Effects of longer lorries and freight trains in an international corridor between Sweden and Germany

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Abstract

The effects of enabling the use of longer road vehicle combinations and/or longer trains in an intermodal freight corridor that extends from central Sweden to the Ruhr area in Germany are studied. Transports are designed based on the smallest vehicle dimensions in the transport chain, currently 18.75 m for trucks in Germany and 650 m for trains in Sweden. The question that is investigated is whether/how the transport system can be improved by using longer vehicles for road transports, rail transports or both. Ten scenarios are simulated with the help of the Swedish national freight model, Samgods. In Scenario Road 1 it is assumed that 25.25 m-long trucks are allowed on the entire road corridor (that also includes a ferry link). It is further assumed that the longer trucks can access the road corridor in Germany via terminals. In Scenario Rail 1, 750 m-long freight trains can be operated in the rail corridor that goes via Jutland/Denmark. In the combined Road 1 + Rail 1 scenario it is assumed that both longer trucks and longer trains can be used in the corridor. The effects on the freight flows, modal split, logistics costs and CO2 emissions are studied and rough socioeconomic analyses are carried out.

Keywords: Vehicle dimensions; heavy goods vehicles; freight trains; international freight corridor, evaluation, cost benefit analysis

1. Introduction

In the government commission Long Lorries’ effect on the transport system VTI\textsuperscript{1} concluded that the use of longer and heavier lorries in Sweden than in most other European countries is economically profitable, Vierth et al.(2008). This paper analyses for an intermodal corridor that stretches from central Sweden to the Ruhr area in Germany if/how the transport system can be improved by using longer road and rail vehicles on their own and in combination. Today Sweden allows longer heavy goods vehicles (HGVs) than are permitted by Denmark and Germany, while the reverse applies to freight trains. The actual situation is compared to scenarios where longer HGV and/or longer freight trains can be used in the international intermodal corridor. Simulations are carried out with the Swedish national freight model, Samgods. The effects on the distribution of the freight flows on different routes, the modal split, firms’ logistics costs and CO2 emissions are calculated and a simplified cost benefit analysis (CBA) is carried out. We do not analyse the political feasibility of the scenarios. In part 2, previous reports that study the socioeconomic impacts of using larger road or rail vehicles for international freight transports are presented. In part 3 the intermodal

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Peer-review under responsibility of the Association for European Transport
doi:10.1016/j.trpro.2014.07.019
corridor central Sweden-Ruhr is described. In part 4 the results of the simulations and the simplified CBA are presented. In part 5 some conclusions are drawn.

2. Earlier studies

2.1. Transport & Mobility

The European Commission engaged Transport & Mobility to analyse the impacts of changing the regulations of the dimensions for HGV in Europe, Transport & Mobility (2008). Three different scenarios are analysed, assuming Europe-wide permission for maximum 25.25 m and 60 tonne HGVs (A), permission for maximum 25.25 m and 60 tonne HGVs in six countries (Finland, Sweden, Denmark, Germany, The Netherlands and Belgium) (B), and Europe-wide permission for maximum 20.75 m and 44 tonne HGVs (C). These scenarios are compared to the business-as-usual scenario with maximum 16.5 m/18.75 m and 40/44 tonne HGVs in 2020. The three scenarios are calculated to give overall positive effects on society in the European Union. Scenario A gives greater benefits than Scenario B and Scenario C. The longer/heavier HGVs are calculated to be more cost effective than the current HGVs as society has to spend less for transporting the same amount of goods. According to the decrease of road-vehicle-km, fewer accidents and emissions are predicted. However, the road infrastructure costs increase as there is a need for additional investments and more maintenance. Transport & Mobility concludes that the reduced costs for society exceed the additional investment costs.

