0	7%	9	6%	8
Total:	100%	130	100%	130	100%	130

In order to be able to compare the groups statistically, with an N of 130, we divided respondents into three groups. We see that nearly half of the drivers and vehicles in the sample are Norwegian, and that half of the drivers are employed in Norway. The other groups of drivers were from Central/Eastern and Western European countries. The group of drivers from Western European countries is unfortunately small. This group actually consists of eight drivers from Nordic countries and nine drivers from other Western European countries (mostly from The Netherlands). This group is generally too small to make any solid conclusions about this group in our analyses. The small size of the drivers from Western European countries reflects the limited kilometres driven by these foreign drivers on Norwegian roads.

We did not include questions on respondents' gender in our survey, as our previous studies (e.g., [36]) have found the proportion of female HGV drivers to be too small (about 2%) to allow for statistical analysis in samples of our size (e.g., N < 200). In Table 2, we present the age groups of the drivers, according to their nationality group.

Table 2 shows that the Norwegian drivers in the sample have the largest proportion of drivers over 56 years old. This proportion is more than twice that of drivers from Central/Eastern European countries. In the latter group, 37% of the drivers are 35 years old or younger, compared to 26% in the Norwegian group of drivers. Thus, it seems that the drivers from Central/Eastern European countries are somewhat younger than the Norwegian drivers. A Chi-square test shows, however, that the differences are not statistically significant ($P = 0.599$).

Table 2. Age groups of the drivers, according to their nationality group. Per cent. Norwegian (N = 61), Western European country (N = 17), Central/Eastern European country (N = 52).

Region	<26	26–35	36–45	46–55	56+
Norwegian:	8%	18%	28%	26%	20%
Western European Countries:	6%	24%	24%	41%	6%
Central/Eastern European countries:	10%	27%	23%	33%	8%
Total:	9%	22%	25%	31%	13%

Drivers were also asked how many days they had driven on Norwegian winter roads in total (Table 3). The purpose of this question was to estimate the respondents' experience with, or exposure to, Norwegian winter roads.

Table 3. National groups' distributions on the question «Approximately how many days have you been driving on Norwegian winter roads in total» Per cent. Norwegian (N = 61), Western European country (N = 17), Central/Eastern European country (N = 52).

Region	Never Driven in Norway in the Winter	1–10 Days	11–50 Days	51–100 Days	More than a Hundred Days
Norwegian:	0%	0%	2%	8%	90%
Western European Countries:	0%	12%	12%	18%	59%
Central/Eastern European countries:	14%	19%	15%	12%	40%

As expected, nearly all the Norwegian drivers had driven more than a hundred days on Norwegian winter roads. The drivers in the two other groups have larger proportions of drivers with less Norwegian winter road experience. This especially applies to drivers from Central/Eastern European countries. Seven of these drivers had never driven in Norway in the winter before. These drivers were therefore not asked questions about their experiences with winter driving. A Chi-square test shows that the differences are statistically significant ($P = 0.000$).

Additionally, results indicated that 10% of the Norwegian drivers were self-employed, while 33% of the drivers from other Western European countries and 20% of the drivers from Central/Eastern European countries were. The self-employed drivers did not answer questions on safety culture, as such questions often concern evaluations of managers or colleagues. A proportion of 8% of the Norwegian drivers owned the truck themselves, while 24% of the drivers from other Western European countries and 8% of the drivers from Central/Eastern European countries did. Table 4 shows the size of the companies of the respondents.

Table 4. Size of the companies of the respondents, according to their nationality group. Per cent. Norwegian (N = 61), Western European country (N = 17), Central/Eastern European country (N = 52).

Region	1–19 Employees	20–99 Employees	>100 Employees
Norwegian:	34%	31%	34%
Western European Countries:	75%	19%	6%
Central/Eastern European countries:	46%	32%	22%

The numbers in Table 4 include the self-employed drivers. This is probably one of the reasons that Table 4 indicates that 75% of Western European countries and 46% of the drivers from Central/Eastern European countries work in small companies. The proportions for small companies are, however, higher than the proportions for self-employed drivers in the two foreign groups. Thus, it seems that the companies of the foreign respondents are smaller than those of the Norwegian respondents. It is, however, difficult to draw conclusions about this, as numbers are small.

3.3.5. Survey Themes and Questions

The surveys included questions on the following themes: (1) Background variables related to age, nationality of driver, vehicle and company, employment status, company size and whether the drivers own the trucks themselves; (2) Winter driving: 11 self-developed questions related to e.g., exposure to Norwegian winter roads, need for towing assistance, drivers' perception of risk and feeling of mastery, winter tyres and snow chains, loading of the trailer on winter roads and winter driving training; (3) 5 of 25 questions on safety culture from the GAIN-scale on safety culture that we have used in previous research [36]. The GAIN-scale is presented in the "Operator's Safety Handbook" [37]. Global Aviation Information Network (GAIN) is a voluntary association of airlines, manufacturers, trade unions, governments and other organizations in aviation. The 5 questions included from GAIN focus on safety commitment, safety training and reporting routines; (4) 6 of 20 questions on work related factors known to influence the traffic safety of professional drivers, e.g., company focus on safety versus efficiency, whether "all drivers'" in respondents' companies use seat belts and drive according to conditions and speed-limits, drivers' violations of procedures to get quicker to their destinations etc. These questions are meant to indicate manager and company focus on and policies for drivers' traffic safety behaviours [31,36]; (5) Questions on exposure (1000 km driven) and accident involvement in the last two years, which also have been used in studies of professional drivers [36]; (6) Questions on driving and working hours, fatigued driving and falling asleep behind wheel, which also have been used in studies of professional drivers [36]; (7) Questions on responsibility for (un)loading, fixed salary, origin and destination of trips and how the respondents got their cargo. (cf. [38]); (8) Questions related to measures: knowledge of the "Donna Diesel" campaign of the Norwegian Public Roads Administration, whether the respondents have smart phones, and if so whether they would like to register their phone numbers in order to receive vital driving information on their phones, or whether they would download an app providing this information.

