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**Demand for commercial and own
transport services in production
sectors**

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1. Introduction

The Central Bureau of Statistics (CBS) has for many decades been involved in the development of sectoral general equilibrium models of the Norwegian economy. The models, which are used for planning purposes by the government, are of the MSG (Multi Sectoral Growth) type, first developed by Leif Johansen in the 1960s¹. Lately, work has been carried out on a version of the MSG model called MSG-EE (EE for Energy and Environment), where one of the aims has been to develop the modelling of supply and demand for transport services in more detail than in previous model versions. Thus, a major task in the construction of the new MSG-EE model, has been the gathering and compilation of data covering transportation activities in more details than has been available previously. The methodology employed in this task and some of the results obtained are presented in this note.

The extensions with regard to transport are along two dimensions in the new model. First, production of domestic transport services, previously lumped together in one production sector, is disaggregated into four sub-activities; road transport, air transport, sea transport, and rail transport described more fully in table 1 below.

Table 1. Commercial transport sectors in the new model

| No | Sector | Description |
|----|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 75 | Road transport | Scheduled motor bus transport. Taxi and other unscheduled passenger transport by road. Unscheduled freight transport by road. Supporting services to land transport. |
| 76 | Air transport | Air transport of freight and passengers. |
| 77 | Domestic sea transport | Coastal and inland water transport. Supporting services to water transport. |
| 78 | Rail transport | Railway transport. Tramway transport. |

Second, the set of aggregate input factors in the production sectors is enlarged from the traditional (KLMU) set of capital, labour, materials and energy, to include transport services as a separate input factor. The transport factor is partly supplied by the four commercial transport sectors (commercial transport), and partly produced in the production sectors themselves (own transport).

In the new model, sectoral production is specified by cost functions dual to production functions with five input factors:

$$(1) \quad Y = F(K, L, V, U, T; \lambda_i, \tau_i)$$

¹ See e.g. L. Johanson (1974), Longva et al. (1985), Offerdal et al. (1987) for a description of earlier versions of the MSG model.

Here, K is capital, L labour, V materials except energy and transport, U is energy - a CES aggregate of electricity and heating oil, while T is the transport aggregate. Capital, labour, materials and energy needed for the production of own transport is included in T . In the model, the production possibilities are described by flexible cost functions of the Generalised Leontief (GL) type (Diewert, 1971), generalised somewhat to include possibilities for non-neutral technological change and non-homotheticity. Factor specific technical change is represented by the parameter t_1 . In some sectors the production functions are non-homothetic, i.e. an increase in production will not necessarily lead to a proportional increase in use of input factors. The degree of non-homotheticity is parameterised by l_1 . The cost functions and their properties are discussed in Bye and Frenger (1990).

The transport factor (T) is an aggregate of four different types of transport:

$$(2) \quad T = t(T_{75}, T_{76}, T_{77}, T_{78})$$

where T_j , $j=75, \dots, 78$, denotes road transport, air transport, coastal and inland water transport, and rail transport, respectively. Lack of data, in particular time series, has dictated the choice of the function t as a linear aggregate:

$$(3) \quad T = \sum_{j=75}^{78} T_j$$

Demand for T_j is either met by producing own transport of type j (TO_j) or by purchasing commercial transport services of type j (TC_j):

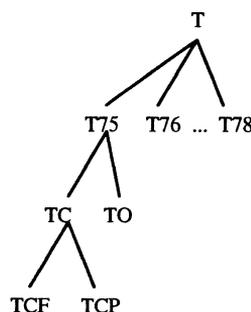
$$(4) \quad T_j = m(TC_j, TO_j); \quad j = 75, \dots, 78$$

Presently, again due to the data situation, this is modelled as a linear aggregate:

$$(5) \quad T_j = TC_j + TO_j; \quad j = 75, \dots, 78$$

A further subdivision of TC into commercial freight transport and commercial passenger transport is possible. A similar split of *own* transport is, however, not possible at present. Figure 1 illustrates the breakdown of the transport aggregate.

Figure 1. Structure of the transport aggregate in the model MSG-EE



2. Demand for transport activities in the Norwegian economy

In the following subsections the methodology employed in obtaining relevant data on transport activities is briefly described, and results illustrating the relative importance of the various types of transport in Norway are presented. We start at the bottom of the tree in figure 1, that is with commercial transport (TC), which is divided into freight (TCF) and passenger transport (TCP). We then present the methodology employed in estimating demand for own transport (TO), before we give an overview of total demand for transport (own transport plus commercial transport) (T).

