
Summary:

Accident risk of heavy goods vehicles on Norwegian roads: Comparison of Norwegian and foreign actors

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This study of the accident risk of Norwegian and foreign heavy goods vehicles (HGVs) on Norwegian roads is based on exposure data from the lorry surveys of Statistics Norway and Eurostat, and accident data from Statistics Norway's data on police reported injury accidents. Accident risk is defined as the number of injury accidents per million vehicle km. Results show that HGVs registered in foreign countries have higher accident risk than Norwegian HGVs on Norwegian roads. Norwegian (0.32) and Danish (0.35) HGVs have the lowest accident risk. The accident risk of HGVs from the rest of the EU15 (0.91) is over 2,5 times higher than the accident risk of Norwegian vehicles. Polish and Baltic vehicles (0.68) have the second highest accident risk, followed by Swedish vehicles and vehicles from other EU-27 countries. The average accident risk of HGVs in Norway is 0,34 accidents per million vehicle km. We have pointed out two risk factors, which to some extent may shed light on the differences. The first is winter driving. HGVs from non-Scandinavian countries have a greater proportion of their accidents in the winter (Oct.-March) (62 %) compared with HGVs from Scandinavia (53 %). The second risk factor we found is that HGVs from non-Scandinavian countries have three times higher accident risk than Scandinavian HGVs in the west/central/northern regions of Norway, and two times higher risk in the southern/eastern regions of Norway. The results must be interpreted with some caution, due to the following factors: 1) HGVs with unknown nationality, 2) relatively few foreign vehicles involved in accidents, 3) possible differences between vehicle's and driver's nationality, 4) different risks of accidents involving personal injury and material damage, 5) the risk of serious accidents is influenced by the roads chosen, 6) different types of HGVs have different accident risks, 7) the risk of triggering accidents may be different from the risk of being involved in accidents, 8) we know little about the causes of the accidents and the differences between the national groups.

Background and aims

Today, the number of foreign hauliers involved in domestic road transport of goods (cabotage) in Norway is profoundly limited by Norwegian regulations. The share of foreign lorries transporting goods in and out of Norway is, however, growing, and future cabotage legislation may lead to a further increase of foreign hauliers transporting goods within Norway.

Norwegian media often report accidents with foreign HGVs on Norwegian roads. Preliminary counts from the National Public Roads Administration and the police seem to indicate that foreign HGVs are overrepresented in accidents and in incidents requiring towing assistance, especially in the winter. Although the increasing share of foreign actors in road transport in Norway is well documented, little is known about the consequences for national road safety, because there are no systematic studies comparing the accident risk of foreign and Norwegian HGVs in Norway.

The aims of the current study are to:

1. Survey the exposure (vehicle km) of Norwegian and foreign HGVs in Norway.
2. Analyse these results in light of data on personal injury accidents to calculate and compare the accident risk of Norwegian and foreign HGVs in Norway.

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 on the website: 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

We use the lorry surveys of Statistics Norway and Eurostat and the border crossing statistics of Statistics Norway to estimate the vehicle kilometres of Norwegian and foreign HGVs on Norwegian roads. This is matched with accident data from Statistics Norway's data on police reported injury accidents to calculate and compare the accident risk of Norwegian and foreign HGVs in Norway.

Data on vehicle kilometres. We use two data sources in order to analyse the development with regard to foreign HGVs' traffic to, from and within Norway, and to examine the share that the transport of foreign actors makes up of the total goods transport on Norwegian roads. 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 purpose of the lorry survey is to describe the Norwegian registered goods transport, commodity types and –utilization, and help to identify transport patterns for Norwegian registered HGVs in Norway and abroad.

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.

In order to analyse the scope of, and trends in the transport of goods in Norway, we have developed trip matrices based on the Lorry surveys in Norway and EU-countries. We have not been able to focus on single countries, as the data are based on sample studies in which specific countries have few observations within the network. 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

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 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 numbers of HGVs which have been involved in personal injury accidents in

the period 2007-2012. Other variables in the accident data statistics are for instance: road type, weather conditions, road conditions, light conditions, severity of injury, safety equipment in use, speed limit, driver age.

