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Summary:

Model for transports in Norwegian foreign trade

Introduction

As a result of Norway's open economy, export and import play an important role in Norwegian trade, industry and social life. Easy access to our main European trade partners is therefore substantial in order to ensure the competitiveness of Norwegian trade and industry. Our foreign competitors have the natural advantage of being located geographically closer to important markets, and, hence, can profit from lower transport costs. Effective logistics and transport solutions could compensate for the disadvantage this represents to Norwegian trade and industry.

Observations of Norwegian import and export of general cargo during the last decades show that road transport is becoming increasingly important at the expense of both rail and sea transport. One of the many factors that can explain this development is the implementation of new logistics and distribution solutions where emphasis is put on quality parameters such as time, flexibility and reliability. In the future, one of the most challenging tasks for both sea and rail operators will be to reverse this trend. In Norway today, there are for instance more than 60 public ports as well as several industrial and fishing ports. This pattern tends to scatter rather than gather the flows of goods. In order to make sea transport more attractive, one solution may be to consolidate the goods in a smaller number of effective ports. This may also lead to increased frequency of service, which is highly demanded by the industry.

With focus on sea transport in particular, the main objective of this project has been to roughly analyse this and other measures in order to elucidate for instance the potential for an increase in the use of intermodal freight supply solutions in Norwegian foreign trade. We have restricted our analysis to the study of transports of general cargo, as this is the area with the highest degree of competition between intermodal and door-to-door road transport.

Methodology

In this project, The Institute of Transport Economics (TOI) has developed the first version of a network model for freight transport to and from Norway.

In a network model, the road links, railway links, sea links, terminals, etc. form a network, and the different modes of transport act as both competitors and partners, as transhipment of goods are permitted in selected terminals. The model, when

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assigned, finds solutions that minimise the total costs of the system given a fixed demand for transport between the zones in the network. Consequently, we can analyse, amongst others, the impact of changes in infrastructure and transport supply, changes in transport demand as well as in transport costs and taxes. Each scenario is compared to a basic scenario, and the effects of the changes are measured as the variation between the two.

Investments in for example infrastructure in one part of a network may have an impact on several transport relations, even in distant areas. Whereas partial analysis only deals with the specific area of study, network models take all these effects into account. This represents one of the great advantages of using this type of model. At the same time, it ensures consistency between transport modes, and the effects are only counted once. In partial analysis there is a risk of counting things twice, as would for example be the case if two or several competing projects measured the gain from the same traffic flow. In some cases, it is also argued that the value of doing several projects simultaneously is higher than the sum of each project separately, an effect it is hard to disclose without the use of network models.

The model developed in this project is based on TOI's Norwegian network model for freight transport (NEMO) as well as a network model for international freight transport developed in a project financed by the European Commission; STrategic European Multimodal Modelling (STEMM). We have made the two transport networks compatible and joined them in order to obtain an international model where the geographical specifications of Norway are particularly detailed.

We have used data from Statistics Norway on foreign trade as well as other relevant data in order to construct the freight-flow matrices (OD-matrices). Each matrix quantifies the flow of a particular commodity between municipalities in Norway and foreign countries.

The model also includes a set of cost functions permitting the calculation of the costs of each commodity on alternative transport modes and paths. This information is used to determine the modal split. In this process, the model uses a generalised cost function comprised of operating costs, costs related to transport quality, and, finally, costs generated in waiting. The latter is related to frequency of service. For the time being, only the time costs and costs of delay are included in the second element. Over time, however, other quality parameters should be included, such as risk of loss and damage.

Simplified analysis

Using the network model developed in this project, we have chosen to analyse six different scenarios, each of which indicates possible measures and trends that may have an impact on the modal distribution in Norwegian export and import. It is however important to stress that we are dealing with *calculations of examples* using a *first version* of this network model. The assumptions on which the model rests today have to be reviewed more closely before it can be used in concrete decision-making. Further elaboration of the model is also needed in certain areas.

Roughly speaking, the six scenarios can be described as follows:

1. Higher frequency of service in all liner shipping between Norwegian and foreign ports.
2. Higher frequency of service and effectiveness in the eight national ports (Oslo, Grenland, Kristiansand, Stavanger, Bergen, Trondheim, Bodø and Tromsø). No liner shipping in the remaining ports.
3. Higher frequency of service and effectiveness in the national ports combined with a sea based feeder supply system in the northernmost part of Norway.
4. Problems of capacity in the road network on the Continent.
5. More importance attached to conveying time and precision in freight transport.
6. Higher transport costs for road transport.

Each scenario is compared to a basic scenario, and the results are expressed in terms of changes in modal distribution, transport costs and emissions to air. The basic scenario roughly describes today's transport network and transport flows.

