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Summary:

Welfare maximisation in public transport

An analysis of the development in 7 Norwegian cities

Background and objectives

Framework conditions for Norwegian public transport have changed substantially over the past two decades. Operating subsidies in Norwegian conurbations have been cut dramatically. Changes in the Transport Act, which allowed for competitive tendering of public transport provision, were approved by the Government in 1991 and set in force in April 1994. Central government transfers to county councils, which are responsible for local public transport, have been reduced partly due to the expected efficiency gains in the sector that would arise from the threat of competitive tendering. In addition the county councils have adapted to their responsibility for local public transport in a number of different ways.

The operators can compensate for subsidy cuts either by reducing service levels, by increasing revenues or by improving cost efficiency. We will investigate the adjustments made by public transport operators and passengers in order to see how they have adapted to the new framework conditions.

Further, we will present a "social balance sheet" which includes the major costs and benefits of the developments in the public transport sector. Norheim and Carlquist (1999) developed a methodology for this, and we have expanded on their work and findings.

This work concentrates on seven major Norwegian cities: Oslo, Drammen, Stavanger, Kristiansand, Bergen, Trondheim, and Tromsø, in the period 1986–1999. See Figure S.1.

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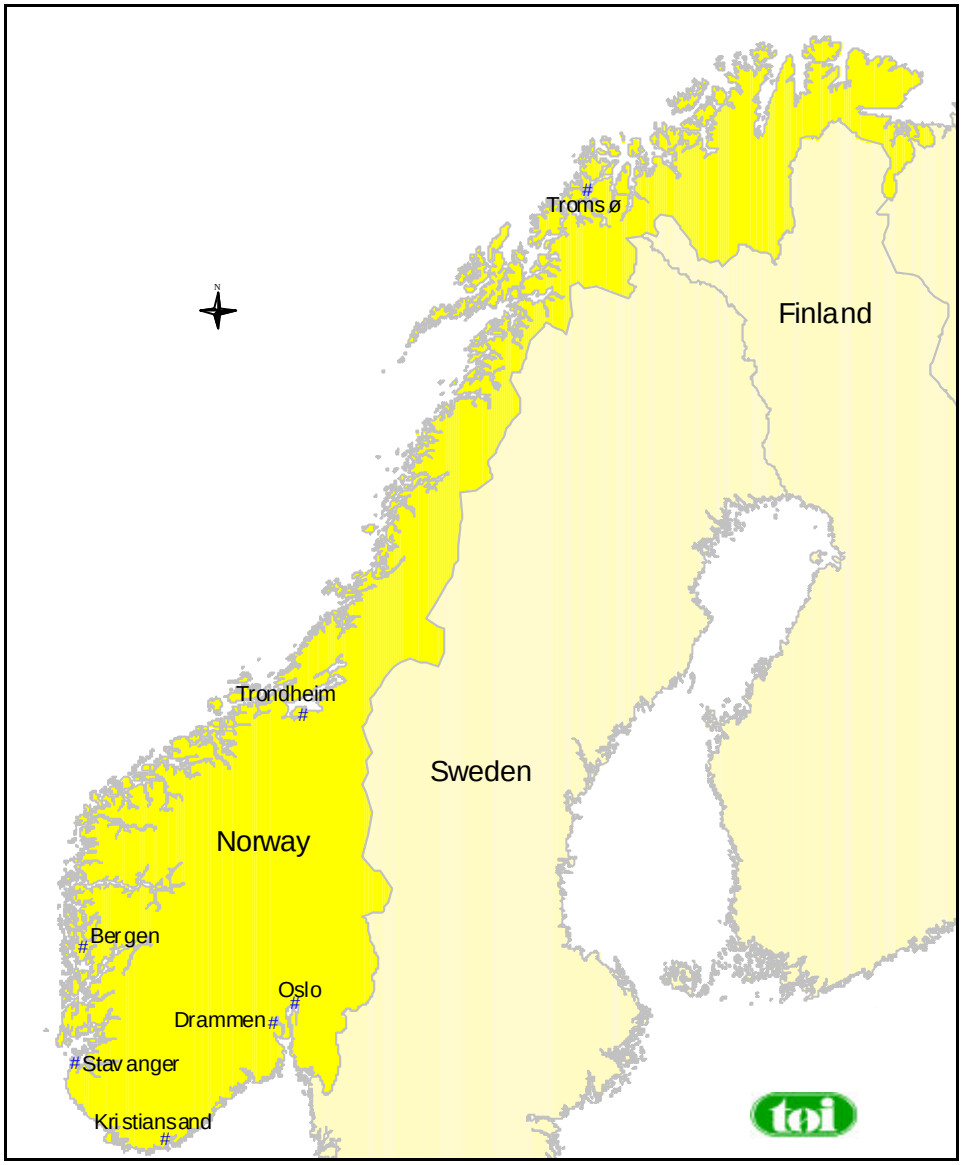