Analysis of risk. In this report, we define HGV risk on Norwegian roads as the number of police reported injury accidents per million vehicle km. 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.

Exposure

Figure S.1 shows the distribution of average annual vehicle kilometres distributed according to counties and HGVs' nationality in the period 2009-2012.

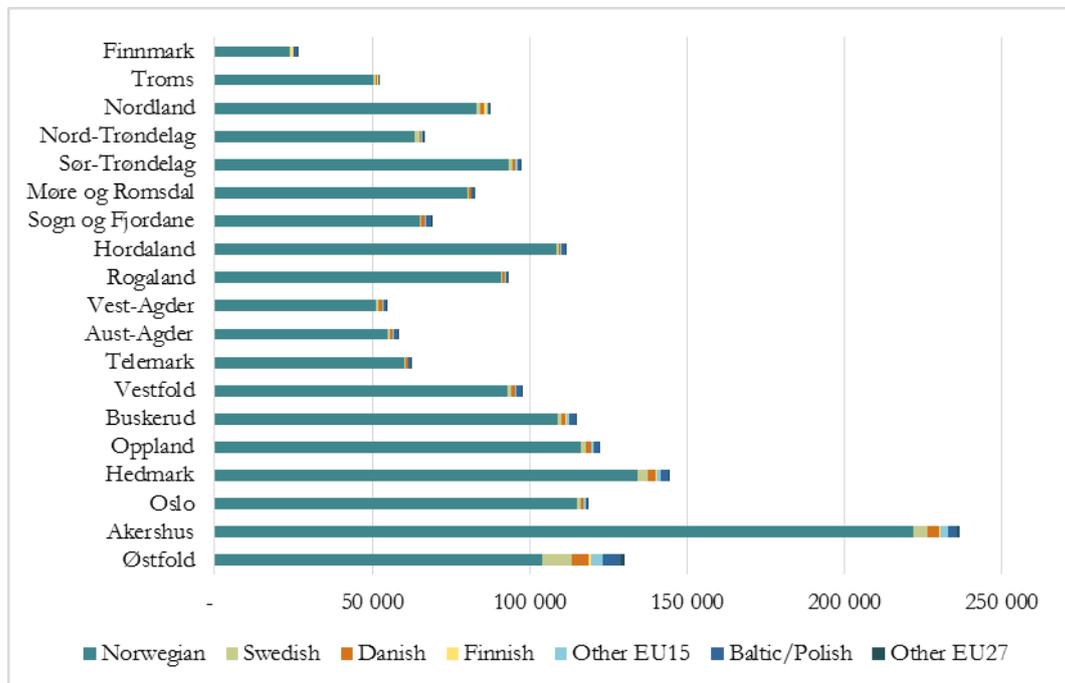


Figure S.1 Overview of traffic with HGVs in Norway, in million kilometres, for county and HGV nationality. Average for 2009-2012. Source: Lorry survey (SSB.no).

Norwegian lorries accounted for the largest share of the total transport. Foreign vehicles accounted for almost 6 % of the average domestic transport in Norway in total in the period 2009-2012. Following the Norwegian lorries, Swedish, Danish and Baltic/Polish HGVs comprised a considerable share of the traffic. Swedish HGVs drove 33 million km, Danish HGVs drove 25.5 million km and Polish/Baltic HGVs drove 24.5 million km in Norway.

It seems that a redistribution of actors who transport goods on Norwegian roads are taking place. The Nordic countries have all experienced a reduction in traffic in Norway, compared with the 2008-level. On the other hand, EU nations outside the Nordic region have improved their position. Especially lorries from Poland and the

Baltic states have strengthened their position. The traffic in Norway with lorries from Poland and the Baltic states has increased by 64 % in four years

When it comes to cross-border transport, we see that lorries from Norway and Sweden accounted for the major share of transport in 2012. Baltic and Polish HGVs, however, accounted for a larger proportion in 2012 than in 2000, and it appears that the vehicle km of these countries increase. Nevertheless, these countries transport only 10 % of the total amount of goods involved in the cross-border transport in Norway.

