SIMULATION ANALYSIS OF BUS TRAIN AND PRIVATE TRAIN COMPETITION IN SWEDEN

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1 INTRODUCTION

During the last five years a number of new policy measures have influenced Swedish passenger transport. In 1989 the Swedish national state-owned railway operator, SJ, was separated into a national state-owned track authority (Banverket, BV) and a state-owned operator SJ. The Swedish air industry was deregulated on January 1st 1992, and on 1st of January 1993 the Swedish coach industry was partially deregulated.

These policy changes led to increased competition between long-distance public transport modes. However, the Swedish Railways, SJ, still has a monopoly for rail passenger transport.

Over the last two years a Swedish Parliamentary Transport and Communications Committee has been working on a new transport policy. On behalf of this committee the Swedish Institute for Transport and Communications Analysis, SIKA, has carried out a number of studies. These studies were aimed at assessing how policy changes over the last years have affected the efficiency of the transport system and what type of measures could be part of a new transport policy. Sections 2 to 4 of this paper present part of this work, with the purposes:

- To analyse how the present transport policy has affected consumers and producers.
- To discuss various measures which may improve the efficiency of the transport system.
- To assess the economic consequences of new measures.

Section 2 describes the general prerequisites and assumptions. Section 3 describes the development of passenger transport in Sweden, in terms of how passengers and producers are affected and in terms of welfare. In section 4 we analyse the consequences of possible measures which may be welfare improving.

Regarding rail, the government has, however, put out for tender the construction and maintenance of a new exclusive shuttle train line from central Stockholm to Arlanda airport, without any direct connection to the existing state rail network. The winning private consortium finances only part of the rail line but receives all its revenues. The new rail line will probably experience competition from both SJ and bus services operated by the regionally owned public transport company (SL). This competition is the theme of cection 5, a study which was carried out as part of EU DGVII research projects.

In section 6 we give some concluding remarks.

2 PREREQUISITES AND ASSUMPTIONS

2.1 Basic analytical method

Basically we regard the passenger transports as a system, where passengers can choose among lines and operators and where a single journey may involve several lines and operators. The method used is therefore a route-network-analysis package, Vips. Some properties of this package are described in the appendix.

In this analysis we assume that:

- Operators compete without regarding the modes as being complementary.
- Passengers regard the modes as alternatives, but also as being complementary.
- Passengers are not homogenous, but have different preferences and face different prices.

For each measure we calculate:

- Demand for each public transport mode and service
- Consumer surplus nationally
- Consumer surplus by region (county level)
- Revenues and costs for each operator
- External effects and taxes
- State finances and excess burden
- Total welfare

Whereas the modal split between public transport modes is calculated within the Vips-system, we use an elasticity model for the split between public transport and car. The elasticity with respect to price is assumed to be -0.8, and the elasticity with respect to generalised cost is proportional, that is -0.8 times generalised cost over price.

The Swedish Transport and Communications Committee has proposed to increase the price of petrol by SEK 0.1 (appr. 1 penny) per year during 23 years. It is assumed that technological improvements and possible regulations will decrease the fuel consumption per kilometre, in which case we assume that the price of car travelling remains unchanged. Since no other policy measures have been proposed with respect to car, we have concentrated on public transport.

2.2 User categories and time values

We take into account that various passenger categories have separate valuations of price, travel time and comfort. These differences are reflected in separate values of time per category. We use one set of time values for the overall national analysis and a slightly different set for the analysis of rail/coach competition between the two cities of Karlstad and Gothenburg, where the travel distance is below average. In the tables below the weights for ride (in-vehicle) time, wait time, transfer time and walk time are related to ride time for InterCity train. The weights which reflect the perceived convenience of various categories for each mode according to stated-preference studies are summarised in the tablee below.