Figure S.1: The Norwegian cities of Oslo, Drammen, Stavanger, Kristiansand, Bergen, Trondheim, and Tromsø.

Methodology

National Transport Statistics and the operators' annual reports are the most important data sources for the study.

In order to facilitate comparability with Norheim and Carlquist (1999), who used times series data for 5 cities between 1986 and 1997, we have used the same data set but expanded the number of cities by two and added the years 1998 and 1999. We have had to make minor amendments to some definitions and have updated some of the previous figures.

The introduction of the diesel duty in 1999 provided a challenge in the data validation process. In principle this fuel tax shall be reimbursed to bus companies, which means that it merely represents a shift in both operating costs and subsidies. In reality it has proven difficult to separate the fuel duty compensation from other transfers, and similarly to separate the diesel duty from other operating costs. On average the compensation has been somewhere around 95% of the diesel duty. The analyses presented in this report exclude costs and subsidies that relate to this tax.

We have described and compared trends for subsidies, costs, fare levels, supply (vehicle kilometres per capita) and demand (patronage measured in trips per capita) for the seven cities. These findings are presented by way of indices, using 1986 as the base year. A number of potential explanatory factors for the various trends are discussed. This part of the analysis is semi-qualitative and presents a number of questions for further research.

In order to describe passenger behaviour we have built an aggregated demand model, which relates number of trips per capita to various explanatory variables. This is a relatively simple regression model. In addition to providing new information about demand elasticities, the model has also been used to separate the effects of the changes in fare and service levels on demand.

The social balance sheet compares public savings from subsidy cuts with the costs that poorer service levels and higher fares incur on passengers and other areas of society. This is a relatively crude measure for the economic impact of the changes in the public transport sector. The approach is not a traditional cost-benefit analysis. Rather, it is an annual summary of the impacts of the changes relative to the base year 1986. On the benefits side there are the reductions in subsidies, which represent a saving which is equivalent to the cuts. (This means that shadow pricing of public spending have not been applied.) These savings are offset by costs that accrue to passengers and others, who experience:

?? poorer service levels
?? fare increases
?? traffic congestion
?? pollution

The monetisation of these effects are based on works by Kjørstad et al. (2000) for waiting time and Eriksen et al. (1999) for external costs of transport.

Reduced public transport subsidies

In total the annual public transport subsidies in the 7 cities have been reduced by 42 percent in real prices. Subsidies fell from about NOK 1.2bn in 1986 to NOK .7bn in 1999, in 1998-prices. Subsidies as a proportion of the costs fell from 45 percent in 1986 to 26 percent in 1999. However, there is great variation between individual cities.

In most of the cities subsidies declined steadily till about 1997. Thereafter subsidies have risen in most of the areas. Bergen and Trondheim have had the largest subsidy cuts, of around 80 percent reduction since 1986.