Baltic and Polish lorries end up being the group with the highest share of goods transported in a third country (i.e. Norway) in 2011. However, the majority of transport and the transport growth of Baltic/Polish vehicles, have been import and export, not cabotage.

Accident risk

Our risk estimates are based on data from 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. We cannot calculate the risk of HGV from countries outside the EU (N=22), because we lack data on their vehicle kilometres in Norway.

Figure S.2 shows the number of HGVs in police reported traffic accidents with personal injuries per million kilometres for HGVs in Norway from 2007 to 2012, distributed according to the vehicles' country of registration.

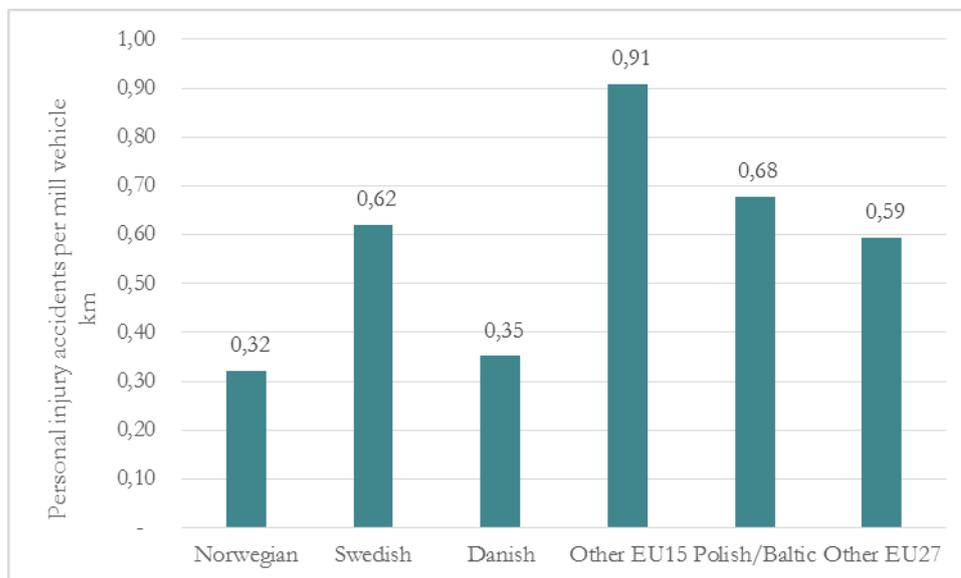


Figure S.2 Number of heavy goods vehicles in police reported traffic accidents with personal injuries per million kilometres in Norway from 2007 to 2012, distributed according to the vehicles' country of registration.

The figure shows that HGVs registered in foreign countries have higher accident risk than Norwegian HGVs on Norwegian roads. Norwegian and Danish HGVs have the lowest accident risk. The accident risk of HGVs from the rest of the EU15 is over 2.5 times higher than the accident risk of Norwegian vehicles. Polish and Baltic vehicles have the second highest accident risk, followed by Sweden and vehicles from other EU27 countries. The average accident risk of HGVs in Norway is 0.34 accidents per million vehicle km.

The accident risk for all national groups are statistically significantly different from the Norwegian at the 5 %-level, except the Danish and other EU27 countries. We have, for reasons elaborated below, included the vehicles with unknown nationality to the Norwegian HGVs in accidents in figure S.2. The risk of the Norwegian HGVs is 0.29 accidents per million km without the HGVs with unknown nationality.

The result that the accident risk of Swedish HGVs was higher than that of Norwegian and Danish HGVs was unexpected, given previous research (Dacota 2010). However, in the project’s reference group meeting March 12. 2014, arguments were presented suggesting that considerable shares of the Swedish HGVs in Norway have foreign drivers (Appendix 1).

