# A TALE OF SEVEN CITIES:
# SUBSIDY REDUCTIONS IN NORWEGIAN PUBLIC TRANSPORT

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## 1. INTRODUCTION

Organisational, financial and regulatory conditions for Norwegian public transport have changed substantially over the past two decades. Operating subsidies in Norwegian conurbations have been reduced dramatically. Changes in the Transport Act, which allowed for competitive tendering of public transport operations, 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 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 the changed regulatory environment for local public transport in a number of different ways.

The operators can compensate for subsidy reductions 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 study how they have adapted to the new regulatory and financial conditions. Further, we will present a “social welfare 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 1.


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

## 2. METHODOLOGY

Norwegian National Transport Statistics and the operators' annual reports are the main data sources for this 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 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 this paper the findings of this part of the analysis are only briefly described.

In order to describe passenger behaviour we have built an aggregated demand model, which relates the number of trips per capita to various explanatory variables. This is a constant elasticity 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 welfare balance sheet compares public savings obtained from subsidy reductions 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. These savings are offset by costs that accrue to passengers and others, who experience poorer service levels, fare increases, traffic congestion and pollution.

## 3. TRENDS IN NORWEGIAN URBAN PUBLIC TRANSPORT

Norwegian urban public transport in the period from 1986 to 1999 was characterised by steeply falling subsidies, decreasing costs and patronage until the mid-1990s, increasing real fares and supply increasing with population growth.

**Reduced public transport subsidies**: In total the annual public transport subsidies in the 7 cities were reduced by 42 percent in real prices, and 50% per vehicle kilometre. Subsidies fell from about NOK 1.2bn in 1986 to NOK 0.7bn 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, measured per vehicle kilometre. The subsidy reductions have rendered Bergen and Trondheim with subsidy levels that in 1999 covered only 8 and 4 percent of operating 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. See Figure A.1.

**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. Average costs per vehicle-kilometre fell by 12 percent between 1986 and 1995. Since 1995 costs have fluctuated around the 1995 level, see Figure A.2. This change of trend may have been brought about for several reasons, including Increases in fuel prices and labour costs, rising passenger numbers, improved quality standards, compensatory measures for previous losses and low subsidy levels, 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 were 23 percent above the base year level in 1986. Bergen and Trondheim, which had the largest cuts in subsidies, have also experienced the largest fare increases. This is illustrated in Figure A.3.

**Supply has kept up with population growth:** Supply, measured by mileage (vehicle kilometres), is rising in line with increasing population. This means that the bus companies in the seven cities produced 16% more vehicle kilometres in 1999 than in 1986, but measured per capita, the mileage growth is a mere 3%.

**Patronage is falling:** Demand, measured in passenger trips per capita, fell by 10% between 1986 and 1992, see figure A.4. Since 1992 demand started rising, and increased by 5% by 1999. The demand for public transport in 1999 is thus about 5% lower than in 1986. 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. Comparing the developments in demand for urban public transport with private car use, it is evident that the modal share of public transport in Norway has fallen dramatically during the period. Car use rose by about 20% on a national level between 1986 and 1999 (Rideng 2000). However, the demand trends vary between cities with regards to demand, service levels and fares. The increase in total demand 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.

**Profit margins are falling**: Operating profits margins fell from around 5% in 1986 to below zero in the period 1992-1999. Property sales is one of the key components which have compensated for these losses. Profit margins slightly increased in 1998 and 1999.

## 4. AGGREGATED DEMAND MODEL

The data set has enabled us to build relatively robust aggregated demand models based on multiple regression modelling. 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. The main model is a constant elasticity model. We have calculated the following elasticities:

*Table 1: Elasticities for urban public transport in Norway*

| 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 NOK 20, 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. In the period from 1986 to 1999 the average annual increase in GNP has been 2.6 percent, causing a annual drop in demand of 1.1 percent.

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 recent previous findings by Norheim and Carlquist (1999) and Norheim and Renolen (1997), who found 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. (It should be noted, however, that Bly and Oldfield (1985) estimated a positive time trend in Norway between 1970 and 1980.)