3.4. Qualitative Interviews and Reference Group Meeting

We have conducted 11 qualitative interviews with 12 sector experts representing employers, employees and authorities in order to gain knowledge on safety outcomes of increasing internationalisation, potential risk factors and relevant measures to increase safety in road transport of goods further. We interviewed two people in one of the interviews. Three interviews were conducted face-to-face, and eight were telephone interviews. The interviews generally lasted for about one and a half hours. We used a semi structured interview guide, which contained questions on the following risk factors: (1) winter driving; (2) drivers' transport safety behaviours; (3) company regulation of drivers' transport safety behaviours; (4) safety culture; (5) organization of transport assignments; (6) safety management system; (7) competence, training and experience; (8) technology and equipment; (9) economy, competition and pay; (10) rules and enforcement; and (11) working hours and fatigue. The interview guide also contains questions on potential measures to address these risk factors. The interviews were not recorded; instead we took notes during each interview. Following each interview, we wrote an extensive summary based on the themes in the interview guide and the viewpoints of each individual interviewee. When we had finished all the interviews, we analysed these summaries, comparing the interviewees' comments on, and opinions about, the themes (see below). To ensure the quality of our analysis, we submitted texts summing up the results of our analysis to the interviewees, giving them the opportunity to comment, provide nuances and correct mistakes.

Most researchers analyse qualitative data by coding text and breaking it up into more manageable chunks [39]. In more deductive modes of analysis, the researcher examines theory, develops hypotheses on this basis, and tests these hypotheses by means of, for instance, interviews. In inductive modes of reasoning, the researcher observes particular phenomena, infers knowledge on particular patterns from these observations, and develops hypotheses and subsequently theory. Most qualitative analyses of interview data rely on a combination of these two ideal-typical approaches, and so did we. Much of

our coding started when we developed our interview guide, which was largely based on previous research, and thus more deductive. When coding our notes from each interview, we grouped individual answers into categories of viewpoints whenever several interviewees presented relatively similar views. We compared the interviewees' views on the themes in the guide and their answers to each of the questions. We did this by systematically comparing the texts and words from each interview, focusing on the extent to which the answers and viewpoints of the interviewees were different or similar. This approach to coding is more inductive, although the interview guide codes were, as noted, largely based on previous research.

We present the results from the interviews together with some of the results of a project reference group meeting which was held at The Institute of Transport Economics (TØI) 12. March 2014. The reference group was established for this project only, and the purpose of the reference group was to provide the project with information and viewpoints from key stakeholders throughout the project period. The reference group meeting was held after an open project meeting, at which we presented the preliminary results of our project. The reference group members are from the Norwegian Public Roads Administration, the Norwegian Labour Inspection Authority, the Norwegian Ministry for Transport and Communications, the police, the Transport Accident Investigation Board Norway and representatives from employer organizations and unions. As we got many important viewpoints and comments in the reference group meeting, we choose to also include some relevant highlights from this meeting together with the presentation of the interview results. Viewpoints and information from the reference meeting are presented when they can complement the other data sources. In the reference group meeting, each member was given the opportunity to present his/her views on a topic in a roundtable discussion. Like the interviewees, reference group members were recruited from different key stakeholder organisations. Thus, these data also provided the opportunity to obtain a relatively balanced description of the themes of our study. Also, in the reference group meeting, members responded to each-others' comments, and thus provided us with relatively rich and nuanced information about our study topics.

4. Results

4.1. Safety Outcomes of Increasing Internationalization

4.1.1. Personal Injury Accidents

Analysis of police-reported traffic accidents with personal injuries from 2007 to 2012 indicates that Norwegian and foreign drivers have a different risk of being involved in different accident types (Figure 1).

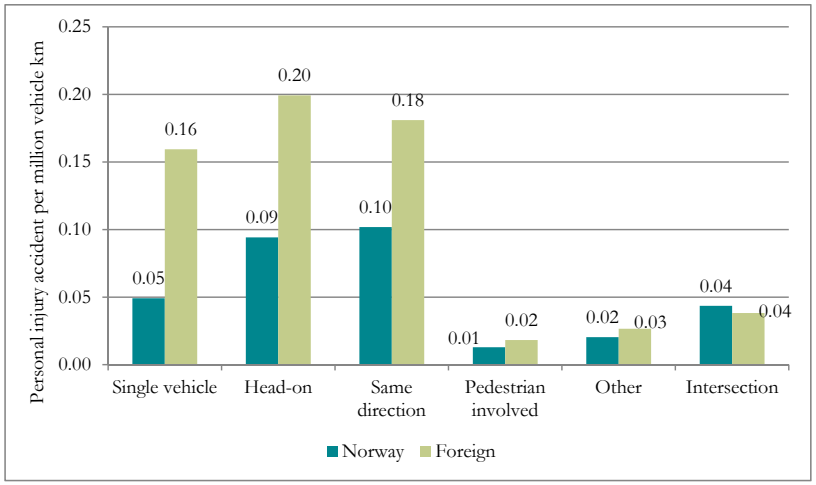

Figure 1. The risk of different accident types for Norwegian (N = 3320) and Foreign HGVs (396) involved in police reported traffic accidents with personal injury in Norway 2007–2012.

Figure 1 indicates that foreign HGVs have a three times higher accident risk of single vehicle accidents than Norwegian HGVs, twice the risk of head-on collisions, and nearly twice the risk of collisions with vehicles driving in the same direction. The risk of being involved in intersection collisions is similar for Norwegian and foreign HGVs, probably because Norwegian HGVs have a higher proportion of their driving in densely populated areas with more intersections, while foreign HGVs have a higher proportion of their driving on main roads. Tests of statistical significance showed that only the differences between Norwegian and foreign HGVs' risk of single vehicle accidents, head-on accidents and accidents with vehicles driving in the same direction are statistically significant (at the 5% level).

4.1.2. Fatal Accidents

Analysis of AAG data from 2010 to 2013 indicates that 17% of the professional drivers involved in fatal accidents in Norway (N = 230), had a foreign nationality, while they account for 6% of the travelled HGV kilometres in Norway. It is important to note, however, that Table 5 refers to drivers and not vehicles, and thus that Figure 2 also includes foreign drivers in Norwegian registered vehicles, and 5 bus drivers (cf. Sections 5.2 and 5.3).

Table 5. Proportions of drivers involved in fatal accidents on Norwegian roads between 2010 and 2013.