2.2. International Union of Railways (UIC)

The International Union of Railways (UIC) engaged PANTEIA-NEA to study the impacts of using longer and heavier trains on the rail infrastructure, capacity and operations as well as economic implications, UIC (2013). PANTEIA-NEA compare the use of longer/heavier trains to today’s typically used trains in Europe of maximum 750 m and maximum 22.5 tonnes per axle. The analysis is carried out for several corridors based on information obtained from rail operators and infrastructure managers completed with own assumptions. The calculations indicate that the use of longer or heavier trains leads to lower per-tonne-transport costs as the same amount of goods can be transported with fewer trains. The cost reductions are typically larger for longer trains than for heavier trains. The infrastructure costs are not quantified.

2.3. K+P Transport Consultants and the Fraunhofer Institute

K+P Transport Consultants and the Fraunhofer Institute investigated how the introduction of longer and heavier HGVs affects the rail transports, K+P Transport Consultants & Fraunhofer (2011). The study - henceforth called the K+P study - was conducted on behalf of the Community of European railway and infrastructure companies (CER). The impact of longer and heavier HGVs on the combined transports and wagonload transports in six rail corridors in Europe is analysed. We focus on the 894 km-long corridor Scandinavia-Denmark-Ruhr with a 4.8 billion tonne-km wagonload and 2.4 billion tonne-km combined transport in 2008.

The K+P study is limited to transports over 200 km as it is assumed that there is no competition between rail and road for shorter transports. System trains are excluded as they have much lower per-tonne costs and are assumed not to compete on the same market. High density commodities, petroleum products, chemicals and hazardous goods are not taken into account either because these transports are not considered to be appropriate for HGV. K+P compares a reference HGV of maximum 16.5 m and 40 tonnes (44 tonnes for transporter till/från combi terminals) i.e. to an investigation HGV of maximum 25.25 m and 40 tonnes HGV and maximum 25.25 m and 60 tonnes HGV. HGVs 25.25 m long have a 50 per cent higher volume capacity than the reference-HGV. The transport costs are assumed to be about 22 per cent and 28 per cent higher for, respectively, 40-tonne HGVs and 60-tonne HGVs than for the reference HGV. For the 60-tonne HGV, 10 per cent extra costs for additional security measures are anticipated and a €0.20 higher toll on the motorways. In all cases 100 per cent capacity utilisation is assumed. The K+P study applies the cross-price elasticities presented in Table 1. The elasticities are based on K+P’s analysis of 17 publications and various own studies dealing with the reaction of rail.

K+P’s cross-price elasticities of 1.0 (for the competition effect, see left-hand column in Table 1) for general cargo transports, i.e. in light containers and swap bodies, are in the same order of magnitude as the elasticities in other studies. Due to higher fixed costs for wagonload, the cross-price elasticities for wagonload are generally higher than the elasticities for combined transports. The secondary volume effect (right-hand column of Table 1) describes the downward spiral for wagonload transports due to the fact that volumes ‘disappear’, ensuring the exploitation of economies of scale and low per-tonne costs. The premise is that carriers pass on cost savings or increases to the shippers.

Table 2 compiles the by K+P forecasted goods volumes in the rail corridor Scandinavia-Ruhr. The rail tonne-kilometres are expected to double between 2008 and 2030; the increase is much higher for combined transports (150 per cent) than for the wagonload (18 per cent). The transfers from rail to road are calculated to be larger for 40-tonne HGVs than for 60-tonne HGVs as the cost savings per tonne are greater for 40-tonne HGVs than for 60-tonne HGVs. This is due to the assumed extra costs for
security measures and higher tolls on the German motorways. The secondary effects for wagonload lead to higher reductions for wagonload than for combined transports.