In all calculations cost figures in nominal basic prices (i.e., sellers' prices excluding all taxes) have been converted to fixed 1988 prices by use of the consumer price indices. Relative to 1988, these are as shown in table 2.

Table 2. Relative consumer price indices

| Year | 1979 | 1983 | 1988 |
|-------------|-------|-------|-------|
| Price index | 0,471 | 0,716 | 1,000 |

2.1 Demand for commercial transport services (TC)

Data on demand for commercial transport in the production sectors are rather scarce and inadequate in the National Accounts. For instance, there are no direct information on cost of transportation by sector. Also, information from surveys of domestic freight transport is not incorporated in the national accounting figures. For these reasons The Norwegian Institute for Transport Economy (TØI) carried out in 1990 a project that, on the basis of a number of surveys, established estimates of transport costs for all sectors of the Norwegian economy for a few historical years (V. Jean-Hansen, 1990). Both

goods and passenger transportation are covered in the analysis. The study gives a decomposition of total demand for commercial transport on different types of transport (road, sea, air, etc.) for each economic sector. The means of transportation included are:

- railway transport (only freight transport)
- the trucking industry (only freight transport)
- sea transport (only freight transport)
- air transport (both passenger and freight transport)
- passenger transport by car.

On the basis of detailed statistics on transport of different commodities by different transport means, and assuming that demand for commercial transport services of a given commodity is proportional to the demand for the same commodity, total demand for commercial transport of freight in each sector has been derived. Care has been taken to calibrate aggregate numbers to national accounts figures where appropriate. This is done in order to secure consistency with the overall picture described by the national account.

The results presented below, covering the years 1979, 1983 and 1988, are based on information of how much of the different commodities are transported by different transportation means. Input-output tables from the national accounts are used to distribute the transportation among sectors after eliminating so called distributional sectors, assuming that each unit of deliverance of a specific commodity requires the same amount of transport. Alternative ways of allocating the transport costs are discussed in V. Jean-Hansen (1990).

2.1.1. Commercial freight transport

Table 3 shows demand for commercial freight transport in 1979, 1983 and 1988 in some aggregate sectors.

Table 3. Commercial freight transport. Million 1988-NOK

| | Primary | Manu- facturing | Oil and gas | Cons- truction | Trade | Services | Others | Totals |
|-------------------------------------------|---------|--------------------|----------------|-------------------|-------|----------|--------|--------|
| Rail transport | | | | | | | | |
| 1979 | 40 | 843 | 8 | 319 | 629 | 293 | 13 | 2.145 |
| 1983 | 35 | 619 | 43 | 201 | 501 | 342 | 14 | 1.755 |
| 1988 | 18 | 442 | 20 | 144 | 372 | 221 | 8 | 1.225 |
| Road transport | | | | | | | | |
| 1979 | 200 | 2.345 | 32 | 924 | 2.077 | 1.264 | 79 | 6.920 |
| 1983 | 193 | 2.262 | 145 | 781 | 2.051 | 1.508 | 57 | 6.998 |
| 1988 | 301 | 2.509 | 148 | 812 | 2.177 | 1.671 | 96 | 7.714 |
| Sea transport | | | | | | | | |
| 1979 | 134 | 1.678 | 15 | 576 | 1.141 | 533 | 36 | 4.112 |
| 1983 | 134 | 1.320 | 64 | 450 | 1.015 | 634 | 31 | 3.648 |
| 1988 | 122 | 794 | 49 | 282 | 695 | 534 | 39 | 2.515 |
| Air transport | | | | | | | | |
| 1979 | 8 | 259 | 6 | 81 | 249 | 102 | 40 | 746 |
| 1983 | 15 | 286 | 20 | 66 | 189 | 105 | 28 | 708 |
| 1988 | 44 | 240 | 14 | 35 | 187 | 81 | 27 | 628 |
| Total commercial freight transport | | | | | | | | |
| 1979 | 382 | 5.125 | 62 | 1.899 | 4.095 | 2.192 | 168 | 13.923 |
| 1983 | 377 | 4.487 | 272 | 1.497 | 3.756 | 2.589 | 130 | 13.108 |
| 1988 | 485 | 3.985 | 231 | 1.273 | 3.431 | 2.507 | 170 | 12.082 |

Overall demand for commercial freight transport from the production sectors has declined by between 1 and 2 per cent annually from 1979 to 1988.

Commercial freight transport by sea and rail have declined over the last years. A slight increase in road transport has led to an increase in the share of commercial freight transport by road from 50 per cent in 1979 to almost 65 per cent in 1988. Sea transport has a share of approximately 20 per cent, rail transport 10 per cent, while air transport in 1988 covered 5 per cent of the commercial freight transport.