Within the demand model fare and service levels are the explanatory variables that are determined within the public transport sector. We have used the demand model to estimate 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 2 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 in 1999 was reduced by about 6 percent on average 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 keeping all other explanatory variables constant.

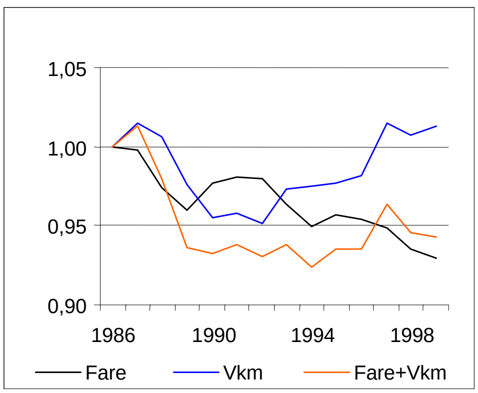


*Figure 2: Partial and combined effects on demand of fares and service levels (Vkm), unweighted average of 7 cities. 1986=1.00*

## 5. 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 compare subsidy savings to other changes in the sector. The balance sheet includes welfare effects (including marginal external costs) of modal shifts, changes in vehicle-mileage, frequency and fares. The net effect of these changes constitutes an indicator for social welfare changes.

In a similar analysis, Carlquist and Norheim (1999) also included a calculation of changed travel time, motivated by substantial road improvement and construction schemes in Bergen. This is a change which has little to do with public transport subsidy changes. However, buses enjoy better access and higher operating speeds, which may influence service levels and fares. Nevertheless we have not considered this factor to be relevant for our analysis.

We do not take into consideration perceived quality improvements, as such effects are difficult to quantify. This is a limitation of our analysis, especially as quality measures can be seen as a consequence of subsidy reductions. This is because public transport operators have had an incentive to increase patronage to compensate for the subsidy reductions. On the other hand reduced subsidies have led to an increased average age of buses (Carlquist 1998) and may have had a negative impact on regularity, thus leading to deteriorating quality.

We have not included operating costs in the social welfare balance sheet. We do not have sufficient data to develop a cost function for the public transport systems. As the companies generally have very low profits, the omission of the cost function will not change our conclusions.

We have considered several accumulation principles. In our analysis, all calculations are related to 1986 as the base year. E.g. if subsidies are NOK 50 million in 1986, NOK 25 million in 1987 and NOK 40 million in 1988, the following table describes our accumulation principle:

*Table 2: Illustration of accumulation principle*

| | 1986 | 1987 | 1988 |
|---|---|---|---|
| Subsidy | 50 | 25 | 40 |
| Change since 1986 | 0 | -25 | -10 |

We will also present a total accumulation, i.e. in the above example the total accumulated subsidy saving would be (25+10)=35.

The following sections discuss the components which are included in the analysis:
- Savings from subsidy reductions (public purse savings)
- Fare changes (costs for passengers)
- Modal shift costs and costs of increased supply (marginal external costs)
- Frequency change costs (waiting time)

**a) Subsidy changes**

We have assumed that a reduction of subsidies (measured in fixed prices) equals an identical social welfare saving. We have not included shadow prices of public spending. This is a reasonable assumption as savings from the transport sector will be transferred mainly to other county council assignments, which involves fairly low transaction costs.

The table below provides an overview of the subsidy changes in the first and second half of the period, and during the entire period.

*Table 3: Changes in operational subsidies to public transport 1986 - 1992, 1992 - 1999 and 1986 – 1999. Per cent*

| | 1986-92 | 1992-99 | 1986-99 |
|---|---|---|---|
| Oslo | -41 | +9 | -36 |
| Drammen | -40 | -48 | -69 |
| Kristiansand | +7 | +48 | +58 |
| Stavanger | +33 | -19 | +59 |
| Bergen | -26 | -64 | -74 |
| Trondheim | -62 | -83 | -94 |
| Tromsø | -29 | -6 | -33 |
| All | -39 | 0 | -39 |

Note that the percentage changes for the two sub-periods do not equal the percentage change for the entire period. This is because the base year of the second sub-period is 1992, whereas for the first sub-period and the entire period it is to 1986. The numbers do not include the diesel levy compensation which was introduced in 1999. Numbers for Kristiansand are for 1997. This also explains why the change total 1992-1999 does not correspond to table 5.