| Table 1 Cross price elasticities in the K+P study (Source: K+P Transport Consultants & Fraunhofer ISI, 2011) |
|-----------------------------------------------|
| Cross-price elasticities (‘primary competition effect’) | Cross-price elasticities (‘secondary volume effect’) |
| Combined transport (light container) | 1.0 | |
| Combined transport (heavy container) | 0.8 | |
| Combined transport (swap bodies) | 1.0 | |
| Combined transport (swap bodies) | 1.4 | |
| Wagonload (200–400 km) | 1.3 | 0.58 |
| Wagonload (over 400 km) | 1.46 | 0.58 |

| Table 2 Scandinavia-Ruhr corridor: forecasted rail volumes and reductions for combined and wagonload transports 2015, 2020, 2030 (Source: K+P Transport Consultants & Fraunhofer ISI, 2011) |
|-------------------------------|
| Billion tonne-km combined transport – base without longer/heavier HGV | 2008 | 2015 | 2020 | 2030 |
| Tonne-km reductions with maximum 25,25 m / 40 tonne HGV | 2.392 | 3.467 | 4.376 | 6.194 |
| with maximum 25,25 m / 60 tonne HGV | - 11,62% | - 12,06% | - 13,32% |
| Billion tonne-km wagonload – base without longer/heavier HGV | 1.609 | 1.699 | 1.766 | 1.905 |
| Tonne-km reductions with maximum 25,25 m / 40 tonne HGV | - 21,37% | - 21,37% | - 21,37% |
| with maximum 25,25 m / 60 tonne HGV | - 20,04% | - 20,04% | - 20,04% |

3. Intermodal central Sweden-Ruhr area corridor

3.1. Trade flows between Sweden and Germany

Germany is one of Sweden’s most important trade partners. In 2010, 14 per cent of Swedish exports and 9 per cent of imports, measured in tonnes, went to/from Germany. About 30 per cent of the exports and about half of the imports were transported by road and rail (including road and rail ferries) (see Trafikanalys, 2012a and Trafikanalys, 2012b). Table 3 comprises the land-based transports to/from Denmark and the Netherlands, that lie on or next to the corridor central Sweden-Ruhr. The incoming and outgoing transports flows were fairly balanced at the total level. Around 60 per cent of the total volumes were transported by road and around 40 per cent by rail. Around 80 per cent of the road transports were carried by HGVs registered in other countries than Sweden (which indicates lower costs for foreign HGVs than for Swedish HGVs). Nearly 90 per cent of the rail transports go to/from Germany (see Table 3). Most of the goods transported by HGVs to/from Sweden is general cargo, food stuff, timber and wood and cork products, chemicals, metal products and transport equipment, Trafikanalys (2012(a)).

| Table 3 Swedish foreign trade to/from Germany, Denmark and The Netherlands (in million tonnes) transported by road (by lorries registered in Sweden or other countries ) and rail 2010 (Source: Trafikanalys, 2011) |
|-----------------|
| By road | Export | Import | By rail | Export | Import |
| Germany | 1.306 | 1,376 | Germany | 2.290 | 2.106 |
| Denmark | 1.57 | 1,911 | Denmark | 0.122 | 0.074 |
| Netherlands | 0.728 | 0.932 | Netherlands | 0.145 | 0.046 |
| Sum | 3.604 | 4,219 | Sum | 2.557 | 2.226 |
3.2. Central Sweden-Ruhr/Germany corridor

The intermodal freight transport corridor that stretches from central Sweden to the Ruhr area is one of the main corridors between Scandinavia and mainland Europe. The number of combined transport lines in the corridor has increased over time, confirming the K+P forecast of a high increase in combined transports in Table 2. The demand for combined transport services increased to such an extent that the transport companies had to carry part of the freight volume on the road. Therefore, one starting point in our project was to use longer trains to meet the high demand for combined transports. The intermodal central Sweden-Ruhr corridor includes a road (sub) corridor that uses the shortest route between central Sweden and Hamburg. The road corridor follows main roads – the E4/E6 in Sweden via Malmö/Trelleborg and Travemünde – and includes a ferry service. From Travemünde the corridor continues via Hamburg, Bremen and Osnabrück to the Ruhr area. The rail (sub) corridor goes via the Southern Main Rail Line, the Oresund Bridge, Jutland, Hamburg, Bremen and Osnabrück to Herne (Fig. 1).

