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*Authors: Kjell Werner Johansen and Bård Norheim**
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Summary:

Output-based funding of urban public transport

Model-simulation of alternative incentives and financial framework

Background

In many Norwegian urban areas public transport receives decreasing amounts of subsidy. This is partly due to reduced transfers from the central government to the county authorities, increased use of efficiency agreements, and the threat to operators of tendering their services. At a national level public transport subsidies have fallen by about 1.2bn NOK (1997 prices) over the period 1986 to 1997. This is a reduction of about 43% (Norheim and Carlquist 1999).

Comparing subsidy levels in Norway with the rest of Europe it seems that the Norwegian operators have relatively limited financial freedom. An extensive survey of public transport services in 140 European cities has shown that the average subsidy levels in Europe are 49% for bus and 63% for railway services (ISOTOPE, EU 1997). In Norway subsidy levels for bus are around 25%. This rank Norway nearly lowest in Europe. Only in Spain and Great Britain are subsidy levels lower than in Norway.

Challenges for public transport in Norway

A main challenge in the larger urban areas in the years to come will be to keep, or increase, the public transport modal shares. This has to be obtained by reducing the growth in private car use, which represents considerable costs to the society in terms of congestion, noise, air pollution and accidents. It is therefore important that an efficient public transport service be provided in order to offer the best services possible with the available resources.

The great challenge ahead will not be to provide the cheapest services possible, but to develop the best possible public transport services that can compete with the private car within the budgetary constraints. This needs to be developed over time.

At the same time the public transport sector must continue its product development in order to retain its market share. According to an analysis of the development of public transport in the 10 largest urban areas the number of passengers will decline by 1.6% per year (Norheim and Renolen 1997) if service levels do not improve. There are, however, significant differences between the urban areas, and the least negative trends are in the larger urban areas.

The report can be ordered from:
Institute of Transport Economics, PO Box 6110 Etterstad, N-0602 Oslo, Norway
Telephone: +47 22 57 38 00 Telefax: +47 22 57 02 90

There are many reasons for this declining trend. Increased car availability, increasing numbers of driving licences, changes in travel patterns, dwelling and business locations have all contributed to reduce the attractiveness of public transport. Further, the highly improved comfort of cars and bicycles have brought about demand for improved quality and comfort on public transport as well. Therefore, public transport in larger urban areas is exposed to fierce competition and is completely dependent on a financial framework that allows for product developments.

The question of how public transport should be organised and financed in the future is therefore primarily a question of what organisational structure is best suited to meet the main objectives of the public transport provision in the region. What may reduce subsidy requirements in the short run may be of little interest if it at the same time is an obstacle to continued product development or product co-ordination. The choice of organisational structure is therefore to a large extent a question of choosing a strategy for developing public transport services in the short and in long run.

The main objective of this report is to explore to what extent it is possible to "club together" ordinary subsidies and extraordinary fines that together provide incentives for an optimal and economically efficient urban transport policy. It is thus implicitly assumed that the current funding system cause inefficiency in the transport sector not just because of the size of the transfers but also because of the actual funding *system.*

A discussion of alternative systems is therefore not only a question of how to identify possible funding sources for increased focus on public transport. It is also a question of whether the funding system encourages efficient use of the resources that are available for public transport operation. *This means that even when an optimal public transport solution requires increased levels of subsidies this will not necessarily be obtained by merely increasing the transfers.* The main challenge, therefore, lies in the design of the structure of incentives, and at all levels. It is not so much a question of the appropriate absolute level of subsidies. Therefore this report takes the following approaches:

1. What problems and challenges are most deficient with the current funding system?
2. Are there economic benefits from increased focus on public transport?
3. To what extent can the local extraordinary fines influence choice of fleet size and specification, and thus the investment needs?
4. To what extent can the funding system provide incentives for a more cost efficient operation?

Methodology

A main problem in the discussion of alternative funding systems is the lack of reference points or measuring scales in order to assess and compare the individual systems. In other words it is difficult to evaluate alternative funding systems consistently before a method for this has been developed.

The objective is to identify a funding system that provides a best possible allocation of the resources that go to the transport sector, and which also facilitates efficiency testing against other sectors.

An optimal urban public transport provision may require considerable financial support from the public. However, public funds must be financed through taxation. There are costs associated with this: Direct costs of the tax collection; and indirect costs of misallocation of resources in the society. These costs have been estimated on several occasions. The official recommendation is to use a shadow price of 20% on public funds (NOU nr 1998:16). In principle these costs also occur when public funds are reallocated. We have therefore used a shadow price of NOK 1.20 for each NOK 1.00 of subsidy in our estimates.