	Share pax	Time value ride time (train) SEK/hour	Weight for wait time	Weight for transfer- and walk time	Ride time weight IC-train	Ride time weight X2000	Ride time weight coach	Ride time weight air
Private journeys								
Working, high value	0,20	105	0,40	2,0	1,0	0,9	1,50	1,1
Working, low value	0,50	80	0,40	2,0	1,0	0,9	1,50	1,1
Students Pensioners	0,30	30	0,20	2,0	1,0	0,9	1,50	1,1
Business journeys	1,00	140	1,0	2,0	1,0	0,9	2,50	2,5

Table 1: Time values and weights for the national network

	Share pax	Time value ride time (train) SEK/hour	Weight for wait time	Weight for transfer- and walk time	Ride time weight train	Ride time weight coach
Private journeys						
Working, low value	0,54	60	0,30	2,0	1,0	1,50
Students	0,32	22	0,13	2,0	1,0	1,50
Pensioners	0,14	22	0,13	2,0	1,0	1,50
Business journeys	1,00	140	1,0	2,0	1,0	1,50

Table 2: Time values and weights for Karlstad-Gothenburgstudy

2.3 Responses and costs with respect to demand changes

Since various measures would cause increased or reduced demand for certain lines and operators, the operators would have to respond in one way or the other.

Here we assume that train supply can always be modified by the introduction/removal of carriages per train. The reason is that Swedish trains seldom use the maximum number of carriages permitted.

For air we assume that the response would be either change in aircraft size or change of service frequency, where service frequency change is only applied when demand changes by more than 10 per cent. Change in frequency is however used for the calculation of user benefits. We assume that air and coach costs change in proportion to 70% of the demand change.

2.4 Uncertainties

Note that all results presented are based on calculations which have some degree of uncertainty. One cause of uncertainty is the travel matrix, which is a hybrid of a synthetic matrix and a matrix based on a national survey. Another cause of uncertainty is the insufficient information provided by the operators on actual passenger loads, which are used for calibration of the model.

3 DEVELOPMENT OF PASSENGER TRANSPORT IN SWEDEN

First we describe the calculated travel standard for the transport system for the base year 1996.

Then we present our calculations of the impact of price and service level changes for air, rail and coach respectively, between the years 1992 and 1996. We do this by comparing the performance of the air, rail and coach system in 1996 with, in turn, the air system in 1992, the rail system in 1992 and the coach system in 1992 respectively. For each mode we first show a background and then the calculated results in terms of modal split, effects on consumers (generalised cost and consumer surplus) and welfare.

3.1 Travel standard

Travel standard is expressed in terms of generalised cost per journey, that is price plus weighted travel time converted into monetary units.

The diagram below illustrates the generalised cost per journeyfor private travellers with the assumed time value SEK80/hour, for journeys to and from each county in Sweden. Corresponding diagrams for other passenger categories show more or less the same regional distribution of travel standard.