![Main road and rail routes in the central Sweden-Ruhr intermodal corridor](image)

Table 4 shows the approximate limitations of the rail infrastructure in the corridor. The maximum train length is shortest (650 m) in Sweden. The maximum permissible axle load (tonnes per axle) and metre weight (tonnes per metre) is lowest on the bridge over the Kiel Canal in Rendsburg. The gauge profile is lowest south of Bremen. Since the end of 2012 it has been possible to run 835 m-long trains between Hamburg and the Danish German border. Around €10 million has been invested to enable the use of 835 m-long (instead of 750 m-long) trains on the 200 km stretch 2.

| Country          | Maximum train length (m) | Maximum axle load (tonnes/axle) | Gauge profile |
|------------------|--------------------------|-------------------------------|---------------|
| Sweden           | 650                      | 22.5                          | G1            |
| Öresund Bridge   | 735                      | 22.5                          | G1            |
| Denmark          | 835                      | 22.5                          | G1            |
| Border to Rendsburg | 740 (835 since Dec 2012) | 22.5                          | G1            |
| Bridge over Kielkanal | 740 (835 since Dec 2012) | 20                            | G1            |
| Hamburg Central station | 740 (835 since Dec 2012) | 22.5                          | G1            |
| South of Bremen  | 740                      | 22.5                          | G2            |
| Germany          | 740                      | 22.5                          | G1            |

4. Effects of longer lorries and trains

4.1. Simulations

The use of longer HGVs and/or trains in the central Sweden-Ruhr corridor is simulated with the help of a preliminary version of the Swedish national freight transport model, Samgods. The model minimises the annual logistics costs for the goods transported in, to, from and through Sweden, divided into 33 commodity groups. The trade-off between inventory costs and transport costs as well as the exploitation of economies of scale and the consolidation of shipments from different shippers are

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2 Around €10 million has been invested to enable the use of 835 m-long (instead of 750 m-long) trains on the 200 km stretch, Interview with Michael Schultz-Wildelau, DB Netz, 10 September 2012.

3 For more information about the model see de Jong et al. (2008) and Vierth et al. (2009). The model version from September 2012 has been used.
modelled. As in the K+P study it is assumed that the carriers pass on cost savings (or cost increases) to the shippers. It is assumed that the transport demand matrix for 2006 (Edwards et al. (2008)) agrees reasonably well with today's demand. Our analysis comprises both goods that are today transported on the corridor and goods that are 'attracted' to the corridor. The results for Swedish transports inside and outside Sweden are shown. The international perspective is necessary as we study a border-crossing corridor and conditions for freight transports change both inside and outside Sweden.

We assume a base scenario with maximum 18.75 m-long HGV in Germany, maximum 25.25 m-long HGV in Sweden and maximum 650 m-long trains in the rail corridor. The eight investigation scenarios presented in Table 5 are compared to the base scenario.

| Scenario   | Description                                                                                     |
|------------|-------------------------------------------------------------------------------------------------|
| Road 1     | maximum 25.25 m-long HGVs are allowed in the road corridor and that HGVs can access the corridor in Germany via terminals. |
| Road 2     | Scenario Road 2 assumes that the HGVs can drive directly between sender/receiver and road corridor. In the light of experience from Sweden and the trial in Denmark, Scenario Road 1 is more realistic than Scenario Road 2. The scenarios Rail 1, Rail 2 and Rail 3 refer to different maximum train lengths in the corridor. Short term, Scenario Rail 1 with a train length of maximum 750 m is most realistic and meets the objectives of the Trans European Networks for Transport (TEN-T). Scenario Rail 2 with maximum 1000 m train length and Scenario Rail 3 with maximum 1500 m train length require major infrastructure investments and adaptations. The combined scenarios Road 1 + Rail 1, Road 1 + Rail 2 and Road 1 + Rail 3 assume that both longer HGVs and longer trains can be used in the corridor. To keep down the number of analyses, the combinations Road 2 + Rail 1, 2, 3 are not systematically presented. It is assumed that the overall freight demand matrix is constant. This assumption is considered to be realistic in the short term. However, more long term, lower transport costs would influence the firms' transport demand and localisation. We calibrated the freight flows on the ferries between Sweden and Germany and the Öresund Bridge. Due to lack of statistics we use the base, including our calibrations and corrections in the form of additional transshipment possibilities for containers between road and rail in Germany, to describe the tonne-km and vehicle-km related to Swedish transports inside and outside Sweden.