Manufacturing industry and retail and wholesale trade are the dominating purchasers of commercial freight transport with a share of approximately 30 per cent of total demand for commercial freight transport each. The service sectors' demand for commercial freight transport is growing in contrast to the demand from other heavy users of commercial transport. In particular demand for road transport grew fast with an average annual rate of 5 per cent over the period from 1979 to 1983.

Table 4 shows demand for commercial freight transport relative to total demand for commercial transport (freight + passenger transport) in each of the aggregate sectors for the years 1983 and 1988.

Half of all demand for commercial transport in the production sectors was freight transport in 1988. Transport by rail and sea are totally dominated by freight transport, while air transport is dominated by passenger transport. Approximately 60 per cent of demand for road transport from the production sectors are for freight transport.

Table 4. Commercial freight transport as share of total commercial transport

| | Primary | Manufac- turing | Oil and gas | Construc- tion | Trade | Services | Others | Totals |
|-------------------------------------------|---------|--------------------|----------------|-------------------|-------|----------|--------|--------|
| Rail transport | | | | | | | | |
| 1983 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| 1988 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| Road transport | | | | | | | | |
| 1983 | 0,40 | 0,61 | 0,70 | 0,54 | 0,66 | 0,42 | 0,22 | 0,55 |
| 1988 | 0,59 | 0,79 | 0,86 | 0,61 | 0,63 | 0,38 | 0,26 | 0,58 |
| Sea transport | | | | | | | | |
| 1983 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| 1988 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| Air transport | | | | | | | | |
| 1983 | 0,11 | 0,33 | 0,02 | 0,20 | 0,32 | 0,05 | 0,32 | 0,14 |
| 1988 | 0,18 | 0,21 | 0,02 | 0,08 | 0,23 | 0,02 | 0,23 | 0,09 |
| Total commercial freight transport | | | | | | | | |
| 1983 | 0,48 | 0,68 | 0,23 | 0,62 | 0,72 | 0,38 | 0,33 | 0,56 |
| 1988 | 0,54 | 0,71 | 0,21 | 0,59 | 0,65 | 0,30 | 0,32 | 0,50 |

2.1.2. Commercial passenger transport

Analysis of data on commercial domestic passenger transport in the production sectors has been carried out by TØI for the years 1983 and 1988 (V. Jean-Hansen, 1990). Only road transport by passenger cars and air flights are covered. Data sources include special surveys carried out by TØI and official Norwegian statistics on the use of automobiles.

Presently, demand is evenly distributed among road and air transport, with air transport showing the highest growth rate in recent years with an annual average growth rate of 7 per cent. Road transport has declined slightly with an annual growth rate of -1 per cent, see table 5.

Table 5. Commercial passenger transport. Million 1988-NOK

| | Primary | Manufac- turing | Oil and gas | Construc- tion | Trade | Services | Others | Totals |
|---------------------------------------------|---------|--------------------|----------------|-------------------|-------|----------|--------|--------|
| Road transport | | | | | | | | |
| 1983 | 283 | 1.473 | 61 | 666 | 1.063 | 2.078 | 204 | 5.829 |
| 1988 | 213 | 683 | 24 | 509 | 1.268 | 2.670 | 276 | 5.643 |
| Air transport | | | | | | | | |
| 1983 | 129 | 594 | 837 | 257 | 401 | 2.146 | 59 | 4.423 |
| 1988 | 197 | 909 | 846 | 393 | 614 | 3.169 | 91 | 6.219 |
| Total commercial passenger transport | | | | | | | | |
| 1983 | 412 | 2.067 | 899 | 923 | 1.464 | 4.224 | 263 | 10.252 |
| 1988 | 410 | 1.592 | 870 | 902 | 1.882 | 5.839 | 367 | 11.862 |

The service sectors are the dominating purchasers of commercial passenger transport, representing approximately 50 per cent of total demand for commercial passenger transport in 1988. The service sectors also show the highest growth rate in recent years with an average annual growth of 7 per cent. Overall, the cost of purchasing commercial passenger transport now is of the same order of magnitude as the cost of commercial freight transport, but demand for commercial passenger transport is growing at a rate of 3 per cent annually, while commercial freight transport has been declining by 2 per cent on an annual basis.

2.1.3. Total demand for commercial transport

Total demand for commercial transport is obtained by adding demand for freight and passenger transport, see table 6.