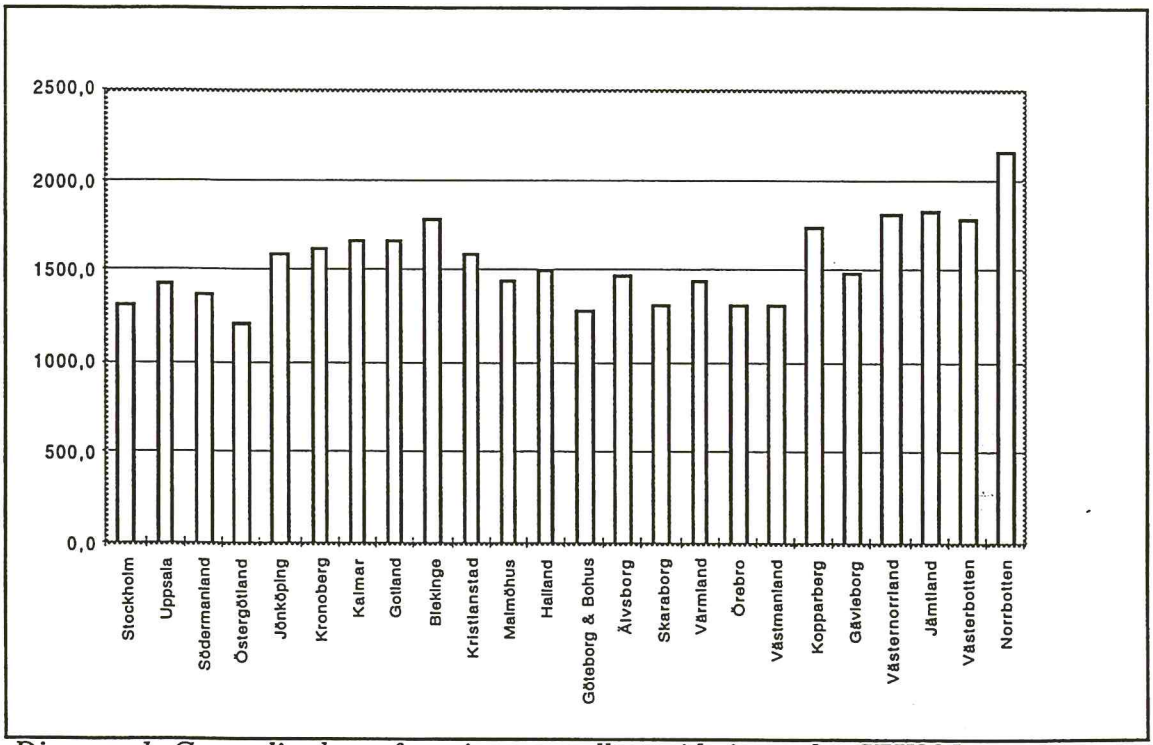

Diagram 1: Generalised cost for private travellers with time value SEK80/hour.

The counties in the north of Sweden (to the right in the diagram) have the lowest travel standard (highest generalised cost), which is understable due to the long distance and relatively low service frequency. Stockholm does not have the highest travel standard even though the service frequency is easily the highest in Sweden. The reason is that journeys to and from Stockholm tend to be fairly long, since Stockholm is a popular destination for travellers from most parts of Sweden.

3.3 Air - Development 1992-1996

Background

The Swedish air industry was deregulated January 1st 1992. Since then the largest operator, SAS, has experienced competition from various other operators. Total supply has been reduced by 10% between 1992 and 1996 in terms of departures and by 3% in terms of aircraft kms, while SAS has decreased its supply by around 25%. The prices have been reduced for full fare tickets (business travellers) and increased for discount fares (private travellers)

Modal split

The development of air transport seems to have affected the demand for the high speed train X2000 negatively and InterCity train positively, probably due to the lower air fares for business travellers.

	Air, rail, coach 1996 Million. pass. km	**Share** %	**Air 1992; rail, coach 1996** Million. pass. km	**Share** %
X2000	573	6,8	703	8,4
Night train	1103	13,1	1031	12,2
IC-train	3605	42,8	3403	40,4
SAS	1987	23,6	2501	29,7
Other air	881	10,5	516	6,1
Coach	278	3,3	263	3,1
Total	8429	100,0	8418	100,0

Table 3: Calculated modal split (in passenger kms and shares), due to the development of air operation

Consumers

Business travellers have gained while private travellers have lost according to the model analysis (see table below). Note that business travellers have lost a little in terms of travel time but gained more in terms of fare. Low income (low value of time) private travellers have lost very little, which is explained by the fact that they use air transport very little.

	Business 140 SEK/h	**Private** 105 SEK/h	**Private** 80 SEK/h	**Private** 30 SEK/h	**Sum**
Generalised cost, SEK (%)	32(1,9%)	-23(-1,8%)	-17(-1,6%)	-1(-0,2%)	
Consumer surplus, mkr	240	-74	-131	-4	31
of which fare	260	-18	28	16	286
of which time	-20	-56	-159	-19	-255

Table 4: Calculated change in generalised cost and consumer surplus per category, due to the development of the air operation.

Welfare

The net benefit is close to zero, which means that the dominating effect is redistributional.

3.4 Rail - Development 1992-1996

In 1989 the Swedish national state-owned railway operator, SJ, was separated into a national state-owned track authority (Banverket, BV) and a state-owned operator SJ. The railway has been characterised by productivity improvements and heavy investment in high-speed trains (X2000). The supply in terms of train kms has increased by 5% between 1992 and 1996, of which X2000 has increased by 17%, while night trains supply has decreased by 5% and InterCity trains by 3%.

Modal split

The most noticeable effect of rail development is the demand shift from InterCity trains to X2000. Air and coach seem to have gained a little demand, probably due to the decreased supply of InterCity trains.