The Samgods model contains a lorry type at maximum 18.75 m and 40 tonnes and a lorry type at maximum 25.25 m and 60 tonnes (allowed in Sweden). The longer and heavier lorry type can easily be activated on the German part of the corridor and the ferry links. In contrast to the road vehicles, the model does not have rail vehicle types with different capacities. We have therefore reduced the link costs in the rail corridor by 8 per cent for the maximum 750 m-long trains in Scenario Rail 1, by 17 per cent for the maximum 1000 m-long trains in Scenario Rail 2 and by 26 per cent for the maximum 1500 m-long trains in Scenario Rail 3 to express the difference in costs compared to the base scenario. The cost decreases are taken from an analysis performed by a consultancy, Transrail (2009). The same rates are applied for combined transport trains, wagonload trains and system trains in Sweden. The transfer costs in terminals are calculated per tonne (and hour) and do not take into account any additional costs for longer HGVs or trains in terminals. The current version of the Samgods model does not contain lorry terminals outside Sweden (as assumed in scenarios Road 1 and Road 2 to get to/from the corridor). Therefore we have introduced

\(^{8}\) The load factor (use of vehicle capacity) is calculated within the model. The actual version of the Samgods model assumes consolidation within the 33 commodities and not across the commodities, which is a shortcoming, especially for rail and sea.

\(^{9}\) It is assumed that it is not profitable to run with 25.25 m vehicles in Sweden and change to 18.75 m long vehicles at the border.

\(^{10}\) In Lübeck, Hamburg, Bremen and Herne.

\(^{11}\) In Denmark ca. 90 per cent of the transports with 25.25 m long HGV are to/from terminals, ports and rest stops (Grontmij & Tetraplan, 2011).

\(^{12}\) We are aware, though, of the fact that the road and sea transports in Sweden and the combined transport inside Sweden are somewhat overestimated in the Samgods base. According to the statistics, the rail share inside Sweden (measured in tonne-km) is about 23 per cent; road and sea have nearly 40 per cent each. Sweden does not have inland waterway transports.

\(^{13}\) The Danish trial with maximum 25.25 m and 60 tonnes HGVs that continues to the end of 2016 is not included in the model.

\(^{14}\) Except for three wagonload trains of different lengths and system trains that can be used on specific parts of the Swedish network.

\(^{15}\) Eriksson, E. (2009). Kostnadskalkyl för kombitransporter. Transrail.
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an additional charge of €235 for the transfer from 18.75 m long HGVs to 25.25 m-long HGVs at the sender/receiver.12 The results presented in Fig. 2 and tables 6, 7 and 8 are calculated with help of the Samgods model.

4.2 Effects of longer trucks and trains singly and in combination

As expected, the permission for maximum 25.25 m-long HGVs in the road corridor in Scenario Road 1 leads, all else being equal, to shifts from rail to road. The competition between the rail route via Jutland and the road route via Travemünde becomes clear in the difference map in Fig. 2 (first map). The difference maps in Fig. 2 show the tonnage of goods transported. The red colours relate to road transports, the green colours to rail transports and the blue colours to sea transports. The dark nuances demonstrate increases and the light nuances decreases. The same scale is used in all the maps.