Table 6. Total demand for commercial transport. Million 1988-NOK

| | Primary | Manufac- turing | Oil and gas | Construc- tion | Trade | Services | Others | Totals |
|-----------------------------------|---------|--------------------|----------------|-------------------|-------|----------|--------|--------|
| Road transport | | | | | | | | |
| 1983 | 476 | 3.736 | 207 | 1.447 | 3.114 | 3.586 | 261 | 12.826 |
| 1988 | 514 | 3.192 | 172 | 1.321 | 3.445 | 4.341 | 372 | 13.357 |
| Air transport | | | | | | | | |
| 1983 | 144 | 880 | 857 | 323 | 590 | 2.250 | 87 | 5.131 |
| 1988 | 241 | 1.149 | 860 | 428 | 801 | 3.250 | 118 | 6.847 |
| Sea transport | | | | | | | | |
| 1983 | 134 | 1.320 | 64 | 450 | 1.015 | 634 | 31 | 3.648 |
| 1988 | 122 | 794 | 49 | 282 | 695 | 534 | 39 | 2.515 |
| Rail transport | | | | | | | | |
| 1983 | 35 | 619 | 43 | 201 | 501 | 342 | 14 | 1.755 |
| 1988 | 18 | 442 | 20 | 144 | 372 | 221 | 8 | 1.225 |
| Total commercial transport | | | | | | | | |
| 1983 | 789 | 6.554 | 1.171 | 2.420 | 5.220 | 6.813 | 393 | 23.361 |
| 1988 | 895 | 5.577 | 1.101 | 2.175 | 5.313 | 8.346 | 537 | 23.944 |

Commercial transport by road is dominating with a share of 56 per cent of all commercial transport. Next comes air transport with a share of almost 30 per cent. This mode of transportation has been growing with an annual rate of 6 per cent lately. Both sea transport with a share of approximately 10 per cent, and rail transport with a share of around 5 per cent, have been declining over the period 1983 to 1988.

Demand for commercial transport services is highest from the services sectors with a relative share of 35 per cent in 1988. Manufacturing and trade each demanded somewhat more than 20 per cent of total commercial transport in 1988. While the demand from the service sectors has been growing by 4 per cent annually over the period 1983 to 1988, demand from the trade sector has been stable, while there has been a decline in the demand from the manufacturing sector of 3 per cent annually.

Table 7 shows the relative importance of commercial transport (freight + passenger) to total demand for transport (own and commercial) in 1983 and 1988. Own transport is covered in the next subsection.

Table 7. Demand for total commercial transport relative to demand for total transport

| | Primary | Manufac- turing | Oil and gas | Construc- tion | Trade | Services | Others | Totals |
|-----------------------------------|---------|--------------------|----------------|-------------------|-------|----------|--------|--------|
| Road transport | | | | | | | | |
| 1983 | 0,22 | 0,75 | 1,00 | 0,47 | 0,43 | 0,70 | 1,00 | 0,56 |
| 1988 | 0,22 | 0,71 | 1,00 | 0,40 | 0,39 | 0,64 | 0,84 | 0,51 |
| Air transport | | | | | | | | |
| 1983 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 0,82 | 1,00 | 0,91 |
| 1988 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 0,69 | 1,00 | 0,82 |
| Sea transport | | | | | | | | |
| 1983 | 0,05 | 0,70 | 0,05 | 0,86 | 0,91 | 0,61 | 1,00 | 0,42 |
| 1988 | 0,03 | 0,77 | 0,03 | 0,77 | 0,81 | 0,54 | 1,00 | 0,30 |
| Rail transport | | | | | | | | |
| 1983 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| 1988 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 | 1,00 |
| Total commercial transport | | | | | | | | |
| 1983 | 0,15 | 0,79 | 0,50 | 0,59 | 0,55 | 0,74 | 1,00 | 0,60 |
| 1988 | 0,14 | 0,79 | 0,44 | 0,52 | 0,49 | 0,66 | 0,88 | 0,54 |

Manufacturing industries and the service sectors both rely heavily on commercial transport services. That is, the share of own produced transport is relative low. In the primary sectors own produced transport services dominate. Overall, the importance of commercial transport has declined over the 5-year period 1983-1988.

2.2. Demand for own transport

Data on demand for own transport is even harder to come by than data on demand for commercial transport. Some sorts of indicators therefore have to be employed in order to estimate the production of own transport in the sectors. We have chosen to take as a starting point data on sectorial use of transport fuels as recorded in the energy accounts for Norway (Ljones, 1982, Hetland et al., 1990). The use of transport fuels is allocated to three different types of transportation; road transport, sea transport and air transport. Generally, gasoline and auto diesel are assumed to be used for production of road transport, marine fuels for sea transport, while special forms of gasoline and kerosene are assumed to be used for production of air transport in some of the sectors. In the fishery sector all fossil fuels are assumed to be used for sea transport, while the defence sector employs some heavy fuel oil for production of sea transport.