Figure S.3 shows the trend in the number of HGVs in police reported traffic accidents with personal injuries per million kilometres in Norway for HGVs registered in Norway and other countries per year in the period 2007-2012.

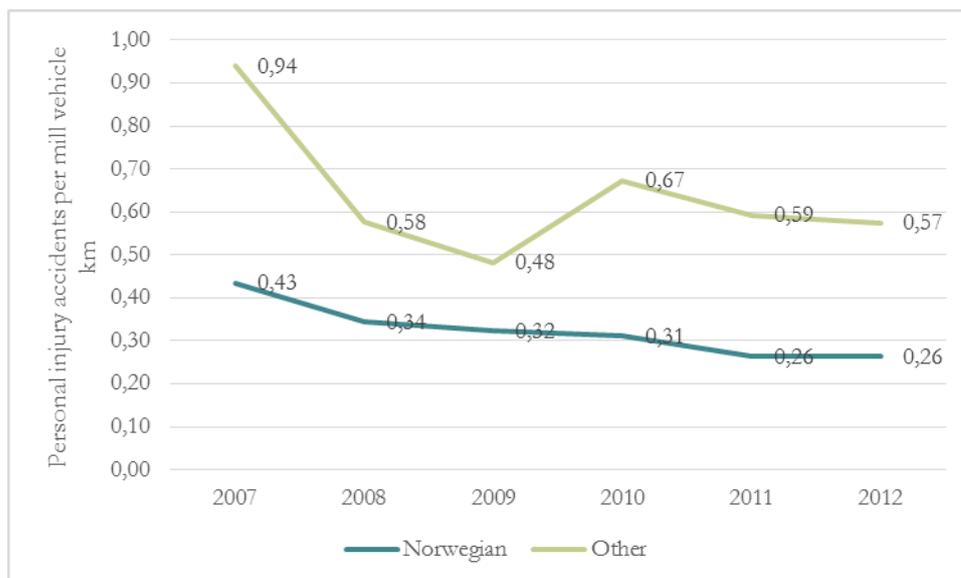


Figure S.3 Number of heavy goods vehicles in police reported traffic accidents with personal injuries per million kilometres in Norway per year from 2007 to 2012, distributed according to vehicles registered in Norway and other countries.

The figure shows a downward trend in accidents for both Norwegian HGVs and HGVs registered in other countries during the period. In addition, we see that HGVs registered in other countries had about twice the risk of personal injury accidents throughout the period. Average risk for Norwegian HGVs is 0.32 accidents per million vehicle km, while it was 0.62 accidents per million vehicle km for HGVs from other nations during the period.

We lack data on vehicle kilometres in the months of the year of foreign vehicles, but to get an idea of the accident risk in the winter and in the summer, we examined the

distribution of HGVs involved in police reported road accidents with injuries in Norway 2007-2012 distributed according to nationality and winter (October-March) and summer (April-September). In figure S.4 we have simplified this, showing the distribution of vehicles from Scandinavia and other countries.