In real life there may be many practical constraints to the theoretical solutions. Therefore, a first-best solution is usually only a theoretical calculation. Budget constraints and limited ability to adjust mean that in real life second-best solutions have to be sought. The main challenges in our analyses lie in the fact that they are bases for the calculations of these second-best solutions. These could be, e.g.

- **Limited opportunities to transfer funds between budgets.**
  Tight budgets in the county councils limit the amounts of subsidy increases that are possible, despite the fact that it may be beneficial in economic terms.
- **Limited opportunities to set fares:**
  The attention that the fare levels receive in the public reduces the number of feasible fare levels. This concerns both the fare structure and the fare relative to the cost of other transport modes.

Such constraints can be included in the optimisation problem. The task is then changed to: *"maximise the net social benefit, subject to different financial constraints, for example a maximum level of subsidy or an upper fare limit etc"*. We can then also estimate the marginal economic value (cost) of that constraint. This value can be interpreted as the social benefit of increasing subsidies by one unit.

The estimates for the three urban areas are made with slightly differing assumptions, but with the same approach, namely to minimise the resource use. Resource use is defined as,

- generalised costs for public transport users, consisting of
  - fare
  - walking time to the bus stop
  - total waiting time
  - in-vehicle time
- profitability, which depends on
  - operating costs
  - fare revenues, which depends on service levels and fare levels
- External costs of car use
- Tax collecting costs

The various models for financing will be evaluated according to the criterion for optimal allocation of resources. This is an important criterion for the authorities in order not to waste the public funds that go to public transport. For the travellers this is important because it makes sure that they receive the best service possible given

the limited resources available, and because it allows for a trade-offs between service levels and fares. At the same time this criterion assures that the same requirements of profitability are required in the public transport sector as it is in other transport sectors.

The requirements of economic efficiency implies that we will explore the possibility of a funding system that maximises net social benefit given the level of transfers to public transport, i.e., a system which at the margin gives costs equal to benefits. Our study focuses on three urban areas, *viz.* Oslo, Bergen, and Kristiansand. The analyses go through three steps:

1. **State of affairs and challenges ahead**
   How is public transport developing in the three urban areas, and to what extent are the organisational and the financing structures an obstacle for an optimal development?
2. **Model estimations**
   To what extent is it possible to make analyses of an optimal public transport service level in these urban areas, and what level of funding will it require?
3. **Constrained optimisation**
   To what extent are the optimal public transport solutions dependent of external conditions, like road pricing, and fare levels and subsidies to public transport?

State of affairs and recent developments

The historic trends in subsidy levels for the three urban areas, in addition to the cities Tromsø and Thondheim, are analysed. Between 1987–97 subsidies in these urban areas fell from NOK 1.15 bn to NOK 0.55 bn in 1997-prices (Table S.1). In 1997 subsidies covered 8%, 4%, and 11% of the costs in Bergen, Trondheim and Tromsø, respectively.

Table S.1: Public transport subsidies in selected urban areas in 1987 and 1997. NOK millions, 1997-prices

	1986		1997		Difference 1986-97	
	Subsidy	% of costs	Subsidy	% of costs	Subsidy	Relative change
Oslo	821	50	468	31	-353	-43%
Bergen	154	28	39	8	-115	-75%
Trondheim	126	59	6	4	-120	-95%
Kristiansand	18	20	28	27	10	58%
Tromsø	26	25	12	11	-14	-54%
Sum	1145		553		-592	-52%

Source: Carlquist and Norheim 1999

As subsidies fall the operators are forced to operate more cost efficiently. Looking at the changes in costs per vehicle-kilometre between 1987 and 1997 we see that Oslo, Trondheim, and Kristiansand have improved cost efficiency by more or less the same relative amount, just over 20% (Carlquist and Norheim 1999). Operators in Bergen have improved cost efficiency by more than 10%, and Tromsø has had unchanged costs despite huge cuts in subsidies. There are large differences between the operators in Bergen, and also between the urban and the regional services in Tromsø.

Even though we should not compare subsidy levels between these urban areas it is interesting to note that cost efficiency in Kristiansand, despite subsidy increases, has improved at the same rate as Oslo and Trondheim. This indicates that the process of improving cost efficiency cannot solely be explained by reduced subsidies. Firstly, there are reasons to believe that there is a "natural" process of efficiency improvement within the industry, e.g. caused by competition from the private car, better route planning tools, and improved right of access on the road network. In addition there may have been an indirect incentive to improve efficiency through the threatening competition and efficiency agreements.