Mode	Air, rail, coach 1996 Million. pass. km	Share %	Rail 1992; air, coach 1996 Million. pass. km	Share %
X2000	573	6,8	183	2,2
Night train	1103	13,1	1102	13,1
IC-train	3605	42,8	4048	48,0
SAS	1987	23,6	1970	23,4
Other air	881	10,5	870	10,3
Coach	278	3,3	262	3,1
Total	8429	100,0	8435	100,0

Table 5: Calculated modal split (in passenger kms and shares), due to the development of rail operation

Consumers

According to the model analysis, primarily low-income private travellers have lost in terms of generalised cost. The reason for the losses is the diminished supply of the relatively cheaper InterCity connections and their replacement by higher priced X2000-trains.

	Business 140 SEK/h	Private 105 SEK/h	Private 80 SEK/h	Private 30 SEK/h	Sum
Generalised cost, SEK (%)	-1,9(-0,1%)	-7,2(-0,6%)	-5,6(-0,5%)	-4,4(-0,9%)	
Consumer surplus, mkr	-14	-23	-44	-21	-102
of which fare	-110	-26	-33	-8	-178
of which time	96	3	-11	-13	76

Table 6: Calculated change in generalised cost and consumer surplus per category, due to the development of rail operation.

Welfare

The net benefit is minus SEK150 million per year. The dominating effects are redistributional.

3.5 Coach - Development 1992-1996 - national level

On the 1st of January 1993 the Swedish coach industry was partially deregulated. This means that the "burden-of -proof" concerning "damage of the railway" has been reversed. SJ must now in principle prove that a new coach line will seriously harm the profits of the railway operation. The supply in terms of coach kms has increased by 39% between 1992 and 1996.

Modal split

According to the model analysis, the choice of mode seems to have changed very little following the partial deregulation of the coach industry.

	Air, rail, coach 1996 Million. pass. km	**Share** %	**Coach 1992; rail, air 1996** Million. pass. km	**Share** %
X2000	573	6,8	577	6,9
Night train	1103	13,1	1105	13,2
IC-train	3605	42,8	3669	43,7
SAS	1987	23,6	1992	23,7
Other air	881	10,5	887	10,6
Coach	278	3,3	170	2,0
Total	8429	100,0	8400	100,0

Table 7: Calculated modal split (in passenger kms and shares), due to the development of coach operation

Consumers

The dominating effect is that low-income travellers have gained, since the gain in price is larger than the loss in terms of travel time.

	Business 140 SEK/h	**Private** 105 SEK/h	**Private** 80 SEK/h	**Private** 30 SEK/h	**Sum**
Generalised cost, SEK (%)	0,5(0,0%)	1,8(0,1%)	2,3(0,2%)	2,6(0,5%)	
Consumer surplus, mkr	3,5	5,5	17,8	12,2	39,0
of which fare	3,7	4,7	18,9	22,1	49,4
of which time	-0,2	0,8	-1,0	-9,9	-10,4

Table 8: Calculated change in generalised cost and consumer surplus per category, due to the development of coach operation.

Welfare

The net benefit is close to zero, which means that the dominating effect is redistributional.

3.6 Coach - Development 1992-1996 for Karlstad - Gothenburg

Background

From the 1950´s until September 1995, SJ and the SJ-owned coach operator Swebus were, under the old regulations, the only operators between the cities of Karlstad and Gothenburg.

Under the new regulations a new coach operator entered the market - Säffle Rese Service (SRS). They charged a price that was about 40% below Swebus, which in turn caused Swebus to respond by setting a price slightly below SRS´s.

In April 1995 SJ responded by decreasing it´s fare by 40%.

We will analyse these situations as well as three hypothetical ones. The first is that SJ is assumed to reduce the number of departures while the coach operators increase their departures. The second situation is that SJ is assumed to close down their operation completely. The third situation is that the coach operation is assumed to cease entirely, while SJ is assumed to maintain their low fare in order to keep out competition.

The table below summarises the cases, indicating number of departures and prices for three categories of private travellers. Note that the price of 1st class tickets are assumed to be unchanged, which they have done throughout the "price war".