For Those Involved in Fatal Accidents on Norwegian Roads 2010–2013 . . .	%
Proportion of all drivers (n = 1028) who are foreign professionals (n = 40)	3.9
Proportion of professional drivers (n = 230) who are foreign (n = 40)	17.3
Proportion of professional drivers driving a foreign registered vehicle (n = 19)	8.3
Proportion professional drivers employed in/owners of foreign firm (n = 21)	9.1

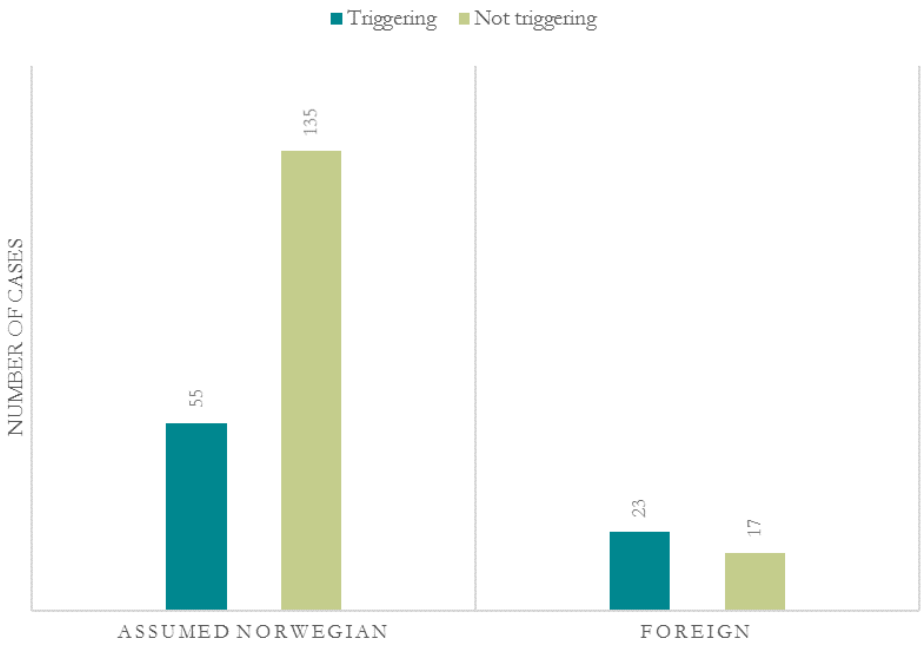

Figure 2. Number of Norwegian and foreign professional drivers involved in fatal accidents on Norwegian roads between 2010 and 2013 who drove a vehicle classified by AAG as triggering.

Results also indicate that foreign professional drivers in Norway seem to be more likely to trigger fatal accidents than Norwegian drivers (Figure 2).

Less than a third (29%) of the Norwegian professional drivers (55 of 190) drove "triggering" vehicles but more than half (58%) of the foreign drivers (23 of 40) did so. The proportion of triggering drivers was similar in the group of professional drivers driving a foreign registered vehicle and in

the group of professional drivers driving a Norwegian registered vehicle. Of the 40 foreign professional drivers, 35 drove HGVs, while 5 drove buses. In comparison, 23 of the assumed Norwegian drivers drove buses. Thus, buses represent about 12% in both groups.

4.2. Risk Factors

4.2.1. Experience with and Competence for Norwegian Roads/Conditions

In the qualitative interviews with stakeholders, interviewees underlined that Norwegian road conditions place strong demands on (foreign) drivers' competence, especially in the parts of Norway with relatively poor road quality—e.g., in northern parts of Norway. When referring to interviewees in the text, we always refer to the qualitative interviews with the sector experts (cf. Section 3.4), and not interviews with drivers. Interviewees stated that driving safely is strongly dependent on driver experience, which allows them to judge situations correctly, evaluate risks and adapt their speed to conditions. Because of their experience, the Norwegian drivers are able to recognize dangerous situations and judge risks correctly. For the foreign drivers, on the other hand, the Norwegian roads may come as a surprise, interviewees suggested. Driving in hilly terrain requires a lot of driver competence and experience, for instance related to using motor brakes and adaptation of speed. Being foreign to the Norwegian road conditions, with varying standards and sometimes poor roads, is a disadvantage in itself, because you do not know what to expect, or how to adapt to the conditions. Interviewees and reference group members especially underlined differences between Norwegian and foreign HGV drivers' experience and competence with driving on winter roads, a topic that we discuss below.

In line with the assumption that the Norwegian road network is demanding for foreign drivers, our estimations of accident risk based on analyses of the personal injury accident data indicate that HGVs from non-Scandinavian EU countries on Norwegian roads have 2.6 times higher accident risk than Scandinavian vehicles in the western, central and northern regions of Norway (Figure 3). Results also indicate that the accident risk for HGVs from non-Scandinavian EU-countries was 1.6 times higher than that of Scandinavian HGVs in the southern and eastern regions of Norway. In comparison, there was little difference between accident risks for Scandinavian HGVs in these two parts of the country. On the other hand, the difference in accident risk for non-Scandinavian HGVs in the two parts of Norway was 1.7. Thus, we may assume that it is more difficult for foreign drivers to drive in some parts of Norway, perhaps because they lack the experience and competence of Norwegian drivers. HGVs from non-Scandinavian EU countries drove 104 million km's in West/Central/Northern Norway in the period, and experienced 94 personal injury accidents in the region. HGVs from Scandinavian countries drove 4718 million km's in the region in the period, and experienced 1624 personal injury accidents.

4.2.2. Winter Driving

Based on the personal injury accident data from 2007–2014, we compared the number of accidents in the summer and in the winter with Norwegian and foreign HGVs. We do not have data on foreign vehicles kilometres for different months of the year. To get an idea of the accident risk in the winter and in the summer we investigated the distribution of HGVs involved in police reported traffic accidents with personal injuries in Norway between 2007 and 2014 by nationality and season (October–March versus April–September).

Table 6 indicates that HGVs from non-Scandinavian EU countries have a greater proportion of their accidents in the winter than the Scandinavian vehicles have. This may indicate that foreign HGVs have a higher accident risk in the winter. We cannot rule out that this finding also may reflect differences in vehicle kilometres in winter to summer, since exposure data for foreign lorries is not detailed enough to investigate the traffic volume in the months of the year. We know, however, that Norwegian heavy

goods vehicles drove 49.4% of their vehicle kilometres in the winter (October–March) (average of 2007–2012).