The extent to which the reduced subsidy levels have contributed to economic efficiency gains depends on the share of the reductions that are paid by other parties than the operators and the authorities. Our analyses from the five urban areas show that there have been considerable efficiency gains in the industry, but that the improved efficiency has not been sufficient to justify the size of the cuts in subsidies. This means that parts of the cuts have been financed through increased fares. This is not an economic benefit but a mere transfer of incomes. Additionally, the increased fares will reduce the number of passengers and increase car use. This must also be included in the economic assessments.

Table S.2: Economic effects of changes in the public transport industry[1]. Million NOK 1997-prices

5 urban areas	**1986-92**	**1992-97**	**1986-97**
Change in subsidy	-462	-129	-592
Costs of increased road traffic	45	32	77
Costs for passengers			
Change in travel time	-19	-12	-31
Reduced frequency	-	33	33
Increased fares	251	96	347
Net saving	-185	20	-166
Net saving, %	40	-16	28

[1] Negative figures represent economic gains, and positive figures represent economic losses.

Source: Carlquist and Norheim 1999.

A joint evaluation of the 5 urban areas shows that of a cut in subsidies of NOK 592m annually the net saving is only NOK 166m (28%) when we correct for increased costs for other market players (Table S.2). This means that about 72% of the cuts are paid by other parties; NOK 77m (13%) because of increased road traffic and NOK 347m (59%) in increased fares. Therefore, in addition to the fact that reduced subsidies have caused a reduction in passenger numbers of around 7%, the remaining passengers are faced with fares that are 24% higher than they would have been without the cuts. A substantial part of the cuts in subsidies are thus borne by passengers. This weakens public transport ability to compete with the car, and in the long run this will cause further reductions in passenger numbers.

Public transport must develop a more market oriented service

A public transport service that focuses more on passengers' benefits and gains accruing from reduced car use, is different from what we see in today’s services.

This is mainly due to the fact that that journey times are given more importance, but also because operators must adjust their fleets to the local demand.

Our analyses of the public transport markets indicate a need for increased frequencies and a more differentiated bus fleet. There is a need to develop a wide range of public transport services, from taxis and dial-a-ride services, mini/midi buses, to ordinary and articulated buses. This promotes good use of resources, as well as it provides operators with possibilities to increase frequencies within their budget constraints.

It is not clear how great the potential for saving is. This is because the prices of different buses vary, and because small buses are not necessarily cheaper than the bigger ones. The results that concern fleet size must therefore be regarded as indications of direction of change rather than absolute numbers. The conclusion of our analyses suggests that the present size of the bus fleets ideally should be halved on average. That is, a larger share of the bus fleets should be smaller in order to adjust to the local demand. At the same time frequencies should increase so as to increase total capacity. An exception is Kristiansand, whose off peak capacity is reduced by 26%, but the peak capacity should be increased by 14%. The other urban areas should ideally increase capacities by 6% to 23%.

Subsidy increases give economic benefits in these urban areas

Both increased supply and reduced fares will increase passenger numbers, but will also require more subsidies. The analyses indicate that there is a good potential for passenger growth in these urban areas. An optimal service level may increase passenger numbers by 16% to 32%, and the biggest growth potential is in Kristiansand. This will, however, require a doubling of subsidies in Kristiansand and a triplication in Bergen, whilst in Oslo it is possible to increase passenger numbers by 16% with the current subsidy levels. This must be seen in relation to the large cuts in subsidies over the past few years, and the fact that subsidy levels are very low compared with the rest of Europe.

This illustrates the entrapment of public transport finances – the fact that county councils cannot afford subsidy increases of this scale, at the same time as fare increases of 50% are not politically feasible in Oslo. Even though solutions like this would bring about economic gains of a total NOK 400m in these urban areas it will not be possible to raise the necessary funds within the prevailing organisational structure.

These figures illustrate the current situation with enormous pressures on yielding good returns. In Bergen and Kristiansand an extra unit in subsidies would yield 1.30 to 1.60 units in benefits at the margin, provided that the subsidies will finance an optimal service. If subsidies were reduced to nothing then a marginal increase would yield 3 units of benefit. This marginal return to subsidies is, however, diminishing. If subsidies are increased to an optimal level then the average return would be 0.70. This is also a high return compared to other transport investments.

Increased subsidies must not become pretexts for doing nothing

Even if our analyses show great returns from increased transfers to public transport in these three urban areas, it does not mean that increased subsidies will improve services automatically. This depends critically on the way the subsidies are given and on the operators' freedom to adjust fares and services. Our analyses show that necessary conditions for success are specific requirements for the returns from the transfers, and that the operators will face the threat of competition if they fail to deliver the defined targets (Norheim and Johansen 1998, Carlquist et al. 1999, Johansen and Norheim 1999). At the same time the operators must be granted more freedom to allocate their resources in order to meet the targets.