By assuming identical technologies fuel-wise in commercially produced and own produced transport services, it is possible to estimate the amount of own transport of the different types produced in each sector. Thus, if ZTD_i is the unit factor for transport oil in the commercial transport sector i , viz.:

$$(6) \quad ZTD_i = \frac{D_i}{TC_i}$$

where D_i is the amount of transport fuels used and TC_i is the amount of transport services produced in the commercial transport sector i , production of own transport of type i in production sector j is estimated as

$$(7) \quad TO_{ij} = \frac{FT_{ij}}{ZTD_i}$$

where FT_{ij} is the amount of transport fuels used in sector j . Other input factors used for the production of own transport of type i can then be estimated as:

$$(8) \quad \begin{aligned} KO_{ij} &= ZTK_i * TO_{ij} && \text{(capital)} \\ LO_{ij} &= ZTL_i * TO_{ij} && \text{(labour)} \\ VO_{ij} &= ZTV_i * TO_{ij} && \text{(materials)} \\ EO_{ij} &= ZTE_i * TO_{ij} && \text{(energy)} \end{aligned} \quad i \in \{road, air, sea\} \quad j = \text{sector}$$

Here, KO is capital, LO is labour, VO is materials except energy, and EO is electricity employed for production of own transport, and the ZT 's are unit factors in the production of commercial transport. Note that no distinction is possible between own transport of passengers and freight. Table 8 gives the unit factors of production in the commercial transport sectors in the base year 1988. Brendemoen (1991) give further details on the development of the unit factors over the last couple of decades.

Table 8. Unit factors of production in the commercial transport sectors. 1988

| | Road | Air | Sea | Rail |
|-----------------------|-------|-------|-------|--------|
| Capital (ZTK) | 0,624 | 0,779 | 1,578 | 10,738 |
| Labour (ZTL) | 0,431 | 0,146 | 0,616 | 0,629 |
| Materials (ZTV) | 0,339 | 0,626 | 0,374 | 0,593 |
| Transport fuels (ZTD) | 0,138 | 0,139 | 0,215 | 0,023 |
| Electricity (ZTE) | 0,000 | 0,000 | 0,003 | 0,052 |

On the basis of the above procedure, total own transport is estimated to be some 20 billion NOK in 1988 measured in basic prices, i.e., somewhat less than the demand for commercial transport this year, see table 9. Own transport in earlier years than 1988 is assumed to be proportional to the use of the respective transport fuels.

Road transport represented approximately 65 per cent of total own transport in 1988, while sea transport was responsible for almost 30 per cent. While road transport has significantly increased over time, the level of sea transport was almost the same in 1988 and 1976. The level of own transport by road is now almost identical to demand for commercial road transport. Sea transport is predominantly produced as own transport, while air transport is almost exclusive produced in the commercial transport sectors.

Table 9. Own transport. Million 1998-NOK

| | Primary | Manufac- | Oil and | Construc- | Trade | Services | Others | Totals |
|----------------------------|---------|----------|---------|-----------|-------|----------|--------|--------|
| | | turing | gas | tion | | | | |
| Road transport | | | | | | | | |
| 1979 | 1.407 | 1.183 | | 1.651 | 4.612 | 1.604 | | 10.457 |
| 1983 | 1.730 | 1.224 | | 1.625 | 4.158 | 1.534 | | 10.271 |
| 1988 | 1.816 | 1.279 | | 1.958 | 5.454 | 2.454 | 72 | 13.033 |
| Air transport | | | | | | | | |
| 1979 | | | | | | 453 | | 453 |
| 1983 | | | | | | 501 | | 501 |
| 1988 | | | | | | 1.459 | | 1.459 |
| Sea transport | | | | | | | | |
| 1979 | 3.983 | 453 | 1.201 | 76 | 163 | 492 | | 6.368 |
| 1983 | 2.710 | 567 | 1.155 | 76 | 98 | 408 | | 5.014 |
| 1988 | 3.669 | 231 | 1.382 | 83 | 163 | 446 | | 5.975 |
| Total own transport | | | | | | | | |
| 1979 | 5.390 | 1.636 | 1.201 | 1.727 | 4.775 | 2.549 | | 17.278 |
| 1983 | 4.440 | 1.792 | 1.155 | 1.700 | 4.256 | 2.443 | | 15.786 |
| 1988 | 5.485 | 1.511 | 1.382 | 2.041 | 5.617 | 4.359 | 72 | 20.467 |

The primary, trade and service sectors dominate the production of own transport. Own transport in manufacturing industries only represented 8 per cent of total own transport in 1988, a far smaller share than for commercial transport. Own transport in the primary sectors is dominated by sea transport in the fisheries. Over time, own transport in the service sectors shows the highest growth rate.