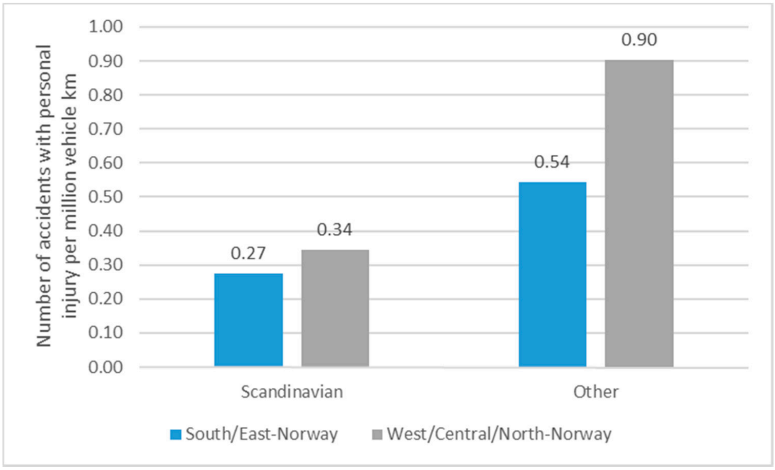

Figure 3. Number of heavy goods vehicles in police reported traffic accidents with personal injuries per million kilometres in Norway from 2007 to 2014, comparing the western/central/northern regions of Norway with the eastern/southern regions, for HGVs registered in Scandinavia and HGVs registered in non-Scandinavian EU countries.

Table 6. Proportions of heavy goods vehicles involved in police reported road accidents with personal injuries in Norway from 2007 to 2014, for Scandinavia and non-Scandinavian EU countries, in the winter (October–March) and the summer (April–September).

Season	Scandinavia	Other	Total
April–September	47%	38%	46%
October–March	53%	62%	54%
Total	4265	294	4559

Interviewees agreed that winter driving is the main safety challenge related to foreign drivers in Norway. This challenge is multi-faceted. Foreign HGVs are less suited to Norwegian winter conditions as they often have two axles, providing them with a poorer grip than three axle HGVs, which can lift the rear "boggi" axle and increase the weight on the driving axle. Winter equipment (tyres, snow chains) has previously been a challenge, but it seems that this situation has improved.

In the small-scale survey, we examined several aspects of winter driving (Figure 4).

Figure 4 indicates that Norwegian drivers have a stronger feeling of mastery of winter conditions than foreign drivers, especially compared to drivers from Central/Eastern European countries. We see that 92% of the Norwegian drivers agree they cope well with the driving conditions of Norwegian winter roads, while 71% and 62% in the other groups agree. In the group of Central/Eastern European drivers, 29% actually disagree with the statement. A Chi-square test shows that the differences are statistically significant ($P = 0.001$). We also found that Central/Eastern European countries drivers are more worried about "getting stuck" when driving in winter conditions than Norwegian drivers. Figure 4 indicate that 29% of the Norwegian drivers are worried about getting stuck, while only 12% of the drivers from western European countries are. However, as many as 65% of the drivers from Central/Eastern European countries agree that they are worried about getting stuck while driving in winter conditions. A Chi-square test shows that the differences are statistically significant ($P = 0.000$). The small-scale survey data also indicate that drivers from Central/Eastern European countries reported of a lower number of snow chains for their trucks/ trailers than Norwegian drivers, and it seems that the Norwegian drivers are more inclined than the two other groups to use snow

chains when they need to. A Chi-square test shows that the differences are statistically significant ($P = 0.001$). Also, the Norwegian drivers report a higher incidence of winter tyres on their vehicles when driving on winter roads. NPRA inspection data (2012–2015) on winter equipment indicates that this has improved in recent years [9].

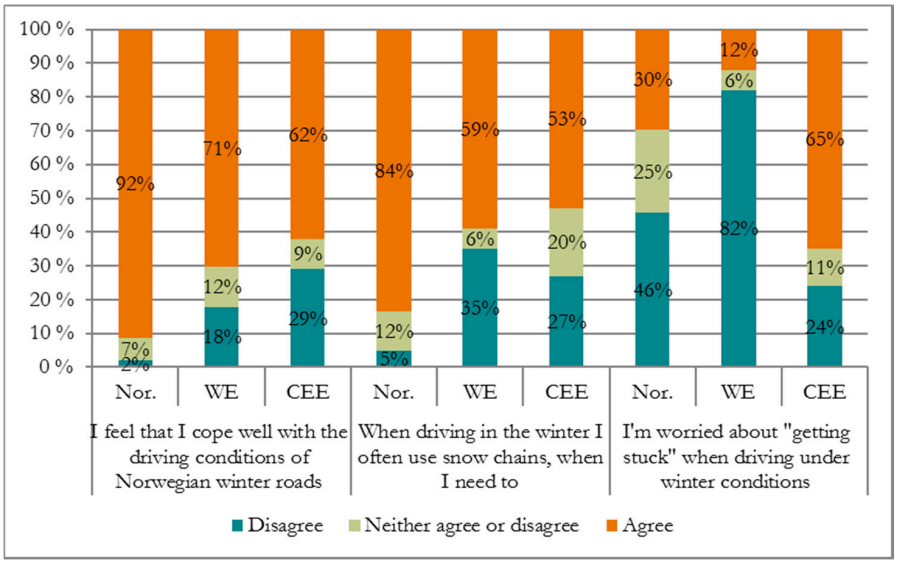

Figure 4. National groups' distributions on three questions on feeling of mastery related to winter driving, snow chain use and perception of risk of "getting stuck" while driving under winter conditions. Percentage of Norwegian (Nor.) (N = 61), Western European country (WE) (N = 17), Central/Eastern European country (CEE) (N = 45).

In the reference group meeting and in the interviews, it was suggested that competence with winter driving also involves loading the truck right for winter roads. Equipment and loading influence how the HGV behaves on the road and this is in turn dependent on how suited drivers are for driving on Norwegian roads. This concerns for example loading in relation to the configuration of the axles, and also how the containers are loaded. Loading the trailers to put extra weight on the driving axle gives the truck a better grip while driving under winter conditions, but foreign drivers seem to have less knowledge on this than Norwegian drivers. They tend to put less than 10 tonnes on the driving axle, fearing to be fined for overweight. Thus, they load the trailers so they have the majority of the weight further back (on the triple-axles of the trailer), and under winter conditions this is unfavourable. It is important to remember that the trailers are not always loaded by the drivers themselves, but by people working at transport terminals, industry sites etc. Interviewees also mentioned that sometimes drivers pick up trailers with containers that were originally loaded for maritime transport, not taking into account the requirements of safe road transport. They also stated that in many cases, drivers are not allowed to open and reconfigure the cargo in such trailers.