![Fig. 2 Calculated effects in terms of tonnes on links compared to base for Scenario Road 1, Scenario Rail 1 and Scenario Road 1 + Rail 1 (Source: Samgods calculations)](image)

The fact that the reduction of the rail transports is calculated to be less south of Bremen than north of Bremen confirms that rail is more competitive over long distances. The road corridor is expected to ‘attract’ goods from other roads.13 Some increase is expected for the road transports using the ferry Trelleborg-Rostock. This can be explained by the decreasing rail transports between Sweden and mainland Europe that lead to higher per-tonne costs for rail and shifts from rail to road. Road transports in Denmark are affected marginally. The effects are calculated to be higher in Scenario Road 2 than in Scenario Road 1, which indicates that access to the road corridor is important for the outcome.

The competition between rail route and road route is also illustrated in Scenario Rail 1 (See Fig. 2, second map.) The lower costs in the rail corridor are expected to ‘attract’ goods along the entire route Sweden-Ruhr as well as the south and west of the Ruhr area. The competitiveness of the rail mode increases with the transport distance (as was also seen in the road scenarios). The impacts are greater in Scenario Rail 2 and Scenario Rail 3, where a bigger shift from rail to sea is expected.

In Scenario Road 1 + Rail 1 both the road and rail transports to/from the Öresund region, which is connected to the road/ferry route and the rail route, increase. The ferry transports on the Travemünde route are expected to increase while the vessel transports decrease. The difference map in Fig. 2 (third map) shows that the road and ferry transports mainly increase for the relatively short-distance transports between Sweden and northern Germany. South of Hamburg the growth is larger for rail transports than road transports. The results indicate that the effects that are calculated for Scenario Road 1 and Scenario Rail 1 are largely additive. The sea transports are computed to be reduced in all combined scenarios because the land transport modes improve their competitiveness.

When it comes to tonne-kilometres, the sea transports are influenced almost exclusively in the scenarios that include rail. In the rail scenarios (Rail 1, Rail 2 and Rail 3) the amount of rail-tonne-km increases with the train length, although the growth rate decreases. This indicates that it becomes more difficult to find sufficiently large freight volumes i.e. to fill the 1 500 m-long train, which is a requirement for the exploitation of economies of scale. In Scenario Road 1 + Rail 1 a small rail transport increase is computed, mainly due to transfers from 18.75 m HGVs. The tonne-km performed by 25.25 m HGVs are calculated to increase in all three combined scenarios. It is obvious that road and rail are complementary but also compete. In Scenario Road 1 and Scenario Road 2 road takes market shares from rail (the less polluting mode) and in Scenario Rail 1 and Scenario Rail 2 vice versa. The road-vehicle-km are calculated to be constant in Scenario Road 1 and increase slightly in Scenario Road 2. The constant amount of road-vehicle-km in Scenario Road 1 indicates that road safety is not affected, provided that the risk is only dependent on the number of road-vehicle-km performed. In all other scenarios less road-vehicle-km than in the base scenario are calculated. (Table 6).

12 1 Euro = approx. SEK 8,5
13 The accuracy is lower in Germany, with a less dense road network in the model, than in Sweden.
We calculate the amount of CO2 emissions based on the vehicle-km for the different vehicle types, emission factors for road transports from the ATREMIS-project, Sjödin et al. (2009) and rough assumptions for sea transport emissions, Vierth & Mellin (2008). Following the Swedish CBA-guidelines, Trafikverket (2012), we do not calculate CO2 emissions from rail transports. In all scenarios except for Scenario Road 1 and Scenario Road 2, the CO2 emissions from road transports are reduced. In Scenario Road 1 the decrease of the CO2 emissions due to the shift to longer HGV is slightly less than the increase due to the shift from rail to road. The CO2 emissions from sea transports are computed to drop in all scenarios and the reported magnitudes need to be interpreted with caution (Table 7).