A compensation subsidy for the diesel levy was introduced in 1999. Previous to this, public transport enjoyed an indirect subsidy as this sector was exempted from the levy. This indirect subsidy has not been included in our analysis.

### b) Fare increases

If savings from subsidy reductions lead to an equal fare increase, social welfare is unchanged although the financing burden has been transferred from the public purse to the passengers. Thus the analysis must include fare increases, which offset the benefits from the subsidy reductions, in our balance sheet. We have calculated the costs for existing passengers in a given year, due to real fare increases (measured by revenue per trip) as compared to 1986. We have assumed that a NOK 1 fare increase reduces the welfare by NOK 1.

### c) Costs due to modal change and increased supply

Service and fare level changes will influence demand for public transport, and therefore also car traffic. Increased car traffic involves a number of external costs. Eriksen, Marcussen and Putz (1999) have studied marginal external costs of transportation. These figures apply for large Norwegian cities and include global and local pollution, noise, congestion, accidents and infrastructure wear. Our definition of social welfare thus includes environmental costs. For Oslo we have assumed that 55 % of public transport is rail-based, which yields a lower external cost. A more thorough analysis would have to consider the proportion of peak to off-peak traffic.

*Table 4: Marginal external costs, 1999-NOK per kilometre*

| | |
|---|---|
| Private car | 1.46 NOK/km |
| Bus | 8.98 NOK/km |
| Public transport in Oslo | 6.68 NOK/km |

Source: Eriksen, Markussen, Pütz 1999.

Kjørstad et al (2000) have analysed transfers from use of private car to public transport. For four major urban areas, they found that the average proportion of new passengers that originally used a private car was 46.9%. Our analysis includes the changes in patronage which are caused by changes in fares and service levels. We have assumed that 46.9 % of all new passengers previously travelled by private cars, and similarly that 46.9 % of patronage reductions are lost to private cars.

We assume that the average trip length is equal for public transport and private car. We also assume that the average car occupancy is 1.4 persons. The demand model as described above has been used to calculate demand changes. In other words, the isolated effects of changed fares and kilometre production has been used to calculate demand changes. Thus the analysis includes only factors within the operators' range of control.

It has been difficult to make good calculations for the change in public transport vehicle kilometres that are caused by demand changes. We have chosen to include external costs of the entire production increase. The reason for this is that we do not know, based on the aggregated figures, how many passengers a departure must lose in order for the departure to be withdrawn. There is no clear pattern in the data. However, the data indicate that supply is relatively unchanged despite demand changes. This may also explain why kilometre production per capita on average has been fairly constant despite fall in demand. Therefore we have assumed that the cost of transferred traffic from public transport to the private car is merely the cost per new car kilometre, and that the public transport production will be maintained. This assumption may be incorrect for individual cities, but seems realistic for the seven cities aggregated.

### d) Costs of frequency changes

A less frequent service implies longer waiting times and therefore costs for passengers. There are several problems concerning these calculations. One is the introduction of service lines for the elderly and disabled. This yields a less frequent service, but on the other hand average walking distance will decrease. Another weakness is that frequency estimations based on network kilometre per vehicle hour, and travel surveys showed quite different patterns. This might be due to inadequate sample size for the surveys, or that the network kilometre data was unreliable. Despite these weaknesses, we have included this component as there are substantial variations between the cities and we believe we have identified the direction of change for the cities. We have applied a valuation of waiting time of NOK 21.28 per hour (Kjørstad et al 2000).

### Net social welfare effects

The analysis cannot determine in detail to what extent the subsidy cuts have caused changes with regard to higher fares, changes service level and increased car traffic. Despite this, it is clear that savings for the public purse due to subsidy reductions will be offset by changes which in part are due to the subsidy reductions. The table below shows that there was a loss in social welfare of NOK 157 million in 1999, compared with the 1986 base level.