4.2.3. Other Results from the Small-Scale Survey

Some of the results from the small-scale survey seem to be counter-intuitive to the other more objective data sources (e.g., on accident numbers and characteristics) that we use in our study (we discuss this further in Section 5.3). Results from the small-scale survey show for instance that drivers from Central/Eastern European (0.33) and Western European countries (0.46) had lower self-reported accident risk (i.e., fewer accidents and more vehicle kms) than the Norwegian drivers (0.69). This is contrary to our more objective and comprehensive data on the risk of personal injury accidents. The small-scale survey also indicates that 14% of the drivers from Central/Eastern European countries have fallen asleep while driving a HGV in the last two years, although they work

and drive as many hours as the two other groups. The corresponding proportion for Norwegian drivers was 41%, while it was 35% for Western European drivers. This difference was contrary to the results of the AAG-data, which indicated that fatigue was just as important, or more important in accidents triggered by foreign HGV drivers, as it was in accidents triggered by Norwegian drivers. Results from the small-scale survey also indicate that drivers from Central/Eastern European and Western European countries agree more with the statements that all drivers in their companies drive according to speed limits and that all drivers in their companies wear seat belts. The differences are statistically significant at the 5% level. Comparisons of safety culture items on managers' and colleagues' commitment to safety indicate that respondents from Western European countries score higher than the other groups, but results were only statistically significant at the 10%-level. The small-scale survey also indicates that Norwegian drivers report to be more stressed because of technical problems with their vehicles or equipment than foreign drivers, and that fixed payment was more prevalent in the two foreign groups of drivers compared with the Norwegian drivers in the sample. As many of these results are at odds with the other data sources, they are discussed further in Section 5.7 "Questions for further research".

5. Concluding Discussion

5.1. Safety Outcomes of Internationalization of Road Goods Transport

Results show that foreign HGVs account for 6% of the average domestic transport in Norway, and 11% of the HGVs involved in personal injury accidents. Additionally, we have found that foreign HGVs in Norway have a three times higher accident risk of single vehicle accidents than Norwegian HGVs, twice the risk of head-on collisions, and nearly twice the risk of collisions with vehicles driving in the same direction. This difference in accident risk is in line with the general conclusions of Nævestad et al.'s [7] literature review. Summing up the results of eight previous studies, this study concludes that the accident risk for foreign HGVs in different European countries is approximately two times higher than it is for domestic HGVs in those European countries studied (cf. [12], p. 8). Most of these studies focus on the risk of fatal accidents, across all different accident types (e.g., single vehicle, head-on, intersection) but some also focus on personal injury accidents. Although numbers are not entirely comparable, as they include foreign drivers of both foreign and Norwegian registered vehicles (cf. Section 4.1.2), results also show that 17% of the professional drivers involved in fatal accidents were foreign.

5.2. Lacking Experience with the Norwegian Road Network Is the Risk Factor, Not Nationality

Given the higher accident risk of foreign HGVs on Norwegian roads, it seems that increased internationalisation of road transport of goods in Norway may have the potential to increase the number of HGV accidents. Our results on risk factors (cf. Section 5.4) indicate that the problem is not that the drivers are foreign, but that they to some extent lack experience and competence with the Norwegian road networks and the challenges that these roads may pose (e.g., narrow roads with high gradients, many curves, snow and ice). Previous research from other countries has also found that lacking experience with national road networks is an important risk factor (e.g., [16,17]). Our results on risk factors seem to indicate that if foreign HGV drivers, who drive into Norway from other countries, are educated and get more experience with Norwegian driving conditions, and if the vehicles that are used are more appropriate, then increased internationalization could be of less concern for road safety. Figure 3 indicates that HGVs from non-Scandinavian EU countries on Norwegian roads had 2.6 times higher accident risk than Scandinavian vehicles in the western, central and northern regions of Norway for the period 2007–2014. Nævestad et al. [1] found the difference to be 3 times higher for the period 2007–2012. The difference in accident risk for HGVs from non-Scandinavian EU-countries in the western, central and northern parts of Norway compared to the southern and eastern part was also smaller in the estimates which included the years 2013 and 2014. Although it is mere speculation, these numbers could indicate that the risk differences between Scandinavian and

non-Scandinavian HGVs are decreasing and that a "learning effect" is taking place. We know that the vehicle kms of HGVs from the Baltics and Poland have increased substantially in recent years, perhaps involving a stable group of drivers who regularly drive in Norway, gaining experience with Norwegian driving conditions. The changes are, however, small and uncertain, and it is currently impossible to draw conclusions about this. Future research should, however, examine whether we see further risk reductions for non-Scandinavian HGV drivers in some parts of Norway, which could indicate increased experience and a "learning effect." It is, however, important to note that the studied risk factors still will apply to foreign HGV drivers who have little experience with, and little education on, Norwegian driving conditions. As long as new foreign HGV drivers come to Norway it is likely that the Norwegian road conditions will constitute a risk factor, as these conditions seem to be more demanding for foreign drivers. Thus, the "learning effect" of foreign drivers is contingent on a stable group of foreign drivers who regularly drive in Norway.

It is important to remember that when we refer to "foreign HGV drivers" in this study, we generally refer to foreign HGV drivers working for foreign hauliers, driving foreign HGVs. These are drivers who drive into Norway as part of international transport assignments, perhaps also involving cabotage. Our comparisons of personal injury accident risk are based on HGV nationality, and not driver nationality. In 2015, 10% of the Norwegian HGVs that were inspected by the Norwegian Public Roads Administration, were driven by foreign HGV drivers. Thus, we may assume that a certain proportion of the Norwegian HGVs in personal injury accidents were driven by foreign HGV drivers employed by Norwegian companies. As these foreign drivers drive in Norway, and are employed by Norwegian companies, we may hypothesize that their experience and accident risk are more similar to that of Norwegian drivers. This hypothesis could be examined in future research. Finally, the AAG-data on the other hand focus on drivers and not vehicles, and include therefore both foreign drivers working for Norwegian companies and foreign drivers working for foreign companies. It is therefore important to remember that the personal injury and the fatal accident data are not entirely comparable.

