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Summary:

Norwegian Coastal Trade - Effects of Measures and Trends in Freight Transport

Introduction

For several years we have seen the Norwegian coastal trade lose market share to road transport. The reasons may be many, and this project takes a close look at how various measures or trends affect competition between modes of transport, i.e. what changes are occurring in the modal split. This, as well as changes in transport costs, are calculated with the aid of the National Network Model for Freight Transport, NEMO *(Nasjonal nettverksmodell for godstransport*) (Ingebrigtsen et al., 1997). We have also developed a post-model for NEMO which gives a rough estimate of the impact of a changed mode distribution on pollution, noise, wear on infrastructure, accidents connected with freight transport, etc., as well as on the social costs involved.

The analyses are limited to domestic, Norwegian freight transport between municipalities, and do not include intramunicipal transport (chiefly road) or international transport.

Analysis scenarios

The scenarios we've chosen to analyse in this project must not by and of themselves be regarded as a complete picture of a future trend. Rather, they should be seen as possible elements in a trend, which may occur individually or collectively. We have chosen to calculate the isolated effect of each individual scenario as compared to a basic scenario that gives a best possible description of the situation in the period 1993-1996 (data material, etc., from various points of time).

The scenarios may be divided into five principal groups:

1. Environmental charges
2. Continued road development
3. Changed supply in sea transport
4. Changed composition of freight
5. Changed requirements of transport users

Presented in this section are the contents of the 12 scenarios we have analyzed. The calculation results are presented in a later section.

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1. Environmental charges

Regarding the introduction of additional environmental charges, we have chosen to base our study on charges linked to CO_2 emissions. Today (1998), sea transport is exempt from CO_2 charge, while diesel-powered road and rail transport pay a charge of NOK 168 per tonne of CO_2 (44.5 øre per litre of fuel). As of January 1, 1999, however, a CO_2 charge of 26 øre per litre of fuel has been levied on domestic freight transport at sea, while the charge for other transport modes has been raised by 1.5 øre per litre of fuel. Our calculations are based on the charge level in 1998.

By introducing new charges, we've made a very rough assumption that the entire charge increase is passed on to the transport buyer through higher freight rates. This is a highly uncertain assumption, hence for one of the scenarios, we've compared the results with what you get if only half the charge is passed on to the transport buyer, the transport provider having to recoup his part, for example through efficiency-boosting measures or reduced profit.

Scenario 1a: CO_2 charge as in the Long-term Programme's basic alternative with a climate agreement

The first scenario is based on the Long-term Programme's (1998-2001) basic alternative with a climate agreement, which stipulates imposing a general CO_2 charge of NOK 360 (at 1997 value) on all CO_2 emissions in all countries, and that this charge be an addition to existing charges.

Scenario 1b: CO_2 charge as proposed in the white paper following the Kyoto Agreement

This scenario is based on the white paper following the Kyoto Agreement, which proposes a charge of NOK 100 (at 1997 value) per tonne of CO_2 (approx. 27 øre per litre of fuel) in sectors currently with a lower charge than that. Since both road transport and diesel rail already have higher charges, this charge level will only apply to sea transport.

Scenario 1c: High CO2 charge on all transport modes

From many quarters, it is estimated that a charge of approx. NOK 650 per tonne of CO_2 (about NOK 1.73 per litre of fuel) is necessary for achieving the desired effect on emission levels. We have chosen to analyze a scenario in which the CO_2 charge on all transport modes is set equal to NOK 650 per tonne of emissions.

2. Comprehensive road development

Many believe the shift we have seen in transport mode from sea and rail to road is attributable, among other things, to improved supply on the road side. As an example of possible effects of investments in the road network, we have chosen to analyze two scenarios in connection with the coastal main road: Kristiansand - Trondheim. In both scenarios, we've only analyzed the effects of ferry routes being replaced by permanent road connections, we have not considered other plans for improving the road standard on the route.

Scenario 2a: Coastal main road with 6 ferries on the route Kristiansand - Trondheim
In this scenario, three of today's ferry routes (Stord-Sveio, Anda-Lote and Folkestad-Volda) are replaced by road connections.

Scenario 2b: Ferryless coastal main road Kristiansand - Trondheim
In Scenario 2b there remain no ferry connections on the entire coastal main road. This is not likely to happen within the next few years, but the scenario can act as an example of conceivable effects of extensive road development.

3. Changed supply in coastal trade

In order to make some rough analyses of what impact a changed supply in coastal trade would have on freight transport in Norway, we've used three different approaches:

Scenario 3a: Fewer ports
We have looked at a scenario in which there is access to sea transport only via the eight designated national ports (Oslo, Grenland, Kristiansand, Stavanger, Bergen, Trondheim, Bodø and Tromsø). This scenario is not particularly realistic, but is chosen in order to illustrate the significance of coastal trade on domestic freight transport and the impact of such a situation on environmental costs as well as on the burden on the road and rail network.