*Table 5: Social welfare balance sheet of the developments in the public transport sector. NOK million 1998-prices. 1992 compared with 1986, 1999 compared with 1992, and 1999 compared with 1986.*

| **7 cities** | **1992 v 1986** | **1999 v 1992** | **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** |

In the first half of the period, there was a substantial saving due to reduced subsidies, but almost three quarters of this was offset by other components, in particular transfer of costs to passengers (increased fares). In the second half of the period, the possibility to reduce subsidies was more limited, most likely because the potential for cost efficiency gains was diminishing. The fares rose substantially, and the external costs of increasing production also increased. This led to a net loss of NOK 276m in the second period.

The findings depend on which year is used as the division line between the two periods. Subsidy cuts and the operators' adjustments vary substantially. Figure 3 illustrates the development over time. There was a positive development in net social welfare throughout most of the 1990s, although the gains are quite small compared to the magnitude of the subsidy cuts. The figure also shows how 1992 was an atypical year. This was mainly due to a large subsidy reduction in Oslo.

The most important change was in 1998/1999, when subsidy increases, fare increases and external cost increases all contributed to a loss in social welfare. Compared to 1986, the loss was 157 million NOK.

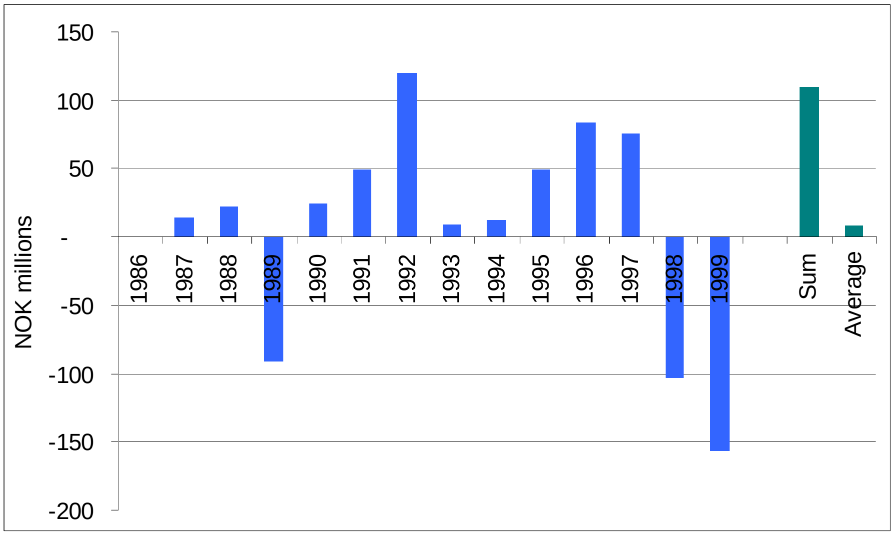


Figure 3*: Social welfare changes compared to base year 1986. Positive values indicate welfare gains. NOK million, 1998-prices.*

Figure 3 illustrates the annual levels as compared to 1986. In order to assess the total net savings for the whole period, we have accumulated these annual savings. This total accumulated annual social welfare saving is NOK 109 million or NOK 8 million per year on average. This is very small compared to the total accumulated public purse saving, which is NOK 4.9 *billion* in the same period. This means that NOK 4.8 billion has been transferred to passengers, car drivers and passengers, and society in general. Although we cannot conclude that all the negative effects are caused by the subsidy cuts, the analysis indicates that subsidy reductions have led to only marginal social welfare gains, and that these gains were negative in 1998-1999.

Oslo represents almost 40% of the population in the seven cities studied. In addition, Oslo has a public transport system comprising bus, tram and metro networks, whereas the other cities with small exceptions have bus systems only. If we separate Oslo and the six other cities, it becomes apparent that it is first and foremost the data for Oslo that cause the large fluctuations in the social welfare development. The other cities, in aggregate, show a more stable development until 1997, but for these as well as for Oslo, the development since 1997 has been negative.