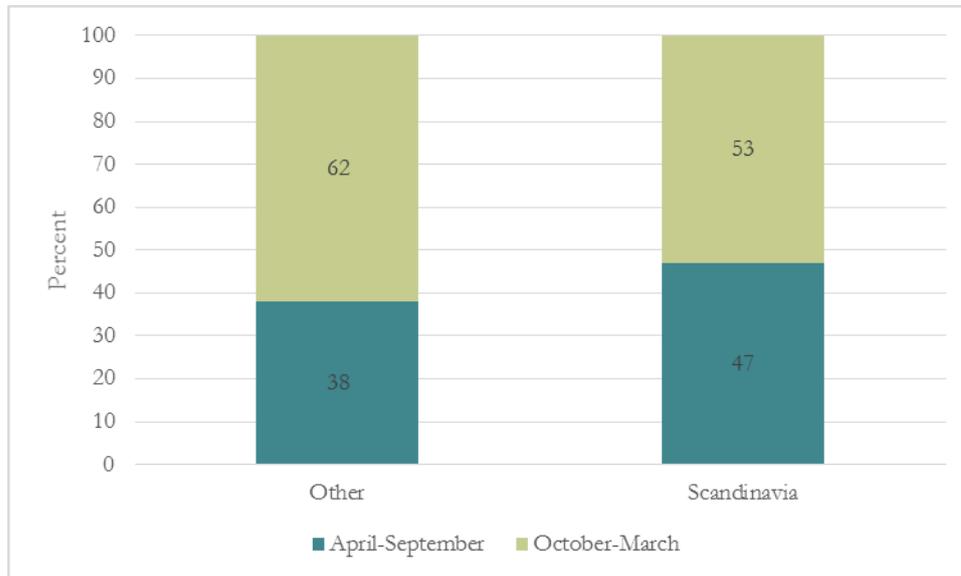


Figure S.4 Shares of heavy goods vehicles involved in police reported road accidents with personal injuries in Norway from 2007 to 2012, for Scandinavia and non-Scandinavian countries, in the winter (October-March) and the summer (April-September).

The figure shows that HGVs from non-Scandinavian countries have a greater proportion of the accidents in the winter than the Scandinavian vehicles have. In addition, the Norwegian HGVs have the greatest share of their accidents on roads without ice/snow (about 70 %), while HGVs from other EU27 nations and the category other nations (from outside the EU) and had a higher share of their accidents on road surfaces with ice/snow/slippy conditions. This finding and the fact that Scandinavian vehicles have a lower percentage of accidents during winter than other countries may indicate that heavy goods vehicles from Scandinavia are better equipped for winter driving and have drivers with more experience and expertise in winter driving than vehicles from other countries have.

We cannot rule out that this finding also may reflect differences in vehicle kilometres in the winter versus the summer, since our exposure data for foreign heavy goods vehicles not are detailed enough to investigate the amount of traffic in the months of the year. We know, however, that Norwegian heavy goods vehicles had 49.4 % of their vehicle kilometres in the winter (October - March) (average of 2007-2012). Future studies should examine differences between Norwegian and foreign drivers in terms of expertise, experience and equipment for winter driving.

Figure S.5 shows the accident risk for HGVs in Norway 2007-2012, comparing the western/central/northern regions of Norway with the eastern/southern regions, for HGVs registered in Scandinavia and HGVs registered in non-Scandinavian countries.



Figure S.5 Number of heavy goods vehicles in police reported traffic accidents with personal injuries per million kilometres in Norway from 2009 to 2012, comparing the western/central/northern regions of Norway with the eastern/southern regions, for HGVs registered in Scandinavia and HGVs registered in non-Scandinavian countries.

The rationale behind the risk estimation in the figure is a hypothesis that it is more demanding to drive HGVs in some of Norway's regions than it is in others, and that Scandinavian drivers are better equipped to drive in these regions than drivers from other countries. As mentioned, we focus on the vehicle's country of registration and not driver's nationality.

The figure shows that HGVs from non-Scandinavian countries have a three times higher accident risk than Scandinavian vehicles in the western, central and northern regions of Norway. We also note that the accident risk for non-Scandinavian HGVs is two times higher than that of Scandinavian HGVs in the southern and eastern regions of Norway.

In line with the hypothesis that it is more difficult for foreign drivers to drive in some parts of Norway, probably because it is different from what they are accustomed to, we see that vehicles from non-Scandinavian countries have twice the risk of accidents in western/central/northern Norway than they have in the southern/eastern region. In comparison there is little difference between accident risks for Scandinavian HGVs in these two parts of the country. The differences in accident risk between the two groups are statistically significant at the 5% level.

Uncertainties, challenges and questions for future research

Our estimates of accident risk is influenced by both the numbers underlying the accident statistics and the numbers underlying the vehicle km's for different groups. If the exposure is underestimated, the accident risk is overestimated and vice versa. If the share of traffic with foreign HGVs in Norway is underestimated, the number of accidents per km will be too high. These numbers may to some extent be influenced by different practices of reporting, registration and so forth.