Scenario 3b and 3c : Change in the vessels' speed
We wanted to study how relatively modest changes in transport time or conveyance speed in sea transport can affect the use of sea transport. To simplify the calculation, we assumed that fuel consumption is not changed as a result of the speed reduction.

In Scenario 3b, speed at sea is reduced by 10 per cent compared to the basic scenario, while in Scenario 3c the speed at sea is increased by 10 per cent.

Scenario 3d: Reduced capacity in coastal trade
A low rate of replacing the coastal fleet combined with, f ex, more stringent rules on environmental emissions can conceivably result in a reduction in the number of vessels in operation. We've chosen to illustrate this in a scenario in which only the products that are most dependent on sea transport - bulk products - are allowed transported by sea. In this scenario, other commodity groups must use the other transport modes.

4. Changed freight composition

Scenario 4: Twenty per cent of the bulk products are transferred to general cargo
Trend characteristics indicate that part of the traditional bulk cargoes are split up into smaller and more frequent shipments, f ex by use of containers. To give a rough picture of such a development, we've studied a scenario in which 20 per cent of today's bulk transport is transferred to the freight group general cargo, which places other demands on transport quality, etc.

5. Changed requirements from transport customers

A changed consumption pattern with more demanding customers and increased international commerce and competition has spurred changed manufacturing and distribution solutions in trade and industry. Consequently, demand from transport buyers is tending toward smaller and more frequent transports, exact delivery times, higher conveyance speed and security. In this connection, a higher frequency of regular service is a significant element.

Scenario 5a and 5b : Changed frequency in regular service at sea
In scenario 5a, the frequency of regular service is doubled in the national ports, while scenario 5b entails doubling the regular service in all ports with regular-service traffic.

Assumptions for the calculations

The calculations are based on a number of assumptions, the most important being:

- Demand for freight transport, in the form of intermunicipal freight flows, remains unchanged in the various scenarios.
- The cost functions in NEMO present the competition between transport modes in a realistic manner.
- Emission factors and unit costs used for air pollution, noise, accidents and wear on the infrastructure, give a correct picture of external consequences of the various transport modes nation-wide.
- Omitted factors do not distort the picture, e.g., that the calculations lead to systematically too low or too high costs for one of the transport modes.
- There is sufficient capacity throughout the transport system, an assumption which may seem questionable, particularly regarding railway.

There is major uncertainty in all the stated assumptions, hence the results must be interpreted with great caution.

Results

A summary of results from the various scenarios is presented in Tables 1, 2 and 3. For each scenario, Table 1 shows the percentage change in transport performance (tonne-kilometres) by the various transport modes compared to the basic scenario, Table 2 shows change in environmental emission, while Table 3 shows how the various cost elements change in comparison with the basic scenario. Intramunicipal transports are not included in the calculations. The same applies to transports with lorries with a payload of less than one tonne. The changes stated in tonne-kilometres thus do not relate to *all* domestic freight transport, only the part that is included in our analyses. This affects road transport in particular, where percentage changes would be less if they were calculated with respect to all freight transport by road.

We stress that these are rough analyses of the twelve scenarios for the purpose of giving some indication of the magnitude and direction of the effects of the measures or trends on which the scenario is based. However, there is a high degree of uncertainty, hence one must not interpret the results as being a complete analysis of the individual scenarios. To do that, we must go into greater detail of content and assumptions in order to make all conditions as realistic as possible.

Table 1. Percentage change in transport performance (tonne-kilometres) in the various scenarios as compared to the basic scenario.

Scenarios		Sea	Rail	Road	Total
Basic scenario. Millions of tonne-kilometres		**7431**	**1490**	**6321**	**15242**
1a*	CO2 charges as in the Long-term programme	-2 %	19 %	-3 %	0 %
1b*	CO2 charges following the Kyoto Agreement	-1 %	3 %	0 %	0 %
1c*	CO2 charges, high alternative	-5 %	32 %	-3 %	-1 %
2a	Coastal main road, 6 ferries	0 %	0 %	0 %	0 %
2b	Ferryless main road	-1 %	1 %	2 %	0 %
3a	Shut down ports (except 8 national)	-41 %	54 %	43 %	3 %
3b	Speed at sea reduced by 10 %	-4 %	13 %	1 %	0 %
3c	Speed at sea increased by 10 %	2 %	-7 %	-1 %	0 %
3d	Only bulk products by boat	-24 %	68 %	20 %	3 %
4	20 % bulk transferred to general cargo	-4 %	4 %	3 %	0 %
5a**	Doubled frequency in 8 national ports	1 %	-4 %	0 %	0 %
5b**	Doubled frequency in all ports	2 %	-6 %	-1 %	0 %

*) Assumes that the entire charge is passed on to the transport buyer.