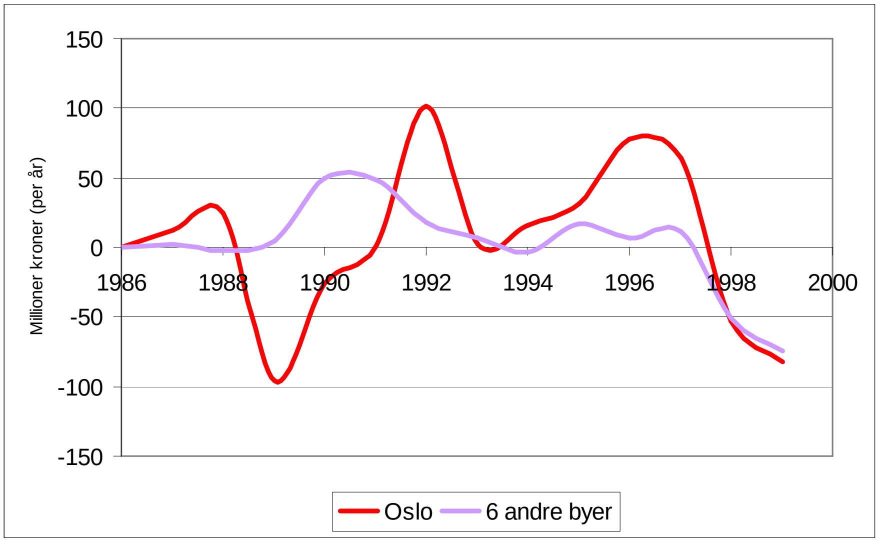


*Figure 4: Annual social welfare savings compared to 1986, divided between Oslo and the six other cities. NOK million, 1998 prices.*

It is possible to distinguish three periods of change:

- Until 1993 there were substantial social welfare fluctuations. Little stability in the subsidy levels in Oslo was the main reason. Between 1990 and 1992 there was a considerable net saving in the other cities. This was caused by several components in several cities and it has not been possible to analyse this in detail. Our hypothesis is that until 1993 it was possible to partly offset subsidy losses by cost reductions, and therefore fares and service levels were not as adversely affected in this period.

- Between 1993 and 1997 there was a social welfare gain in Oslo. Subsidies remained rather constant in Oslo and there were qualitative improvements, especially due to the integration of the eastern and western metro networks. This led to increasing patronage. In the other cities, subsidies were reduced and it gradually became more difficult to reduce costs, so there was not the same positive development as in Oslo.

- After 1997, there was a social welfare loss in Oslo as well as in the other cities. There are a number of reasons for the net cost (negative benefit) that accrued in this period. 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 that the potential for further cost efficiency has been exhausted, that costs of input factors have risen, and that previous adjustments have been sub-optimal in the sense that necessary costs and investments have been postponed.

The analysis demonstrates that it is important to distinguish Oslo from the other cities. The developments in Oslo have contributed to a positive picture of Norwegian urban public transport in terms of patronage developments and social welfare gains up to

1997. Recurring operational problems in the second half of the 1990s clearly indicate that the operators in Oslo have approached their production capacity limits, and this had has an adverse effect on investments and maintenance.

## 5. CONCLUSIONS

The public purse savings from reduced subsidies in seven Norwegian cities have had consequences for other actors. The operators have become more cost effective. This indicates that it was “right” to reduce subsidies. When it was no longer possible to reduce costs to the same extent, operators either reduced their profit margins or transferred costs to other actors. The passengers have had to bear the brunt of this cost, mainly through increased fares but also through reduced frequency. Society in general has also had to bear costs due to a modal shift from public transport to private car traffic.

It is the development since 1997 that makes this picture dramatic, but this is not necessarily a long-term trend. On the other hand, the short-term focus on cost efficiency gains may lead to an unsustainable development, because operators are forced to postpone necessary maintenance costs and investments. The other option for operators is to reduce the service level and increase fares, which may lead to a loss of market share for public transport, and declining social welfare.