Our results must be interpreted with some caution, as there are certain uncertainties and challenges associated with the analyses. We have discussed the importance of eight.

1) *Vehicles with unknown nationality.* There are a total of 363 HGVs with unknown nationality in accidents in the period 2007-2012. The proportion of vehicles with unknown nationality declined dramatically during the period, probably as the focus on accidents with foreign HGVs on Norwegian roads increased in the period. We have indications that significant proportions of the vehicles with unknown nationality are Norwegian, since these groups share several common features. To assess the possibility of a reporting bias meaning that some of the foreign vehicles had substantial shares of vehicles in the group with unknown nationality, we did a risk estimation examining whether the different groups' accident risks increased as the number of vehicles with unknown nationality in accidents fell dramatically over the period. The differences between groups were maintained in this calculation. We therefore assume that the group of vehicles with unknown nationality not are particularly unevenly distributed between the national groups, which means that they primarily are Norwegian. We therefore included the vehicles with unknown nationality to the Norwegian HGVs in the risk calculations, both because we assumed that significant proportions of the vehicles with unknown nationality were Norwegian and because we did not want to underestimate the accident risk of Norwegian HGVs in the calculations. We also specify the accident risk of the Norwegian HGVs without the vehicles with unknown nationality.

Additionally, we have made risk calculations assuming that the nationality of HGVs with unknown nationality is distributed in the same manner as the HGVs in accidents with known nationality are. When we exclude combined vehicles, 3332 vehicles have a known nationality. Of these 89 % are Norwegian, 3.5 % are Swedish, 1.5 % are Danish, 3 % are from other EU15 countries, 2.8 % are Polish/Baltic and 0.5 % are from other EU27 countries. When we divide the 363 vehicles with unknown nationality according to this distribution, the accident risk of the Norwegian HGVs is 0.32 accidents per million vehicle km. The accident risks of the other nationalities are as follows: Swedish lorries 0.69 accidents per million km, Danish lorries 0.39 accidents per million km, lorries from other EU15 1.01 accidents per million km, Polish and Baltic lorries 0.75 accidents per million km and lorries from other EU27 0.66 accidents per million km.

2) *Relatively few foreign vehicles involved in accidents.* About 80 % of the HGVs involved in accidents during the period were Norwegian, while about 10 % were foreign and 10 % had unknown nationality. Although we have aggregated the nationalities into groups, the numbers of traffic accidents and vehicle km for foreign HGVs are relatively small. The comparison of accident risk for the foreign groups are therefore subject to uncertainty. With relatively small numbers, the differences between the groups of foreign-registered vehicles must be relatively substantial to be statistically significant at the 5 % level, as we take into account uncertainty in both accidents and vehicle km. At the same time, it may to some extent be inappropriate to merge national groups because of different accident risks. This must be taken into account when comparing the results. Our calculations show however that the differences between the Norwegian registered vehicles and the foreign registered vehicles with the exception of Danish vehicles and vehicles from other EU27 are statistically significant at the 5 % level. We have merged vehicles registered in Scandinavia in several calculations, as we have assumed that they share vital characteristics that are different from vehicles from other European countries. For example we assume that

the former are better equipped for winter driving, have drivers with experience and expertise for winter driving and for driving in the western/central/northern regions of Norway. Because of small numbers, we merged lorries from Poland/Baltics and other EU27 countries in the significance tests where we compare the accident risk of HGVs from other EU15 countries with HGVs from other countries. These calculations show that the difference in accident risk for lorries from other EU15 countries and Poland/Baltics/other EU27 countries is significant at the 10 % level. The risk of HGVs from other countries is significantly different from other EU15 countries at the 5 % level.

3) Different nationality of vehicles and drivers? Our accident risk calculations are made possible as we have data for HGVs nationality both when it comes to exposure and accident involvement. We know, however, that the nationality of the vehicle and the driver may be different. This is a premise that must be noted when interpreting the results of the present study.