**) The frequency has significance only for general cargo, other commodity groups are supposed to use vessels for hire or reward.

Table 2. Percentage change in emission to air in the various scenarios compared to the basic scenario.

Scenarios		CO2	CH4	N2O	SO2	Nox	NMVOC	CO	Part
Basic scenario. Tonnes		**1391667**	**85**	**558**	**4049**	**530815**	**684**	**5489**	**1447**
1a	CO2 charges as in the Long-term programme	-1 %	-2 %	0 %	-1 %	0 %	-5 %	-2 %	-1 %
1b	CO2 charges following the Kyoto Agreement	0 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %
1c	CO2 charges, high alternative	-1 %	-4 %	-1 %	-1 %	0 %	-7 %	-2 %	-2 %
2a	Coastal main road, 6 ferries	0 %	-1 %	0 %	0 %	0 %	0 %	0 %	0 %
2b	Ferryless main road	-5 %	-7 %	0 %	-1 %	0 %	-7 %	0 %	0 %
3a	Shut down ports (except 8 national)	28 %	-2 %	9 %	-1 %	1 %	84 %	34 %	20 %
3b	Speed at sea reduced by 10 %	0 %	-3 %	0 %	-1 %	0 %	0 %	1 %	0 %
3c	Speed at sea increased by 10 %	0 %	2 %	0 %	0 %	0 %	0 %	0 %	0 %
3d	Only bulk products by boat	10 %	-13 %	4 %	-2 %	0 %	33 %	16 %	10 %
4	20 % bulk transferred to general cargo	3 %	0 %	1 %	0 %	0 %	7 %	3 %	1 %
5a	Doubled frequency in 8 national ports	0 %	1 %	0 %	0 %	0 %	0 %	0 %	0 %
5b	Doubled frequency in all ports	0 %	1 %	0 %	0 %	0 %	-1 %	-1 %	0 %

Table 3. Summary of socio-economic costs in the various scenarios. Changes compared to the basic scenario, in per cent.

Scenarios		Freight costs	Time costs	External costs	State tax revenues
Basic scenario. NOK millions		**16237**	**1833**	**3049**	**1087**
1a	CO2 charges as in the Long-term programme	2 %	-1 %	-1 %	-4 %
1b	CO2 charges following the Kyoto Agreement	0 %	-1 %	0 %	0 %
1c	CO2 charges, high alternative	3 %	-2 %	-1 %	-6 %
2a	Coastal main road, 6 ferries	0 %	-1 %	0 %	0 %
2b	Ferryless main road	0 %	-4 %	-1 %	2 %
3a	Shut down ports (except 8 national)	11 %	-7 %	31 %	42 %
3b	Speed at sea reduced by 10 %	0 %	2 %	1 %	1 %
3c	Speed at sea increased by 10 %	0 %	-3 %	0 %	-1 %
3d	Only bulk products by boat	5 %	-12 %	14 %	20 %
4	20 % bulk transferred to general cargo	5 %	5 %	2 %	3 %
5a	Doubled frequency in 8 national ports	0 %	0 %	0 %	0 %
5b	Doubled frequency in all ports	0 %	0 %	-1 %	-1 %

We see from the tables that none of the scenarios results in a significant increase in sea transport. Most scenarios are rather an illustration of cost and environmental consequences of a shift from sea transport to the other transport modes. Since sea transport is the mode operating with definitely the lowest transport costs per tonne-kilometre, you get an increase in the total costs in several scenarios

In spite of its strong increase in certain scenarios, rail transport will nevertheless comprise a modest portion of the tonne-kilometres (from 9 to 16 per cent), reduced sea transport will in most cases result in more road transport, with the consequences to cost and environment that this will bring. Only in the scenarios with increased environmental charges does rail transport gain market share from both sea and road.

The percentage growth in tonne-kilometres by rail is high in some of the scenarios, particularly in the less realistic scenarios 3a (54 per cent) and 3c (68 per cent), but powerful growth (32 per cent) is also calculated in the scenario with the highest CO_2 charges (1c). An important question, therefore, is whether the Norwegian railway system has the capacity for such an increase in tonne-kilometres. According to the Norwegian National Rail Administration, there is considerable available capacity in freight transport today, as long as one avoids the busiest hours of the day and the busiest lines, and do not place too strict demands on conveyance speed. However, relatively modest investments in railway sidings will boost capacity considerably.