It is important to notice that our results are only related to the type of transport and freight that we are dealing with in this project, i.e. Norwegian import and export of general cargo. When we observe a change in the amount of tonne-kilometres generated on Norwegian territory, we are exclusively talking about a change in the amount of tonne-kilometres generated by the transport of general cargo in Norwegian foreign trade. The measured effects would be smaller if we considered all transport on Norwegian territory.

All the results are expressed in percentages. Consequently, they must be interpreted with great caution, as the impact of a certain increase in tonne or tonne-kilometres, when measured in percentages, will be larger for a mode whose market share is originally small than for the market leader. As a matter of fact, in order to increase the amount of goods transported by liner shipping by one percent, ten times the amount of tons required to obtain the same effect in rail transport, is needed.

In all scenarios, there is an increase in both the amount of general cargo handled by Norwegian ports and the amount crossing the border by liner shipping. In scenario 5, however, the increase is rather small as the most significant exchange of goods is observed between road transport and rail transport. Similarly, the amount of tonne-kilometres at sea increases in all scenarios, with the exception of scenario 2 and 5. The effect on air pollution and global warming, however, varies according to the scenario in question. In fact, it depends on whether sea transport increases its market share at the expense of rail transport, for which the emissions are lower than for sea transport, or road transport, for which the emissions are higher.

In the next section, the results of each scenario are studied more carefully.

Results

Scenario 1: Higher frequency of service in liner shipping results in a modest increase in the use of sea transport

The object of this scenario is to study the impact on modal distribution of a 20 per cent increase in the frequency of all regular services between Norwegian and foreign ports.

The amount of general cargo that crosses the border by liner shipping increases by one percent, while that of the other means of transport decreases. The greatest loss, in both absolute and relative values, is observed for rail transport, which loses nine percents of its traffic of general cargo.

On Norwegian territory, the amount of tonne-kilometres generated by the transport of general cargo in foreign trade drops by one percent for rail, road and ferry whilst that of liner shipping increases by the same amount. Consequently, the emissions of both SO_2 and NO_X increase, whereas those of particle matter decrease. The rise in the emissions of CO_2 is without significance.

In Norwegian ports, the total volume of general cargo grows by one percent. Whilst some of the bigger ports handle less freight than in the basic scenario, the situation is different for several smaller ports for which the amount of goods increases.

The impact of this measure on the total transport costs is negligible as the operative costs representing 60 per cent of the total costs, vary little. The same applies to time costs and costs of delay, while the frequency costs (costs connected to waiting time) decrease by 5 per cent. The latter represents no more than 3 per cent of the total costs.

Scenario 2: Consolidation of freight in a selected number of national ports may lead to an increase in the volume of goods transported by ship

The object of this scenario is to examine a situation where only a restricted number of effective ports with high frequency of service are operative. Consequently, liner shipping is limited to the eight national ports, i.e. Oslo, Grenland, Kristiansand, Stavanger, Bergen, Trondheim, Bodø and Tromsø.

The frequency is tripled in these ports. At the same time, the effectiveness is enhanced as both costs and time of transhipment decrease by 10 per cent. As regular services are no longer provided in the other Norwegian ports, this is a highly unrealistic scenario.

As expected in such a situation, the national ports now manage general cargo formerly handled by other Norwegian ports. In some cases, ship is replaced by other modes for the transport of this freight. Yet, all in all, the amount of general cargo passing through Norwegian ports increases by 2 per cent. In other words, more goods cross the boarder by liner shipping. Nevertheless, the amount of tonne-kilometres generated in liner trade decreases slightly. One explanation is more extensive use of ports located in the southernmost part of Norway.

The amount of tonne-kilometres generated by both road and rail increases substantially, primarily because of longer pre- and end haulage to and from ports. On Norwegian territory, the total number of tonne-kilometres generated by the transportation of general cargo in foreign trade increases by 7 per cent.

As a result of these changes, the emissions of SO_2 and NO_X decrease slightly whereas the emissions of particle matter increase by 12 per cent. The growth in tonne-kilometres explains, at least partially, the 3 per cent increase in the emissions of CO_2 and NMVOC. It equally helps to explain why the generalised transport costs increase by 3 per cent despite a halving of the frequency costs. Another explanation is the extensive use of road transport, which has the highest operative costs of all modes in the model.

Scenario 3: The introduction of a sea based feeder supply system to and from national ports increases the use of sea transport

In a situation as the one described above, where regular liners operate in a selected number of national ports, it is interesting to study the implications for sea transport of an introduction of a regional sea based feeder supply system between national ports and other ports in the region. In this scenario, we introduce such a system between the port of Tromsø and the majority of ports in the counties of Troms and Finnmark.