We have calculated the amount of output-based subsidy that is needed in order to achieve economically optimal services (Table S.3). This is a funding system where operators are given net contracts in which they are responsible for the revenues themselves and in addition they receive a subsidy that depends on mileage and the number of passengers. We have modelled how profit maximising operators will adjust to this funding framework. A funding model like this implies that operators will aim at maximising their revenues through more cost efficient operations and increased numbers of passengers. In other words, the funding model combines internal and external targets for efficiency improvements, i.e., productive efficiency and market efficiency.

Table S.3: Examples of output-based subsidies in the three urban areas that combine socio-economic and business economic optimal supply. Subsidy of NOK per vehicle-kilometre and per passenger, in addition to an annual deduction.

		Bergen	Oslo	Kristiansand
Vehicle-kilometre				
Basis	NOK/veh.-km	10	11	8
Extra efforts	NOK/veh.-km	18	20	15
Passengers				
Basis	NOK/passenger			8
Peak travel	NOK/passenger		4,5	15
Fixed deduction	NOK million / year	110	250	64
Cost per passenger	NOK/passenger	16	18,2	14

Source: Norheim and Johansen 1998, Carlquist at al. 1999, Johansen and Norheim 1999.

Possibilities for clubbing together for increased focus on public transport

Our analyses show that a transition towards output-based subsidies may yield considerable benefits to the society. At the same time there are financial barriers to achieving these benefits. This applies both to the tight budgets in county councils, the lack of co-operation between funds made available for investments and for operation, the lack of road pricing, and the way the current school transport is organised. All these circumstances limit the effect of introducing output-based subsidies. It is therefore necessary to regard the different financing regimes as one, and to introduce incentives that may break these barriers.

It is not necessary to introduce full-scale road pricing order to obtain the effect that is outlined above. The main problem is, according to our estimates, the financial

constraints that the county councils face, which makes an increased focus on public transport impossible to support financially. The question is, therefore, whether a solution can be found, which lies between the current situation and a situation with road pricing, which may trigger a process towards a better public transport.

We have studied the consequences of a "Dutch treat" where the output-based subsidies are combined with car levies and transfers of public funds. This is not a model with full-scale road pricing but an alternative where we explore what taxes are necessary to finance the increased subsidy levels. The analyses are based on the following assumptions:

- Fares are kept at today's level, and operators are given the responsibility for their revenues, and possible financial risk
- In addition output-based subsidies per vehicle-kilometre and passenger during off-peak
- The operators are free to adjust their service levels and bus fleet within their budgets
- A peak road user charge of NOK 2 that finance the development of public transport and other environmentally friendly means of transport.
- The central government makes extraordinary transfers that are earmarked for output-based compensations. In these estimates we have calculated NOK 4 for each new passenger. This lies below the average subsidy per passenger that is reported in the Public Transport statistics for 1997.

We have optimised the public transport supply within these new external conditions. According to our estimates this will yield a service level where the number of bus departures are increased by about 50%, and about 80% in the peak. The optimal level of service implies smaller vehicle sizes and hence less resource use and emissions per passenger. This is a long-term adjustment, and as mentioned above, only a measure for average fleet sizes. This is, however, an important economic and environmental effect of output-based contracts. In total, peak hour capacity will increase and off-peak capacity will decrease, according to the estimates.

The effects of this kind of funding, where the output-based incomes motivates operators to improve their services, is an increase of 28% peak and 19% off-peak passengers. Additionally it will take 7–11% of the cars off the road, of which 3% is the effect of increased road taxes, and 4–8% are due to public transport improvements. This is not a radical reduction in the number of car journeys but it is important for the capacity of the road network and for the need for further road development.

This increase in supply requires increased transfers totalling NOK 19.1m compared to the current level. Additionally, the toll road revenues and passenger-related subsidies from the central government will increase by about NOK 14m. County councils must cover the remaining NOK 5m. In total this will yield an economic benefit of about NOK 30m annually. This is mainly made up of user benefits, but there are also considerable non-user and external benefits.

Our estimates show that the central government can initiate a process that provides huge benefits relatively easily. Such a funding system will reward the areas that succeed in developing more attractive public transport services. The more local efforts in terms of funding and road user charging the more can be extracted from the central government. Firm knowledge of the market and good planning will be required in order to gain from this new regime. And for the central government it should not be necessary to audit the appropriateness of individual schemes. Contributions from the central government will only be released if schemes are successful. The financial risks of an unsuccessful scheme are assigned to operators and local authorities. We believe that this is a solution that provides a rational allocation of responsibilities and resources for the development of the public transport in these urban areas.