Moreover, it is also important to note that Germany has a relatively low HGV-related fatality risk [8], despite having probably the highest proportion of transport with foreign HGVs in Europe [40]. Thus, it seems that the differences we see in safety outcomes in Norway are to some extent due to the unique risk factors that the Norwegian road network presents to foreign HGV drivers. We have not been able to identify studies of the accident risk of Norwegian drivers in foreign countries, but based on the literature review of Nævestad et al. [7], we would perhaps hypothesize that it is twice that of domestic drivers, as most studies find that the risk of foreign drivers is twice as high as that of domestic drivers in European countries.

5.3. Are Foreign and Domestic HGVs Too Wide Groups to Compare?

When comparing the personal injury accident risk of foreign and domestic HGVs in Norway, it is important to note that these two groups are general, and that it is relevant to ask whether foreign and domestic HGVs are too wide groups to compare. Ideally, we should have compared the risks of different HGV types, as research indicates that different types of HGVs have different accidents risks [32]. We are unfortunately unable to assess the importance of vehicle type for accident risk compared with nationality, as we lack traffic data for the different vehicle types. The Norwegian HGVs in the personal injury accident statistics from 2007–2012 are largely lorries with and without trailers while the foreign HGVs primarily are tractors with and without semitrailers. The latter vehicle type was prevalent among the foreign vehicles, and the accident risk varied substantially between the different groups of foreign HGVs [1]. This indicates that vehicle type not was a more important predictor of accident risk than nationality in the data. This should be examined in future studies. Additionally, we have also seen that Norwegian HGVs seem to do a higher proportion of their driving in densely populated areas with more intersections, while foreign HGVs have a higher proportion of their driving on main roads, and that this influences their accident risks. Future research should look

more into such factors (e.g., vehicle type, road type) that may shed light on the general differences that we have found.

5.4. Main Strengths and Weaknesses of Our Four Data Sources

This study draws on four different sources of data, involving different methods: (1) analysis of personal injury accident data; (2) analysis of fatal accident data; (3) small-scale survey; and (4) qualitative interviews and reference group discussion. The main strength of the personal injury and fatal accident data (1,2) is that they present relatively objective accounts of the incidence of certain events that we can compare with exposure data (e.g., kms driven) to compare risk between domestic and foreign groups. The main weakness with these data is, however, that they denote a relatively general level—e.g., all HGVs from one national group in a country—perhaps calling for more detailed analyses—e.g., comparing types of HGVS or types of transport. Moreover, these data only provide limited or indirect indications of risk factors. An additional weakness with the AAG data is that they also include buses and not only HGVs.

Our estimates of personal injury accident risk must be interpreted with some caution, because of the following uncertainties and challenges: (1) There are a total of 363 HGVs with unknown nationality in accidents in the period 2007–2012. As noted, these are added to the Norwegian HGVs involved in accidents in the calculations of accident risk; (2) There are relatively few foreign vehicles (11%) involved in accidents; (3) The nationality of vehicles and drivers may be different; (4) The risk of accidents involving personal injury and material damage may be different; (5) The risk of serious accidents is influenced by where you drive—i.e., roads and road environment. Foreign HGVs are primarily involved in long-haul (international) transport on roads with higher standards, and we may underestimate their accident risk; (6) Different types of HGVs have different accident risks [32] and (7) The risk of triggering traffic accidents may be different to the risk of being involved in a traffic accident.

The main strength of the small-scale survey data is that they may provide more information about risk factors. The main weakness with the survey data is that they may include reporting effects which make it difficult to trust the results from it, especially if results are contrary to the more objective accident data. The main strength of the interview and reference group data is that it provides detailed suggestions and elaborations on risk factors and potential mechanisms that may shed light on results from the other data sources, based on the experiences of a group of sector experts. The main weakness with these data is however that they are based on two limited groups of people and that the samples of each group may influence the results. We have however strived to get a balanced group of people into both groups, although it could be noted that we could have had more representatives of the interest of foreign drivers in both groups. The purpose of the interviews was to give us a deeper understanding of the context of relevant risk factors and safety problems, to give us insight into potential mechanisms that could shed light on different safety outcomes and the pros and cons of potential measures. It is important to note that interviewees were encouraged to "think out loud" and they were assured that the purpose of the interview was to supplement the other data in our study. Thus, the interview and reference group data are mainly used to indicate hypotheses and mechanisms that could shed light on the other data, and/or issues that should be examined in future research. To sum up, each of our data sources have distinct strengths and weaknesses. In some cases, the data sources do to some extent complement each other in manners that allow us to draw cautious conclusions. In most cases, they indicate questions for further research.

5.5. Potential Risk Factors Related to Increasing Proportions of Foreign HGVs

When assessing the importance of potential risk factors, we have emphasized risk factors which have been found to be important in more than one of our data sources (cf. [9]). Risk factors which were indicated by only one data source, or which our different data sources provided inconclusive results about, are discussed in Section 5.7 "Questions for future research." In our examination of

potential risk factors—e.g., in the qualitative interview guide and to some extent in the small-scale survey—we have tried to assess the importance of the following risk factors: (1) winter driving; (2) drivers' transport safety behaviours; (3) company follow up of drivers' transport safety behaviours; (4) safety culture; (5) organization of transport assignments; (6) safety management; (7) competence, training and experience; (8) technology and equipment; (9) economy, competition and pay; (10) rules and enforcement; (11) working hours and fatigue; and (12) the road and road environment. We are unable to conclude on the importance of several of these risk factors, as we have not measured the relative importance of them in our survey, or as the different data sources provided inconclusive results (cf. [9]). Nevertheless, we can say that two risk factors seem to be important, as the importance of each is underlined in at least three data sources.

The first is driver competence/experience with Norwegian roads. In the results section, we saw that interviewees underlined the importance of foreign HGV drivers' lacking competence on and experience with Norwegian roads as a potential risk factor, especially in the Northern parts of Norway, where road conditions are generally more challenging for HGV drivers. In accordance with this, our estimations of accident risk based on analyses of the personal injury accident data indicate that HGVs from non-Scandinavian EU countries on Norwegian roads have a 2.6 times higher accident risk than Scandinavian vehicles in the western, central and northern regions of Norway. We also found that the accident risk for HGVs from non-Scandinavian EU-countries was two times higher than that of Scandinavian HGVs in the southern and eastern regions of Norway. In comparison, there was little difference between accident risks for Scandinavian HGVs in these two parts of the country. Thus, we may assume that it is more difficult for foreign drivers to drive in some parts of Norway, perhaps because they lack the experience and competence of Norwegian drivers.