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## APPENDIX: DIAGRAMS

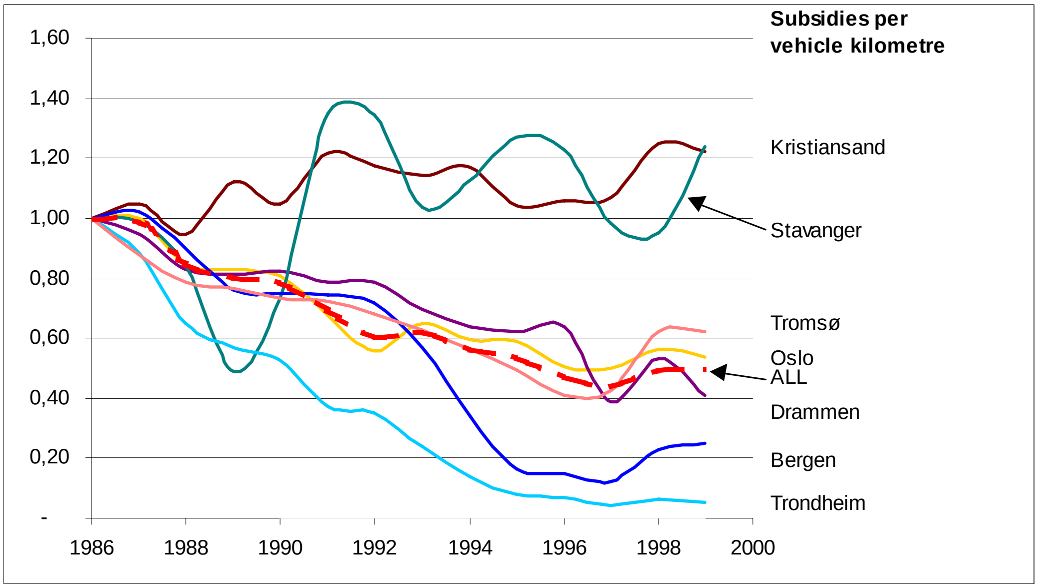


*Figure A.1: Trends in subsidies per vehicle kilometre. 1986=1.00. The dotted line is a weighted average of the seven cities.*

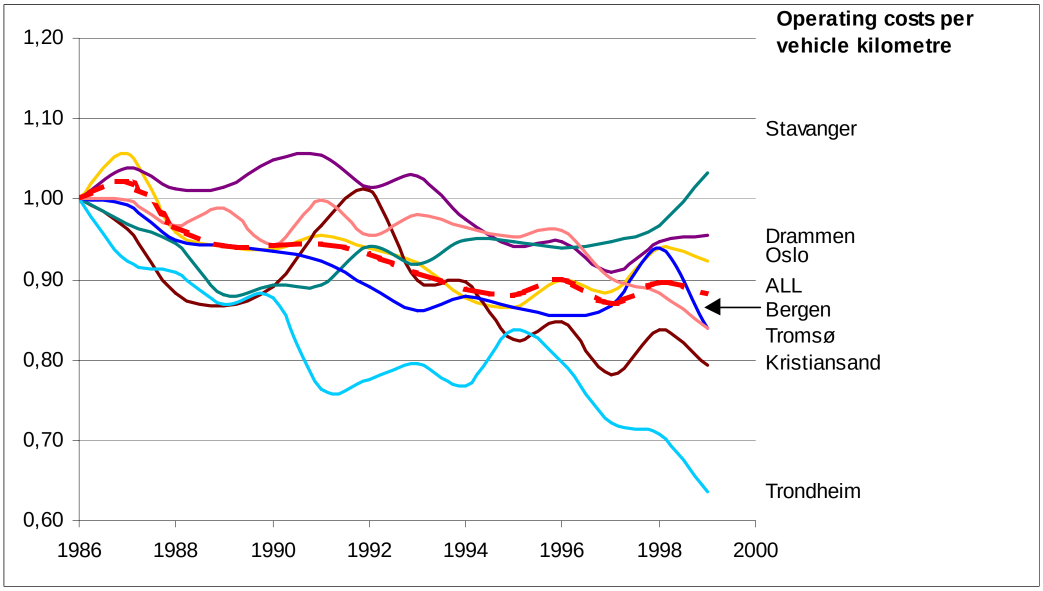


*Figure A.2: Trends in operating costs per vehicle-kilometre. 1986=1.00. The dotted line is a weighted average of the seven cities.*