Compared with scenario 2, the amount of general cargo transported by liner shipping between the port of Tromsø and foreign ports increases by 7 per cent. Similarly, less freight is transported by road between Tromsø and other places in the region. The feeder supply system is used instead. Consequently, the emissions of particle matter and CO_2 are reduced whereas those of SO_2 and NO_X increase. The impact on the transport costs, however, is negligible.

Scenario 4: Problems of capacity in the road network on the Continent increase the volume of freight transported by regular liners

Two of the most important factors that may boost the use of intermodal transport are the risk of delays and the increasing problems of congestion on the roads in continental Europe. In this project, no study of concrete bottlenecks has been made. Instead, we have made a simplified analysis assuming a 10 per cent reduction in conveyance speed on all road links in Germany, France and Italy.

The number of tons of general cargo ferried to and from Norway drops by 6 per cent. This reduction is an indication of the declining importance of lorries as the main means of transport in certain parts of foreign trade. The amount of tonne-kilometres generated by ferry decreases by 5 per cent. The majority of this freight is transferred to liner shipping, but also rail obtains a share.

Even if some goods now go by liner shipping and rail instead of by road and ferry, the emissions to air increases slightly as a result of the increase in the total amount of tonne-kilometres. The variation, however, is very small, and, hence, hardly measurable. The same applies to the rise in total transport costs.

Scenario 5: New production- and distribution solutions may increase the use of road transport

With the introduction of new production- and distribution solutions such as Just-in-time in trade and industry, one might expect owners of goods and/or buyers of transport to attach more importance to time and precision in freight transport than is described in the basic scenario. We have tried to analyse this by changing the relative weights of the components in the model's total cost function. The weights related to the costs of time, of delay and of frequency are increased by 20 per cent whereas that related to the operative costs, i.e. the price of freight, remains unchanged.

Road transport is considered both the fastest and the most flexible means of transport as well as being less risky than rail when it comes to delays. Consequently, there is an increase of 2 and 1 per cent in the amount of general cargo crossing the border by lorry and ferry, respectively. The majority of this freight was formerly crossing the border by rail, which now transports 19 per cent less tonnes across the border. On the continent, goods formerly transported by rail are transferred to road in areas where the railway line is parallel to the road. The national ports receive some cargo that was formerly handled by other Norwegian ports, i. e. more goods are passing through the national ports as these usually operate with a higher frequency of service.

When it comes to environmental pollution, there is an increase in the emissions of most substances. Yet, these changes are negligible.

The rise in the use of road transport results in higher operative costs, which increase by 1 per cent. However, the generalised transport costs remains approximately the same as the other components in the total cost function decrease slightly.

Scenario 6: Rail transport profits from higher transport costs in road haulage

In our last scenario, we study the implications of an increase in transport costs and transport prices in road haulage, which could for instance be the result of higher taxes. We are looking at an example where the distance-related operative costs, i. e. costs that among others depend on the price of fuel, are increased by 5 percent for road transport while all the other elements in the cost functions remains unchanged.

As expected, less freight go by road as a result of these changes. The amount of general cargo transported across the Norwegian border by lorry decreases by 4 per cent and by ferry 5 per cent. The majority of this cargo now goes by train, but even liner shipping increases its market share slightly.

The effects on air pollution and global warming are, as in other scenarios, small. The emissions of SO_2 and NO_X increase slightly while those of particle matter and CO_2 decrease.

Despite a 1 per cent increase in the operative costs resulting from higher costs for the goods transported by road, the effects on the total costs are insignificant.

The calculations are uncertain

The calculations that are made in each scenario are both uncertain and incomplete. They should therefore not be treated as a complete analysis of the scenario in question. They are merely a rough indication of the direction and the magnitude of the changes in modal distribution that may result from such measures as those illustrated above. As a matter of fact, the conclusions may change if our assumptions do not materialise or do not correspond to reality.

The cost functions represent one of the most important sources of uncertainty in this model. In practice, the cost functions determine which means of transport should be used and which path should be taken. If some elements such as factors of quality are left out of the model, distortions may arise. The total costs of a means of transport could for example systematically become too high or too low. One could also question the value of the parameters included in this model (value of time, cost per tonne-kilometre, cost per tonne transhipped, etc.). In this first version of the model, we have not been able to collect all the data necessary to determine them. Instead, we have introduced values established for Swedish freight transport. We will however continue to work with these problems, so that the uncertainty can be reduced in the long run.

It is also realistic to believe that the effects on modal distribution might be smaller than what is determined in this model as transport firms may choose to cut costs and prices in order not to lose market shares when faced with competition from other firms. Such action will influence the effects of the measures in question. Despite this, we believe that network models of the type developed in this project should be viewed as suitable tools for comparing different scenarios and roughly evaluating the effects.