We have not conducted a systematic analysis to examine why roads in these regions are more demanding for foreign drivers. However, a recent report comparing the road quality of national main roads in European countries shows that the average speed on Norwegian main roads is among the lowest in Europe, and that the proportion of main roads deviating from straight stretch (55%) in Norway is far higher than both in Sweden and Finland, where the corresponding proportion is about 15% ([41] cf. [11]). This indicates that the main roads in Norway have more curves than in other European countries. Moreover, there is general agreement among experts in Norway that compared with neighbouring countries, the roads in the western, central and northern regions of Norway generally have less traffic and are of a poorer standard. This was also underlined by all the interviewees in the qualitative interviews and reference group members in the reference group meeting. Thus, it is likely that these roads are more demanding for foreign HGV drivers because they are narrower, have more (tight) curves and because they are hillier than roads that foreign HGV drivers are accustomed to. As noted, Langeland and Phillips [11] also point to slippery and narrow roads with many curves as an important risk factor related to HGV accidents in Norway. The little difference between the risk of Scandinavian HGV drivers in the different parts of Norway (Figure 3), could indicate that these drivers have more experience with and competence on how to drive safely on the more challenging part of the Norwegian road network.

Under winter conditions, it is even more demanding for foreign HGV drivers to drive on these roads. Driving safely with HGVs on roads that are narrow, hilly, have many curves and which perhaps also are slippery requires a certain competence and experience. Our accident analyses and survey could perhaps indicate that Norwegian HGV drivers to a greater extent than foreign drivers have this experience and competence. It is, however, important to note that we have not studied or compared competence, only possible symptoms of competence (i.e., accident risk and types). This finding is in line with previous research, indicating that foreign drivers are more vulnerable than domestic drivers, as they are unfamiliar with the existing road environment [16,17]. More research is needed on these issues. Although Vlavkveld, Stipdonk & Bos [20] conclude that poor driver training is unlikely to represent a risk factor for foreign HGV drivers, it seems that the Norwegian road network requires a competence which can only be acquired through experience. In Section 5.2, we discuss whether

foreign HGV drivers who drive in Norway for several years also will acquire this experience and competence, and whether the difference in risk between the groups will be smaller in the future.

The second risk factor is winter driving. Our results indicate that compared to foreign drivers, Norwegian HGV drivers are better equipped (e.g., with three-axle tractors), have more competence for, and mastery of winter driving. Norwegian drivers also have a lower perception of risk of "getting stuck" while driving under winter conditions. This finding is also in line with previous research [12] but the present study contributes to this research by highlighting the relationships between key variables like experience, competence, equipment and risk perception.

5.6. Reporting Effects in the Small-Scale Survey?

The results of the small-scale survey yielded some findings that were counter-intuitive and appear to be at odds with previous research and other findings in this study. We found that drivers from Central/Eastern European countries and other Western European countries reported a very high level of safety, and receive very high scores for some safety culture items in their firms. In some cases, they exceed the scores of Norwegian firms with a documented history of targeted safety work and very low accident levels, which would be expected to outperform any random group of HGV drivers (cf. [36]). The results from the small-scale survey are also not supported by the estimations of HGV accident risk in this study, which show that the accident risk for HGVs from Central/Eastern European countries and other Western European countries is significantly higher than that of Norwegian HGVs. We therefore hypothesize that the survey results are not straightforwardly comparable between national samples, and should be used with extreme caution. There may be several potential explanations for this. It is important to note that most of these are hypotheses that should be examined further in future research:

(1) *Small samples*. The samples are small—in the case of drivers from other Western European countries, extremely small—and respondents may not be representative. It seems that the foreign respondents are somewhat younger than the Norwegian and that there are higher proportions of self-employed drivers in the foreign groups compared to the Norwegian. The self-employed drivers have, however, not answered questions about safety culture, as these often concern assessments of mangers and colleagues. It is, however, difficult to assess the importance of these sample characteristics (e.g., the age distribution) as numbers are small and differences are not statistically significant.

(2) *Respondents in different countries have different points of reference.* The drivers may refer to different baselines or have different anchoring; if safety standards vary substantially between different nationalities or cultures. Thus, respondents from different countries have different expectations to the safety commitment of their managers and their colleagues and the safety level of their businesses.

(3) *Experience with and trust in surveys.* Drivers from different nationalities or cultures may relate to surveys differently. Norwegian drivers are accustomed to being subjects of various tests and surveys. Drivers from other nationalities, however, may be less culturally attuned to these kinds of surveys, and react to them differently. It is conceivable, for instance, that promises of anonymity are not trusted.

(4) *Awareness of comparison.* Drivers may be aware that they will be compared to other groups, and respond correspondingly. We intentionally omitted to inform the Norwegian sample that they would be compared to foreign drivers, as we believed this might compromise results. In the sample of foreign drivers, however, this was more complicated. In spite of the fact that they were not informed about the comparison, they would perhaps take this as a given, as they were approached in their capacity as foreign drivers in Norway. Since these two groups are competing in the same market, it is conceivable that this influenced responses.

(5) *The items are not good enough.* When questionnaires generate results that are unexpected, and when actual objective differences (e.g., differences in accident risk) between groups are not reflected in survey results, we should also consider whether the items account sufficiently for the different contexts of the groups we compare.

(6) *National culture and reporting*. Previous research suggests that national culture may constitute a potential risk factor [12,24–28]. We have, however, been unable to measure the effect of national culture and we hypothesise that this is due to differences in national culture. Measuring safety culture and reporting culture by means of surveys (i.e., self-reports) is in one sense paradoxical, as giving straightforward answers is dependent on a culture that encourages the communication of negative issues (i.e., a good reporting culture). A previous study of safety culture in construction in Denmark, the UK, and The Netherlands found that Eastern European migrant workers generally rated their managers more positively than employees who were born in the respective countries [42]. The study suggests that that Eastern European migrant workers' deference to authority may explain this result. Deference to authority is a trait of national culture that may explain the over-reporting of positive results. It may perhaps also explain the under-reporting of negative results. Although these questions are interesting, it is impossible for us to draw conclusions about this. These hypotheses should therefore be examined further in future research.