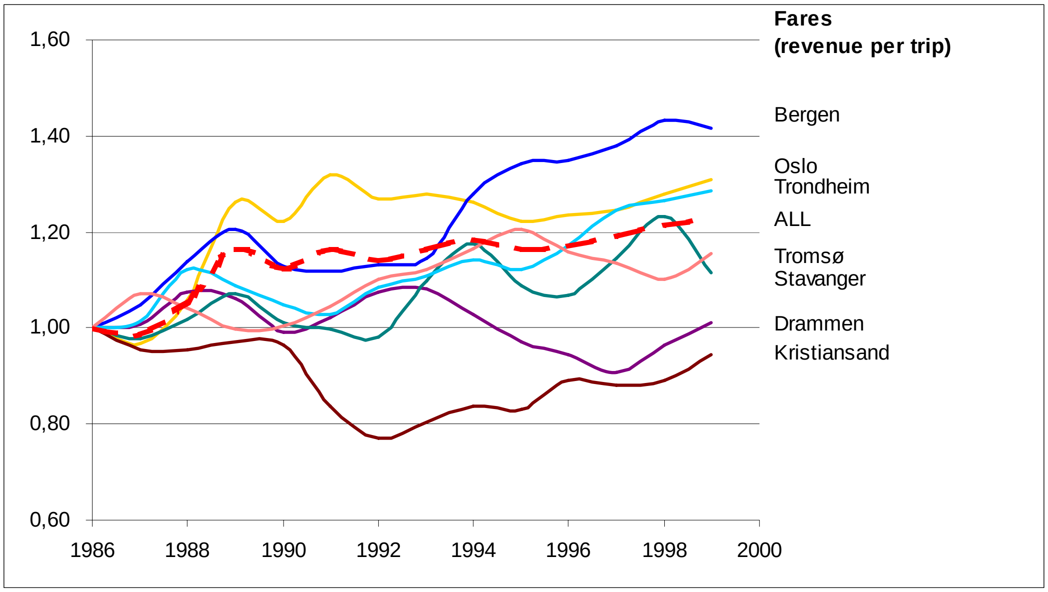


*Figure A.3: Trends in fare levels, calculated as total fare box revenues divided by number of passengers. 1986=1,00. The dotted line is a weighted average of the seven cities*

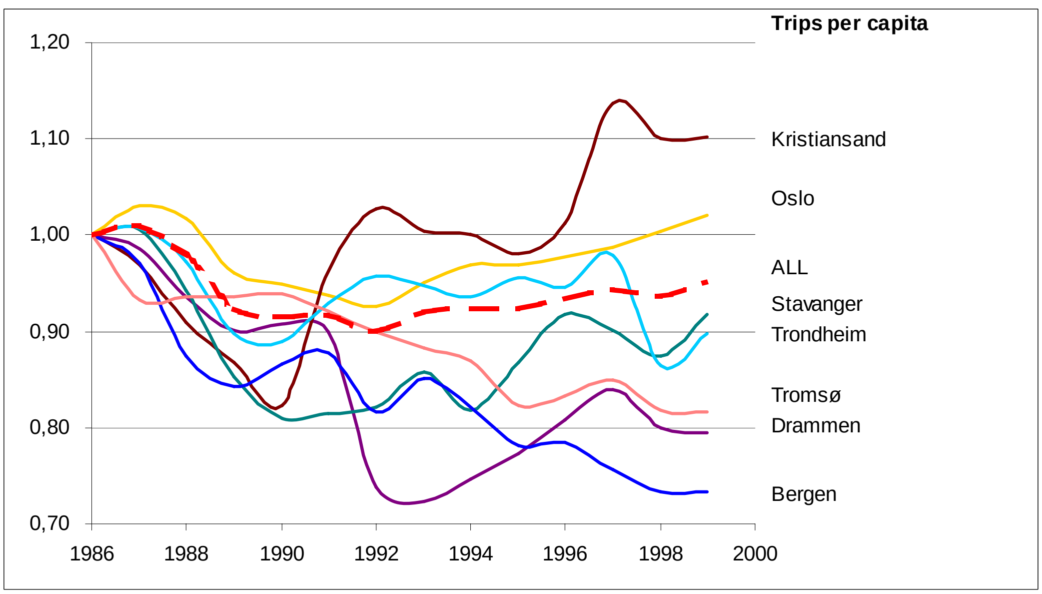


*Figure A.4: Passenger trips per capita. 1986=1,00. The dotted line is weighted average of the seven cities*