Whether or not the growth calculated in each scenario is realistic, depends greatly on how it is broken down into the various railway lines, a factor we haven't studied in conjunction with the examples we have calculated. However, this will be necessary if we're to make a complete analysis of a measure. Neither we have included any costs for capacity-boosting measures in the rail network when calculating social costs.

We get the greatest change in transport-mode distribution and costs in the scenario in which supply in sea transport is dramatically limited by "shutting down" most ports (3a), and in the scenario that limits sea transport to include only bulk products

(3d). As previously stated, these scenarios are not very realistic, but can provide some idea of the importance of coastal trade in Norway by way of rough figures indicating the impact of such changes on costs and the environment. In scenario 3a, tonne-kilometres at sea is reduced by more than 40 per cent, while tonne-kilometres by road is increased correspondingly and rail a bit more. The extent of transshipping is reduced by 16 per cent, while external costs rise by 31 per cent. This entails a 45 per cent increase in costs linked to noise and wear on the road and rail network, a 17 per cent increase in accident costs as well as costs connected with local and global air pollution of 22 and 28 per cent, respectively.

The scenarios illustrating the effects of increased environmental charges are more realistic, and also have a relatively major impact. Scenario 1c describes the consequences of a CO_2 charge of NOK 650 per tonne of emission, which is included entirely in the freight prices. As a result, rail transport will increase by 32 per cent, while tonne-kilometres by sea and road will decrease by 5 and 4 per cent, respectively. However, it may be interesting to note that CO_2 emissions do not decline significantly as a result of the charge, only by 1 per cent. That is because the freight-flow matrixes are fixed, and that all transport modes have a certain emission of CO_2 (it is assumed that electricity for railway is produced by gas power plants). The extent of transshipments increases, which also entails a certain energy consumption. The CO_2 charge linked to transshipment is very small compared to the transshipment cost itself, and hence has minimal effect on modal split. Costs derived from air pollution and accidents are reduced by 3 per cent each. However, because costs from noise and wear increase, there is only a small reduction in total external costs. Basically, it is conceivable that this type of increase in transport charges will result in changes in transport demand itself (i.e. changed OD matrixes), e.g., in that the average transport distance shrinks because of relocations, trading with companies that are geographically nearer, etc. These are factors that may affect emissions and costs.

Because the assumption that environmental charges will be passed on entirely to the transport buyer is rather uncertain, we have for scenario 1c also chosen to calculate the effect if only half the charge increase for each of the transport modes is passed on to the customer through the freight price. We then get less redistribution between transport modes. Tonne-kilometres by rail increases by 22 per cent, while road and rail are reduced by 2 and 3 per cent, respectively. The changes in external costs, etc., will also be correspondingly less.

In the other scenarios, we do not find equally great changes in modal split. In scenario 4, we looked at the consequences of changed freight composition, with a larger share of general cargo and less bulk products. General cargo has a higher value of time, resulting in greater use of faster transport modes such as road and rail. In this scenario, freight and time costs increase by 5 per cent and external costs by 2 per cent.

Three scenarios give a slight increase in freight transport at sea: the scenario (3c) in which conveyance speed at sea is increased by 10 per cent compared to the basic scenario, and two scenarios in which the frequency of regular (scheduled) service in the ports is increased (5a and 5b). However, the increase in tonne-kilometres at sea is rather small: 1-2 per cent. The effect of a frequency increase in regular service is not so great because we in the model only allows this to affect the transport of general cargo, which comprises a relatively small portion of freight volume at sea. In scenario 3c we find that a 10 per cent increase in speed at sea yields a 2 per cent increase in tonne-kilometres at sea. However, a 10 per cent reduction in speed at sea is estimated to give a 4 per cent reduction in tonne-kilometres at sea.

The results of the scenarios clearly show that a more limited supply at sea will result in increased costs in several areas. Freight costs are most important, and are definitely lowest at sea. The time costs are higher than for the other transport modes, but make up a relatively small part of the total cost picture. Shipping is in a unique position regarding infrastructure, since costs from wear and maintenance are only linked to the ports. Roughly speaking, noise costs can also be ruled out (although some noise should be considered in conjunction with transshipment in ports). External costs relating to noise and wear thus increase substantially when transferring freight to other transport modes. Regarding accidents and air pollution, shipping has costs per tonne-kilometres that are below road transport, but above rail transport.

A main conclusion from the calculations is that the total costs linked to transport mainly increase when the extent of domestic sea transport declines. Emissions, too, increase with a transition away from sea transport, except in the scenarios with increased environmental charges, where there at the same time is a shift away from road transport.