The utilisation of economies of scale for HGVs and freight trains individually and/or in combination is calculated to result in reduced logistics costs in all scenarios. The use of maximum 25.25 m-long HGVs in the road corridor with access via terminals in Scenario Road 1 is computed to lead to cost savings of about €8 million per year for the industry. The cost savings are estimated to be greater in Scenario Road 2 than in Scenario Rail 1. The cost savings in the combined scenarios are calculated to be at least as large as the sum of the savings for the individual road rail scenarios. The lower logistics costs dominate the economic benefits in all scenarios. The benefits resulting from reduced CO2 emissions are estimated to be less than 1 per cent of the benefits due to reduced logistics costs (Table 8).

4.3. Uncertainties

Although we receive consistently intuitively expected results we want to emphasise that the figures in tables 6 to 8 above have to be seen as indications of the impacts of the change of the dimensions for the land-based vehicles in the central Sweden-Ruhr corridor rather than precise quantifications. The results are broadly consistent with the effects that Transport & Mobility compute for the use of longer/heaver HGV and PANTEIA-NEA for the use of longer/heavier trains. The effects concerning the competition between road and rail are also largely consistent with the results in the K+P study. However, different assumptions and delimitations do not allow direct comparisons; the K+P study excludes transports under 200 km and specific commodities and analyses the impact on rail corridors in future years, while our study comprises all today performed freight transports in, to/from and through Sweden. The modal shifts in our study, addressing changed dimensions in an international long-distance corridor, are as expected larger than the shifts calculated in the government commission that studied smaller HGVs in Sweden (Vierth et al., 2008).
4.4 Simplified CBA

The results presented in section 4.2 indicate that a ‘financial potential’ is generated that (at least to some extent) can be used for infrastructure measures. Therefore we performed a rough cost benefit analysis. The analysis cannot be as complete as the analyses in the government commission (Vierth et al., 2008) as we do not have the detailed information on traffic other than Swedish import and export flows in the corridor which is needed to calculate the impact on i.e. the travel time for other travellers. Neither do we have information about the distribution of the residents along the corridor (which is needed to calculate the impact on noise and air pollution,) nor the need for infrastructure measures outside Sweden. As the road scenarios are constructed no infrastructure investments are required in Sweden. The permission for up to 25.25 m-long HGVs in the corridor is calculated to lead to annual cost savings for the industry of about €8 million. In Scenario Road 2 about €27 million less logistics costs and less CO2 emissions worth €8,352 are calculated.

The premise is that only investment in the Swedish rail infrastructure is required and that the existing Danish and German infrastructure is already developed for the 750 m-long trains. The removal of the bottleneck in Sweden is calculated to generate cost savings for the entire route. The Swedish Transport Administration (Ekmark, 2012) estimates that infrastructure investments of €23 million (short term) and €117 million (long term) are required to upgrade meeting and bypass tracks to be able to operate 750 m-long trains between central Sweden and the Öresund Bridge. The benefits of Scenario Rail 1 are calculated to be about €18 million due to reduced logistics costs and about €117 764 due to reduced CO2 emissions. This means that the short-term investments in the rail infrastructure are expected to be repaid after about one year (costs around €23 million, benefits around €18 million per year) and the long-term investments after about five years (costs around €117 million, benefits around €18 million per year). Our rough calculations indicate that the profitability of rail investments does not decrease if longer HGVs and longer trains are simultaneously used in the corridor.

4.5. Needs for development

Our calculations suggest the need for in-depth analyses of the costs and benefits that are not included above (e.g. transport time for other travellers or noise). There is also a need to proceed in steps to align the Swedish rail network and the TEN-T network to a minimum train length of 750 m. Another issue, which we have not dealt with in this paper, is the weight restrictions that would apply to at least a share of the longer HGVs and trains. A further question is how the access to the corridor should be developed. More detailed investigations should also include in-depth analysis for sea transports. We showed that sea transports are both complementary to and competitive with land transports. An example of the latter is the relatively large increase of transit traffic (with increased external effects) through the county of Skåne in the south of Sweden that is calculated in Scenario Road 1 + Rail 1.