The subsidy reductions have rendered Trondheim and Bergen with subsidy levels that in 1999 covered only 4 and 8 percent of the costs, respectively. These levels place Trondheim and Bergen among the European cities with the lowest level of subsidies and the highest rates of farebox recovery.

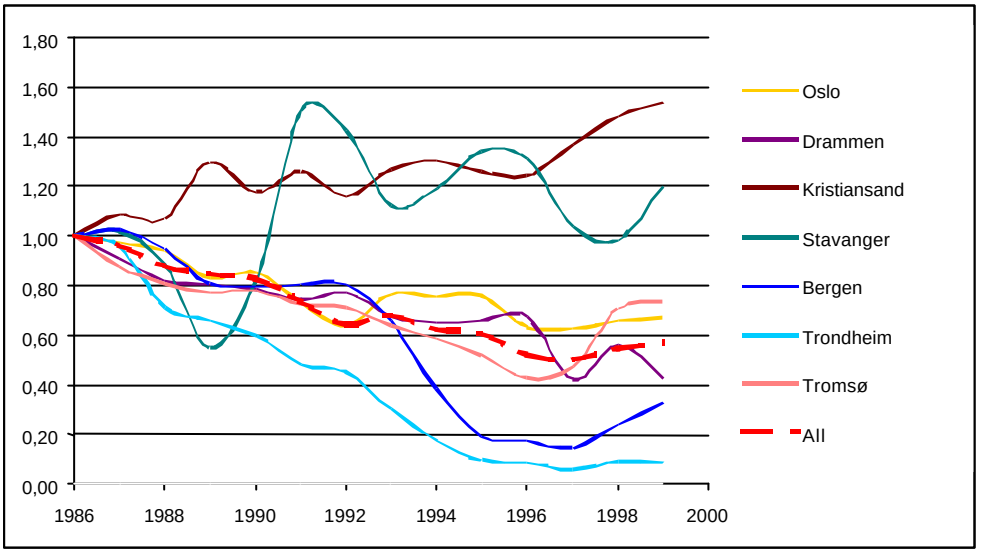

Figure S.2: Trends in subsidies per vehicle-kilometre. 1986=1.00. Dotted line is veighted average.

Operators have become more cost efficient

Our analyses of operators' productivity performance indicate that the potential for cost efficiency gains has been exhausted. This partly explains the fare increases in the late 1990s.

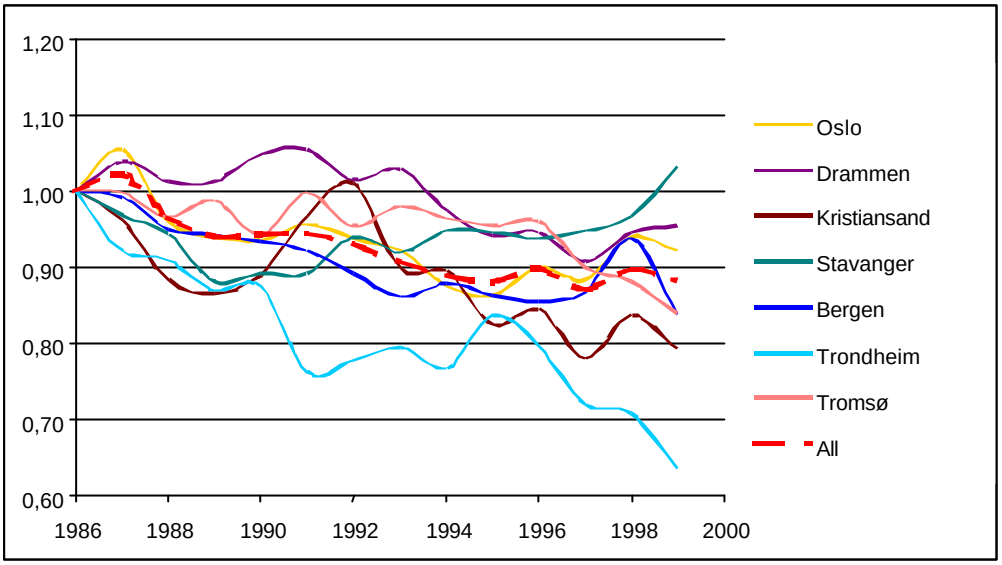

Figure S.3: Trends in operating costs per vehicle-kilometre. 1986=1.00. Dotted line is weighted average.