The shares of own transport in the production sectors are obtained as 1 minus the shares of commercial transport, cf. table 6.

2.3. Total demand for transportation services in the production sectors

Adding the cost figures for commercially purchased transport services and own produced transport services give an estimate of total demand for transport in the production sectors. In 1988 this amounted to nearly 45 billion NOK. Costs of road transport represented 60 per cent of all transport costs in 1988, while air and sea transport represented almost 20 per cent each, see table 10.

Table 10. Demand for total transport. Million 1988-NOK

| | Primary | Manufac- turing | Oil and gas | Construc- -tion | Trade | Services | Others | Totals |
|------------------------|---------|--------------------|----------------|--------------------|--------|----------|--------|--------|
| Road transport | | | | | | | | |
| 1983 | 2.071 | 3.899 | 148 | 2.661 | 6.388 | 4.102 | 187 | 19.456 |
| 1988 | 2.330 | 4.471 | 172 | 3.279 | 8.899 | 6.795 | 444 | 26.390 |
| Air transport | | | | | | | | |
| 1983 | 103 | 630 | 614 | 231 | 422 | 2.113 | 63 | 4.176 |
| 1988 | 241 | 1.149 | 860 | 428 | 801 | 4.709 | 118 | 8.306 |
| Sea transport | | | | | | | | |
| 1983 | 2.806 | 1.512 | 1.201 | 398 | 825 | 862 | 22 | 7.626 |
| 1988 | 3.791 | 1.025 | 1.431 | 365 | 858 | 980 | 39 | 8.490 |
| Rail transport | | | | | | | | |
| 1983 | 25 | 443 | 31 | 144 | 359 | 245 | 10 | 1.257 |
| 1988 | 18 | 442 | 20 | 144 | 372 | 221 | 8 | 1.225 |
| Total transport | | | | | | | | |
| 1983 | 5.006 | 6.485 | 1.994 | 3.433 | 7.994 | 7.322 | 282 | 32.515 |
| 1988 | 6.380 | 7.088 | 2.483 | 4.216 | 10.930 | 12.705 | 610 | 44.411 |

The total purchases of transport services (commercial and own produced) in the trade and service sectors amounted to over 10 billion NOK each in 1988 (representing 25-30 per cent of the total), while manufacturing and the primary sectors each used approximately 7 billion NOK in 1988 (corresponding to 15 per cent). The average annual growth rate in total demand for transport services was 3 per cent from 1983 to 1988. The annual growth in transport demand was highest in the services sectors with a rate of 7 per cent. In manufacturing the same rate was negative; -3 per cent, in this period.

Air transport grew by 6 per cent annually on average from 1983 to 1989. Road transport showed a growth rate of 1 per cent, while both sea and rail transport declined by 7 per cent annually on average over the period.