4) Different risks of accidents involving personal injury and material damage? The results show that the other EU15 countries have higher accident risk than Polish and Baltic vehicles and vehicles from other EU27 countries. This may seem unexpected, given the focus on the accident risk of eastern European drivers of HGVs in Norway. However, the risk of accidents or incidents involving only material damage and/or towing assistance may be distributed in a different way than the risk of accidents with personal injuries. Thus, the analyses could have revealed other differences between the groups if we had focused on accidents with material damage. We may to some extent test this hypothesis if we obtain towing assistance data with information about the HGVs' nationality.

Preliminary data from 18 towing assistance companies in Norway estimates that 25 % of the HGVs that they have assisted have been foreign. This indicates that foreign HGVs are over-represented among HGVs which require towing assistance. The proportion of foreign HGVs receiving towing assistance (25 %) is greater than the proportion of foreign HGVs involved in traffic accidents with personal injuries (10 %). This may indicate that foreign lorries are at higher risk of accidents with material damage than personal injury accidents. Although these data are incomplete and based on general estimates made by towing companies, they indicate a topic that should be investigated further in future research.

5) The risk of serious accidents is influenced by where you drive, i.e. roads and road environment. We have seen that foreign HGVs primarily are involved long-haul (international transport). If foreign HGVs drive long distances on roads with a good standard, we may underestimate their accident risk. Norwegian HGVs, on the other hand, are involved in more local transport assignments than foreign HGVs. Distribution of goods in a city environment for example, result in few vehicle kilometres in an environment with a relatively high accident risk. This may increase the risk of accidents for the Norwegian HGVs in the sample. We have compared the distribution of speed limits on the roads where the HGVs in the study were involved in accidents. The Norwegian HGVs had a higher proportion of their accidents on roads with a speed limit of 60 km/h or lower (39 %) than other countries (26 %). This may indicate that the foreign-registered vehicles generally drive on roads with higher speed limits, and we may perhaps assume that these roads have better standards and lower accident risk. Future studies should compare the accident risk of Norwegian and foreign HGVs on different road types and in different traffic

environments, e.g. city versus motorway. Currently, exposure data lacks on roads and road environment for foreign HGVs.

6) Different types of HGVs have different accident risks. We compare the accident risk of HGVs in general, but traffic safety research indicates that different types of HGVs have different accident risks (Høye, Elvik, Sørensen & Vaa 2012). 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.

In the accident statistic, the HGVs are distributed on two different types: lorries with and without trailer (N=2599) og tractors with or without semi-trailers (N=1014). This reflects the fact that the Norwegian HGVs in the accident statistics largely are lorries with and without trailer while the foreign HGVs primarily are tractors with and without semitrailers. The latter vehicle type is prevalent among the foreign vehicles, and we have seen that the accident risk vary substantially between them. This indicates that vehicle type not is a more important predictor of accident risk than nationality in our data. This should be examined in future studies.

7) The risk of triggering traffic accidents may be different than the risk of being involved in a traffic accident. Unfortunately, we do not have the data to examine how many of the 3928 accidents in our study that actually were triggered by the 4150 HGVs that we focus on, or whether there are differences between the national groups when it comes to the risk of triggering accidents. The shares of drivers triggering traffic accidents are lower for HGV drivers than it is for other drivers (Nævestad and Phillips 2013). However, we cannot rule out that there are differences between the various national groups of HGVs when it comes to triggering accidents. If we could have done such a calculation, we would perhaps have seen different results when it comes to the differences between the national groups.

8) We know little about the cause of the events and causes of the differences between national groups. In this report, we primarily focus on estimating and comparing accident risk between different national groups. However, in the continuation of the project, we will examine the importance of at least four risk factors: 1) safety culture, 2) competence and training, 3) technology and equipment, and 4) framework conditions. We will also inquire whether there are additional factors that may shed light on the