5. Conclusions

The project has been studying the effects of enabling the use of longer HGVs and freight trains in an intermodal freight corridor that stretches from central Sweden to the Ruhr area in Germany. Today the transports are assumed to be designed based on the smallest vehicle dimensions along the corridor: 18.75 m for HGVs in Germany and 650 m for trains in Sweden. Road transports typically use the shortest route, which includes a ferry service from Malmö/Trelleborg to Travemünde, while rail transports typically use the route via Öresund/Jutland.

In total eight investigation scenarios are assumed and compared to the base scenario that assumes a maximum length of 18.75 m for HGVs and of 650 m for trains in the intermodal corridor:

- **Scenario Road 1** where maximum 25.25 m-long HGVs are permitted in the corridor and have access to the corridor via terminals, **Scenario Road 2** where maximum 25.25 m-long HGV are permitted in the corridor and have access to the corridor via terminals and direct.
- **Scenario Rail 1** where maximum 750 m-long freight trains are permitted in corridor.
- **Scenario Rail 2** where maximum 1000 m-long freight trains are permitted in corridor, **Scenario Rail 3** where maximum 1500 m-long freight trains are permitted in corridor.
- **Combined Scenarios Road 1 + Rail 1, Combined Scenario Road 1 + Rail 2, Combined Scenario Road 1 + Rail 3.**

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18 On the roadside, especially investments in bridges and parking/rest areas are needed (Irzik, 2009).
19 Valued according to the Swedish CBA-guidelines, Trafikverket (2012). In Scenario 1 the CO2 emissions are more or less the same as in the reference scenario.
20 For 835 m-long trains in Denmark and between the Danish/German border and Hamburg.
21 According to the calculations that the National Rail Administration (since 2010 Swedish Transport Administration) made in connection with the Infrastructure Master Plan 2010–2021, investments in meeting and bypass tracks between Hallsberg and Malmö/Trelleborg and Hallsberg and Gothenburg to allow traffic of 750 m-long trains are profitable, Banverket (2008). It is not explicitly stated in the report, but we assume that the Rail Administration only includes savings on Swedish territory. Our calculation, however, includes benefits in Sweden and abroad.
22 Interview with Anders Ekmark, Trafikverket, 23 Oktober 2012.
The scenarios were analysed using a preliminary version of the national freight model, Samgods, that includes all Swedish goods transports in, to/from and through Sweden. The model assumes constant demand. Economies of scale, consolidation of shipments are modelled and the firms’ annual logistics costs are minimised. The permission of longer HGVs and/or freight trains affects the relative cost differences between different transport solutions.

It is shown that the transport system can be enhanced by using longer HGVs, longer freight trains or both. The cursory CBA for investments in Sweden indicates that:

- the permission of up to 25.25 m-long HGV in the corridor is calculated to generate a about 8 million reduction of the firms’ logistics costs per year Scenario Road 1 (no investments in Sweden are needed and we do not have detailed information about the need for infrastructure measures in Germany);
- the use of 750 m-long trains in the corridor in Scenario Rail 1 leads to about €18 million reduction of the logistics costs and less CO2 emissions worth about €10,000. The investments in the Swedish rail infrastructure, that are needed, are expected to be repaid after around one year resp. five years (no major investments in Denmark and Germany are needed);
- the profitability of the rail investments does not decrease if longer HGVs and longer trains are simultaneously used in the corridor.

Our rough calculations suggest that there is a need for in-depth analyses of the costs and benefits that are not included above, such as air pollution, noise and the impacts on the travel time of other travellers in the corridor. Another issue which we have not dealt with in this paper is the weight restrictions that would apply for at least a share of the longer HGVs and trains. More detailed investigations should also include in-depth analyses for sea transports. In light of the development of trans-European networks, Green Corridors, etc., we see a need to improve the evaluation methods and models for international policies and infrastructure projects.

Acknowledgements

The paper is based on a subproject in the so called Co-modality project that was funded by the Swedish Governmental Agency for Innovation Systems VINNOVA, the Swedish Transport Administration and the Swedish Energy Agency. The authors would like to thank these authorities.

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