Average costs per vehicle-kilometre fell by 12 percent between 1986 and 1995. Since 1995 costs have fluctuated around the 1995-level, see Figure S.3. The year 1995 can therefore represent a change of the trend. This change may have been brought about for several reasons: Increases in fuel prices, labour costs and passenger numbers; improved quality standards; compensation for previous losses and low subsidy levels; little room for further efficiency gains; and the need for new investments.

Major fare increases

Fare levels, calculated as the average fare box revenue per passenger trip, have increased steadily since 1990. In 1999 fare levels had increased by 23 percent compared to the base year 1986. Trondheim and Bergen, which had the largest cuts in subsidies, have also experienced the largest fare increases. This is illustrated in Figure S.4.

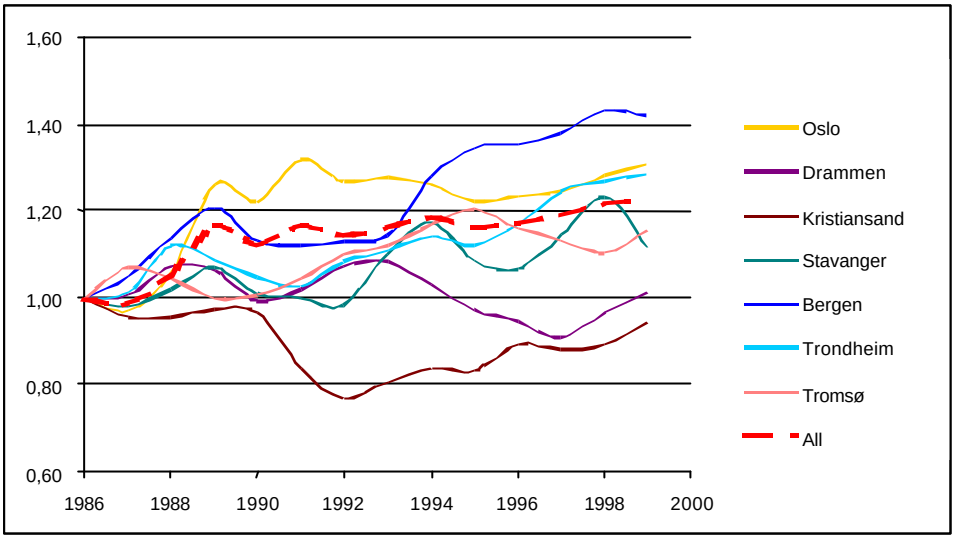

Figure S.4: Trends in fare levels, calculated as total fare box revenues divided by number of passengers. 1986=1,00. Dotted line is weighted average.

Falling profit levels

Operating profits as percentage of turnover have, with a few exceptions, fallen steadily in the period between 1986 and 1996. Since 1992 the average level has in fact been negative even though the subsidies have been included in the turnover. Although rising again after 1996 the profit ratio is still negative in 1999. To the extent that these estimates represent the actual situations in the operating companies these figures are alarming. Negative operating profits are not sustainable in any industry.

Service levels have increased in pace with population growth

Service levels, measured by vehicle mileage production, have increased throughout the period. In 1999 bus, tram and underground services ran 16% more kilometres than in 1986. If we compare this with the population growth in the cities then service levels have kept more or less in pace with the size of the population. Keeping in mind that subsidy levels have fallen dramatically over the period it is worth noting that operators have maintained and increased their production levels.