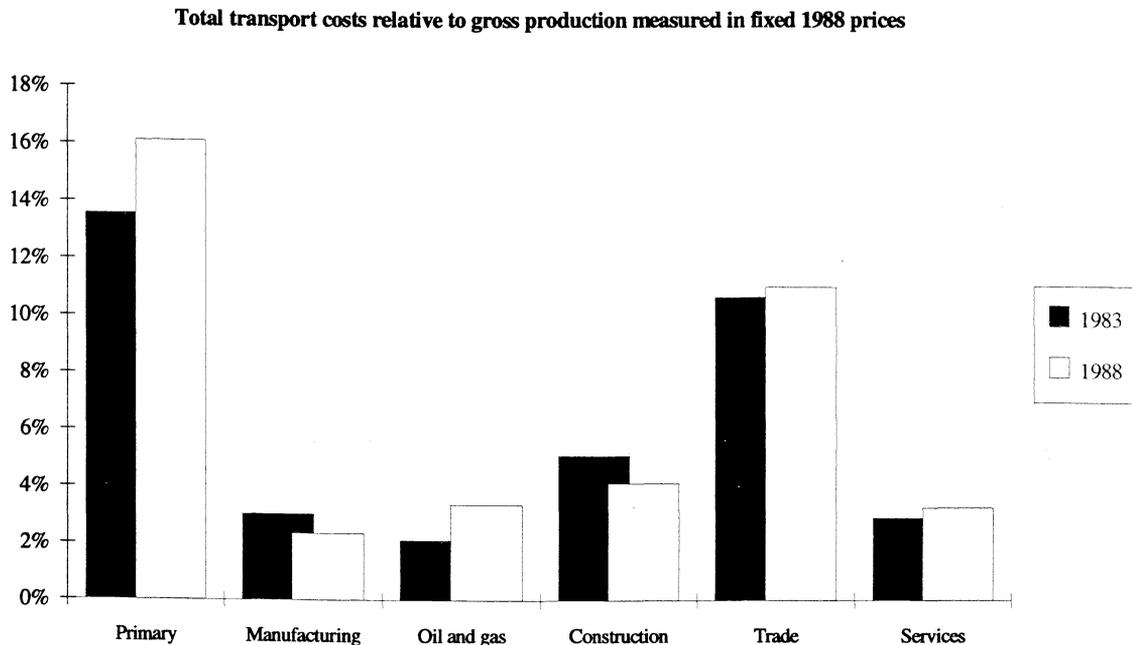
Table 11 shows total transport costs (commercially purchased and own produced) as percentage of the gross production of the respective sectors in 1983 and 1988. According to the estimates, the transport costs represented approximately 16 per cent of the gross product in the primary sectors and somewhat more than 10 per cent in the trade sector in 1988. While the service sectors demand large amount of transportation services measured in absolute numbers (cf. the previous figure), its demand is more modest when measured relative to the level of gross production.

Table 11. Total transport cost relative to gross production measured in fixed 1988 basic prices. Per cent

| | Primary | Manufac- turing | Oil and gas | Construc- tion | Trade | Services | Totals |
|------------------------|---------|--------------------|----------------|-------------------|-------|----------|--------|
| Road transport | | | | | | | |
| 1983 | 6 | 2 | 0 | 4 | 8 | 2 | 2 |
| 1988 | 6 | 1 | 0 | 3 | 9 | 2 | 2 |
| Air transport | | | | | | | |
| 1983 | 0 | 0 | 1 | 0 | 1 | 1 | 1 |
| 1988 | 1 | 0 | 1 | 0 | 1 | 1 | 1 |
| Sea transport | | | | | | | |
| 1983 | 7 | 1 | 1 | 1 | 1 | 0 | 1 |
| 1988 | 10 | 0 | 2 | 0 | 1 | 0 | 1 |
| Rail transport | | | | | | | |
| 1983 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1988 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total transport | | | | | | | |
| 1983 | 14 | 3 | 2 | 5 | 11 | 3 | 4 |
| 1988 | 16 | 2 | 3 | 4 | 11 | 3 | 4 |

Figure 2 illustrates the sectorial data of table 11. Most of the transport in the primary sectors is own produced, in particular sea transport in connection with fishing activities. In the trade sector commercial and own transport represent almost equal shares of total transport demand, while manufacturing industries mainly demand commercial transport services.

Figure.2



3. Summary

The results presented above give a first comprehensive overview of transport activities in the Norwegian production sectors. However, it is important to recognise that both the data sources and the methodology employed are affected by uncertainties. For instance, detailed data on the purchase of commercial transport services are calibrated against summary figures in the national accounts. The national account figures are known to be quite uncertain, with a probable bias to under reporting the amount of commercial transport activities. Also, the process of allocating certain energy commodities to specific transportation means is uncertain, in particular in sectors like the primary sectors. The amount of fuel used for machinery other than vehicles is the main uncertain factor here. Furthermore, the assumption of identical technologies in the commercial transport sectors and in own production of transport is uncertain. Further research is clearly needed to uncover the production structure of the different forms of transportation (commercially and own produced). Despite the obvious shortcomings of this study, we feel that the study has been well worth undertaking in order to get a first glimpse of the total amount and distribution of transport activities within the production sectors. The picture drawn up in this study of transportation activities in the Norwegian economy points to some expected, but also some unexpected facts. We end this study by summarising some of the main findings:

- Almost half (46 per cent in 1988) of all demand for transport in the production sectors is own produced. The share has been increasing since at least 1983.
- Own produced transport grew by 4 per cent annually over the period from 1983 to 1988, while the amount of commercial transport was stable, resulting in an overall annual growth rate of transport of 3 per cent on average.
- Despite the shift between commercial and own produced transport, the overall level of transport activities has grown in line with gross production. The total cost of transport was equal to 4 per cent of gross production measured in fixed prices both in 1983 and in 1988.
- Manufacturing is the only sector where demand for commercial transportation services dominates the production of own transport.
- The service sector is the aggregate sector with the highest absolute demand for transport services; almost 13 billion NOK in 1988. This represented approximately 30 per cent of the total demand for transport which was 44 billion NOK in 1988. Also the trade sector spent more than 10 billion NOK on transport in 1988.
- The transport intensities (transport costs relative to gross production) are highest in the trade and primary sectors (11 and 16 per cent in 1988, respectively). Most of the demand for transport services in the primary sectors is covered by own transport, while the trade sector covered approximately half of its transport needs by own production.
- Road transport dominates the transport activities, accounting for almost 60 per cent of the total transport in 1988. In particular the trade sector use road transport intensively. The primary sector dominates sea transport (mostly own produced in the fishing sector), while the service sectors employed much air transport. Sea and air transport each accounted for approximately 20 per cent of the total transport in the production sectors in 1988.
- Rail transport only accounted for 3 per cent of total transport. Manufacturing industries was the largest employer of this type of transport in 1988, followed by the trade and service sectors.

References

- Alfsen, K. H. (1991):** *Environmental economics based on general equilibrium models: The Norwegian experience*. Discussion paper no. 61. Central Bureau of Statistics, Oslo.
- Alfsen, K. H. (1992):** *Demand for transport services in the production sectors the Norwegian economy*. To be published as a report from the Central Bureau of Statistics, Oslo.
- Bjerkholt, O., S. Longva, Ø. Olsen and S. Strøm (Eds.) (1983):** *Analysis of supply and demand of electricity in the Norwegian economy*. Social and economic studies no. 53, Central Bureau of Statistics of Norway, Oslo.
- Bjerkholt, O. and J. Rinde (1983):** *Consumption demand in the MSG model*. In Bjerkholt, O., S. Longva, Ø. Olsen and S. Strøm (Eds.) (1983): *Analysis of supply and demand of electricity in the Norwegian economy*. Social and economic studies no. 53, Central Bureau of Statistics of Norway, Oslo.
- Brendemoen, A. (1991):** *Faktoreterspørsmål i transportproduserende sektorer*. Central Bureau of Statistics, Oslo.
- Bye, T. og P. Frenger (1990):** *Factor substitution, non-homotheticity, and technical change in the Norwegian production sectors*. Unpublished note.
- Bye, T., T. A. Johnsen, H. T. Mysen (1991):** *An integrated economy-energy-environment general equilibrium model of the Norwegian economy*. Paper presented at the International Symposium on Economic Modelling, London 9-11 July, 1991.
- Diewert, W. E. (1971):** *An application of the Shephard duality theorem: A Generalized Leontief production function*. *Journal of Political Economy*, 79, 481-507.
- Hetland, T., T. Vik and A. Aaheim (1990):** *Tilgang og bruk av energi 1980-1987*. (Supply and demand for energy 1980-1987). Interne notater no. 90/2. Central Bureau of Statistics. Oslo.
- Holtmark, B., H. Vennemo, E. Holmøy, and J. Aasness (1991):** *A new general equilibrium model*. Forthcoming as Discussion Paper, Central Bureau of Statistics of Norway, Oslo.
- Jean-Hansen, V. (1990):** *Transportkostnader i norsk næringsliv og offentlig forvaltning for årene 1962-1988*. (Transport costs in Norwegian production sectors and public services for the years 1962-1988). Transportøkonomisk institutt, Notat 0941/1990. Oslo.
- Johansen, L. (1974):** *A multi-sectoral study of economic growth*. Second enlarged edition. North-Holland Publishing Company, Amsterdam.
- Ljones, A. (1982):** *Tilgang og bruk av energi 1976-1980*. (Supply and demand for energy 1976-1980). Interne notater no. 82/21. Central Bureau of Statistics. Oslo.
- Longva, S., L. Lorentsen and Ø. Olsen (1985):** *The multi-sectoral growth model MSG-4. Formal structure and empirical characteristics*. In: F. R. Førsund, M. Hoel and S. Longva (Eds): *Planning, Multi-sectoral Growth and Production. Essays in honour of Professor Leif Johansen, Contribution to economic analysis no. 154*. Elsevier Science Publishers B. V (North-Holland Publishing Company), Amsterdam.

Ministry of Environment (MoE) (1991): *Drivhuseffekten.*(The greenhouse effect.) In Norwegian.
Report no. T-841. Oslo.

Offerdal, E., K. Thonstad and H. Vennemo (1987): *MSG-4: A complete description of the system of equations.* Report no. 87/14. Central Bureau of Statistics, Oslo.

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