5.7. Questions for Future Research

The current study lacks, as noted, data to conclude on the importance of several of the risk factors that we have tried to study, and the different methods we used in some cases, provide divergent results on the risk factors. This indicates the need for more research, particularly in the following areas.

(1) *Drivers' transport safety behaviours*. Previous research indicates that speed too high for the circumstances, failure to use seat belt and insufficient information gathering are the most important risk factors in fatal accidents triggered by drivers at work [43]. Analyses of objective AAG-data indicate that lacking seat belt use, too high speed and lacking information gathering are more prevalent risk factors among foreign drivers. It is important to remember, however, that numbers are small and that the drivers in the AAG data not necessarily are representative of foreign drivers in general. Although we have no reason to believe that foreign drivers who are merely involved in accidents (and not triggering them) are different from foreign drivers in general, the numbers are too small to conclude about this. More research is needed on this issue.

(2) *Company regulation of drivers' transport behaviours.* Previous research indicates that company regulation of drivers' transport safety behaviours is an important precondition for safe transport behaviours [36]. More research is needed, because the present study has not compared the policies of the foreign and Norwegian companies on this issue.

(3) *Safety culture.* As noted, we did not measure national safety culture adequately in the present study, although we suggest that national culture (deference to authority) may have influenced the way that respondents have answered. Deference to authority should be examined in future studies.

(4) *Organization of transport assignments and safety management system.* Previous research indicates that organization of transport assignments and safety management systems are important for transport safety [44,45], but the present study has unfortunately not assessed the prevalence of this in foreign versus domestic hauliers and the consequences for safety.

(5) *Economy, competition and pay.* Previous research diverges when it comes to the issue of whether and how competition may influence the safety level in HGV transport (cf. [46,47]). According to Steen Jensen et al. [38], one in four Norwegian HGV drivers do not have a fixed wage, and different forms of fixed wage combined with some form of bonus is more common among long-distance than among local delivery drivers. It has been claimed by some that foreign HGV drivers have

higher proportions of performance-based pay (cf. [31]). Even though there was little concrete knowledge about the prevalence of different pay systems among foreign drivers, interviewees stressed that commission pay among foreign drivers may be detrimental to transport safety, as it may lead to higher levels of time pressure, stress, and over speeding [31]. The small-scale survey indicates that fixed payment is more prevalent in the two foreign groups of drivers compared with the Norwegian drivers in the sample. This is contrary to what interviewees in previous research have suggested (e.g., [31]) and the AAG data. Analysing the objective AAG data, we have looked at the condition of the drivers triggering fatal accidents. Our results indicate that time pressure/stress is just as important, or more important in accidents triggered by foreign HGV drivers, as it is in accidents triggered by Norwegian drivers. The numbers are small, however.

(6) *Technology and equipment.* Previous research is inconclusive when it comes to the question of whether foreign HGVs have lower technical standards. Some studies reach this conclusion ([18,19]), while the Norwegian Public Roads Administration [21] conclude that they did not find substantial differences between the technical state of Norwegian and foreign HGVs after controlling 17,000 HGVs from January to August 2013. However, interviewees suggested that foreign HGVs are generally less suited to Norwegian roads, especially in the winter, as the majority of them are semi tractors with only two axles compared to Norwegian tractors, which have three axles. The small-scale survey indicates that Norwegian drivers report to be more stressed because of technical problems with their vehicles or equipment than foreign drivers. This may be due to different expectations. More research is needed.

(7) *Working hours and fatigue.* Previous research shows that HGV drivers have long working days (an average of 10.6 h) and that many HGV drivers spend considerable time on physical tasks (e.g., loading/unloading) in addition to driving [48]. International research shows that between 36% and 64% of professional drivers report to have fallen asleep behind the wheel one time or another [49]. Our analysis of fatal accidents indicate that fatigue is just as important, or more important, in accidents triggered by foreign HGV drivers as it is in accidents triggered by Norwegian drivers. The small-scale survey, on the other hand, indicates that foreign drivers, especially those from Central/Eastern European countries, are less inclined to have fallen asleep behind the wheel and to drive while fatigued than Norwegian drivers. The differences are surprisingly big and hard to explain.

5.8. Policy Implications

Based on results from our four data sources, including previous research, we conclude that six measures addressing risk factors for foreign actors transporting goods on Norwegian roads are important for transport safety: (1) Increase the number of heavy vehicle inspections; (2) Education/information on winter driving and Norwegian road conditions aimed at foreign drivers; (3) Clarify and increase the responsibilities of transport buyers, as these set the premises for transport safety; (4) Expand the authority of the NPRA to issue "on-the-spot-fines" for a larger range of violations than they have the authority to sanction today; (5) Change the sanctioning opportunity from police reports to on-the-spot fines, to avoid police-reported cases being dismissed by the prosecutors and (6) Increased and formalized cooperation between domestic authorities.

When discussing the higher accident risk and lower experience of foreign HGV drivers in Norway it is important to note that the reason for foreign HGV drivers, working for foreign hauliers, to drive in Norway is that there are customers for foreign goods in Norway. Interviewees stressed that the foreign driver is often the last link in a long and complex chain of actors involved in the transport. According to legislation, e.g., the rules on drivers' hours and working hours (Directive 2002/15/EC), all links in the transport chain (e.g., forwarders, principals, the actors sending and receiving the goods) must "contribute" to the adherence to the rules on drivers' hours. Interviewees stated however, that if an accident happens, the driver is held responsible although transport safety regulations state that, for example, the forwarders also have a responsibility to contribute to transport

safety. Although forwarders and transport buyers have a legal responsibility to "contribute to safety," interviewees stated that the responsibilities of different actors involved in the transport are too vague, and not clearly enforced (per June 2016). This was also concluded in a Norwegian report on road cabotage in Norway [50], and in a report on working conditions in tour bus and goods transport [38]. In accordance with the conclusions and recommendations in both these publications, we therefore suggest to clarify and increase of the responsibilities of the different parties involved in goods transport, especially the transport buyers. This means both to ensure the experience and training of the drivers (e.g., preparing them properly to drive on winter roads) and to positively influence their transport safety in other ways (e.g., reducing stress, time-pressure, and ensuring that vehicles are sufficiently equipped for winter driving).

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