Norwegian public transport authorities and operators can be said to have put greater emphasis on accessibility than service frequency. This means that mileage increases have less effect on the average waiting time. Much of the increased mileage is due to new service lines that cater for the special needs of the mobility impaired passengers.

Patronage is falling

Demand, measured in passenger trips per capita, fell by 10% between 1986 and 1992. Since 1992 demand has increased again by 5%. This is illustrated in Table S.5. The demand for public transport in 1999 is thus about 5% lower than in 1986.

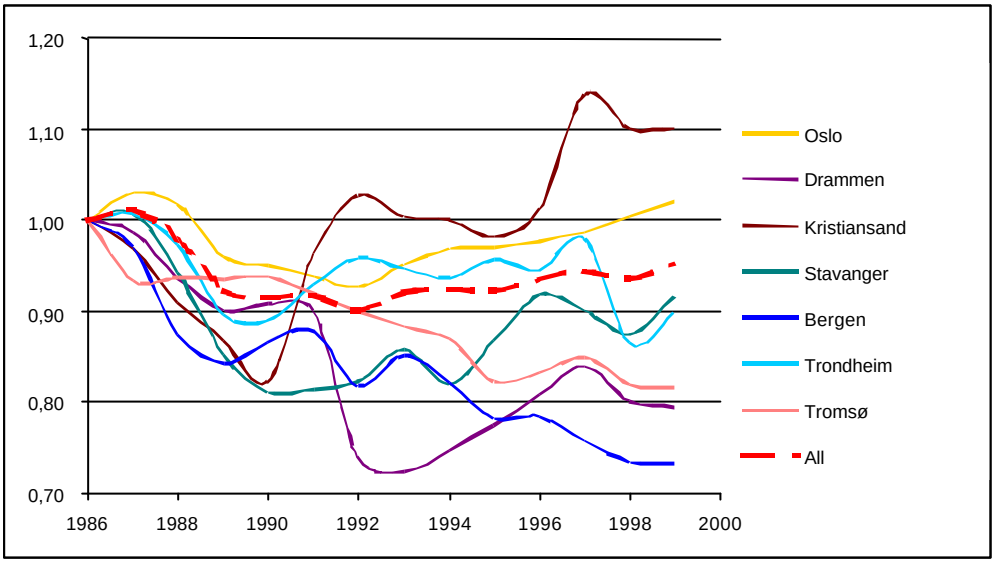

Figure S.5: Passenger trips per capita. 1986=1,00. Dotted line is weighted average.

Because of the relatively stable levels of production per capita it is likely that the loss of passengers has been caused mainly by the large fare increases. However, the findings vary between cities with regards to demand, service levels and fares. The demand increase since 1992 has mainly been driven by the developments in Oslo, which is by far the largest of the seven cities. Since the early 1990s service quality has increased substantially in Oslo, due to the integration of eastern and western metro networks and a successful customer orientation scheme.

Comparing the developments in demand for public transport with private car use, it is evident that public transport modal shares have fallen dramatically during the period. Car use rose by about 20% on a national level between 1986 ands 1999, whilst in the same period public transport demand fell by 5% in the seven cities.

Aggregated demand model

We have been able to develop relatively robust aggregated demand models based on multiple regression models. The model has been used to analyse the effects of income levels, fare levels, service levels, and petrol price on demand for public transport. A time trend has also been included in the model. Our main model is a constant elasticity model. We have calculated the following elasticities:

Variable	Elasticity
Income (GNP/capita)	-0,40
Petrol price	0,14
Fare	-0,49
Vehicle-km per capita	0,66

The model produces a fare elasticity estimate of about 0.5. This fits well into a trend towards higher demand sensitivity to prices over time, which is mainly caused by fare increases. The proportionate decrease in demand increases as the fare levels rise. An alternative model which estimates a proportional price elasticity shows that this is indeed the case. This model estimates a fare elasticity equal to -0.05*Price. From the operators' point of view, then, fare levels should not exceed NOK20, at which stage the price elasticity is equal to -1. However, this depends crucially on the socio-economic profile of the passengers, fare structure, travel patterns and size of the city.

The model also shows that public transport is an inferior good. That is, when income levels rise, demand for public transport falls. This fact represents a major challenge for the public transport industry. Service quality must continually improve in order to offset this negative effect of income on demand.

The time trend comprises the effect of omitted variables. The model estimate is an annual increase in demand of about 1.1 percent per year. This figure differs from previous findings, which have indicated a *negative* time trend. The main reasons for this are

- the fact that our model separates the income effect from the time trend (as opposed to previous studies), and
- the fact that we have not been able to include the substantial improvements in service quality that have taken place in some of the cities.

Falling demand due to fare increases

We have used the demand model to illustrate the partial and combined effects of the changes in fare and service levels on demand. With the exception of Kristiansand, fare increases have caused declining demand in all cities. There is more variation in the effects of changing service levels. In some cities improved service levels have to some degree offset the negative effects of fare increases, whilst in others the combined action of deteriorating service levels and increasing fares have reduced demand even further.

Figure S.6 shows how fares and service levels (Vkm) have influenced total demand for public transport in the seven cities. It shows that relative to 1986 demand fell by about 6 percent as a combined result of a 7 percent reduction in demand due to fare increases and a 1 percent increase in demand due to improved service levels. These are the partial effects of the changes in fares and service levels that have taken place in the period.

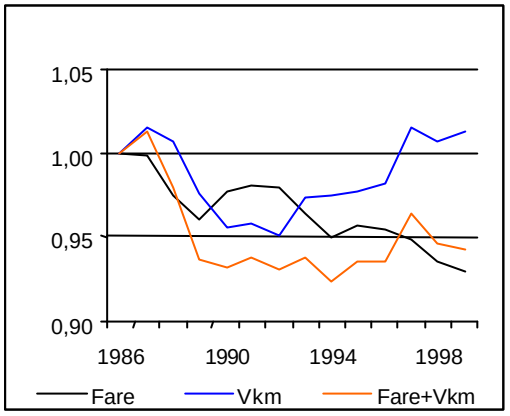

Figure S.6: Partial and combined effects on demand of fares and service levels (Vehicle-km). Unweighted average of 7 cities. 1986=1.00

Social welfare balance sheet

The social welfare balance sheet describes the developments in the public transport sector over the period 1986 to 1999. Here, we have regarded the changes in subsidies in relation to the other changes in the sector. The balance sheet includes welfare effects (including marginal external costs) of modal shift, changes in vehicle-mileage, frequency and fares. The analysis indicates to what extent the subsidy cuts have contributed to real economic benefits for the society.

Table S.1: Social welfare balance sheet of the developments in the public transport sector. NOK million 1999-prices. 1992 compared with 1986, 1999 compared with 1992, and 1999 compared with 1986.

7 cities	1992 v 1986	1999 v 1992	Sum: 1999 v 1986
Savings: Reduced subsidies	452	40	493
Costs:			
Fare increases	224	200	424
Increased vehicle mileage	7	102	109
Modal shift	51	14	66
Waiting time	50	1	50
Net saving (benefit)	120	-276	-157

Our analyses (Table S.1) show that up until the mid 1990s there were real economic gains from the adjustments. But in the late 1990s this picture changes. The analysis indicates that the situation has changed to a state where there are no additional gains from further cuts in subsidy.

There are a number of reasons for the net cost (negative benefit) that has accrued mainly in the period 1997-1999. Firstly, subsidies to public transport increased in this period. Secondly, it has probably not been possible for operators to cut costs further without also reducing the quality of the services offered to the public. The reasons for this are partly the fact that the potential for further cost efficiency has been exhausted, partly the fact that costs of input factors have risen, and partly the fact that previous adjustments have been sub-optimal in the sense that necessary costs and investments have been postponed.