Situations		round trips/ weekday	Fare Gothenburg-Karlstad, SEK Working	Students	Pensioners
Actual cases					
6 trains, 3 coaches	SJ	6	208	143	143
(till 9/95)	Swebus	3	185	95	95
6 trains, 5 low-price coaches	SJ	6	208	143	143
(from 9/95)	Swebus	3	95	76	76
	Säffle	2	100	80	80
6 low-price trains, 5 low-price coaches	SJ	6	135	95	135
(as present, from 4/96)	Swebus	3	95	76	76
	Säffle	2	100	80	80
Hypothetical cases					
4 low-price trains, 8 low-price coaches	SJ	4	135	95	135
	Swebus	5	95	76	76
	Säffle	3	100	80	80
only 20 low-price coaches	Swebus	10	95	76	76
	Säffle	10	100	80	80
only 6 low-price trains	SJ	6	135	95	135

Table 9: Situations for Gothenburg - Karlstad

Results

Consumer surplus

The present situation seems to be the best one from the users´ point of view. See table below.

...compared with present situation	Business	Working	Students	Pensioners	total
6 trains, 3 coaches	-2,3	-3,3	-0,8	-1,8	-8,2
6 trains, 5 low-price coaches	-1,8	-2,6	-0,7	-0,3	-5,3
4 low-price trains, 8 low-price coaches	-7,6	-2,3	0,1	-0,1	-9,9
only 20 low-price coaches	-12,1	-7,7	-0,5	-0,1	-20,4
only 6 low-price trains	-0,4	-0,5	-0,7	-0,5	-2,1

Table 10: Change in consumer surplus for each situation, in million SEK per year.

Producer surplus

The situation during the original regulations was the most profitable entirely. Note that the profit by SJ is actually highest if the train service was abandoned. This reflects the fact that this train operation according to the model assumptions is not profitable either during the original regulations or in the present situation.

	Revenues minus costs			
...compared with the present situation	SJ	Swebus	SRS	total
6 trains, 3 coaches	5,3	-0,3	0,4	5,4
6 trains, 5 low-price coaches	0,2	0,8	1,1	2,1
4 low-price trains, 8 low-price coaches	5,6	-1,4	-0,5	3,9
only 20 low-price coaches	6,1	-3,9	-0,1	2,5
only 6 low-price trains	3,3	1,8	0,3	5,2

Table 11: Calculation of revenues minus costs, in million SEK per year

Welfare

The analysis shows that the worst situation would be that SJ decides to cease operation, leaving all operations to the coach operators. The reason is that the users, especially business travellers and high value of time private travellers, would lose the option of taking the train which is faster and has a lower value of time than coach.

The best situation seems to be where SJ is the only operator. Note, however, that this situation is hardly sustainable. If SJ were left alone it would be unlikely that they would keep the low price level, since the higher price level yields a higher profit.

...compared with the present situation	Consumers	Producers	External effects	Taxes, excess burden	Sum
6 trains, 3 coaches	-8,2	5,4	0,3	1,1	-1,4
6 trains, 5 low-price coaches	-5,3	2,1	-0,9	1,4	-2,7
4 low-price trains, 8 low-price coaches	-9,9	3,9	1,3	-0,4	-5,1
only 20 low-price coaches	-20,4	2,5	-0,3	1,6	-16,6
only 6 low-price trains	-2,1	5,2	1,4	-0,5	4,0

Table12: Calculation of welfare, in million SEK per year

3.7 Conclusions concerning the development over the last years

- The development of air is fairly neutral from an aggregate welfare point of view, but business travellers have gained and private travellers have lost.
- The development of rail is neutral from an aggregate welfare point of view, but business travellers have gained and private travellers have lost. The main reason is that supply of the cheaper-ticketed InterCity trains has gone down.
- The development of coach is neutral from an aggregate welfare point of view, but low income (low value of time) private travellers have gained, while SJ has lost a little revenue.
- Coach deregulation suffers from two problems: it is not easy to prove harm and it is only harm to the operator, not to the passengers, which is considered.
- Increased coach competition is considered to be predominantly positive from a welfare point of view, partly due to the pressure it puts on SJ to increase convenience and reduce prices. However, this competition may in certain cases imply that SJ would cease to operate lines which become non-viable from a profit point of view even if they are motivated from a welfare point of view.

4 ANALYSIS OF POSSIBLE MEASURES FOR A NEW POLICY

4.1 Introduction

The measures we analyse are the following:
- Internalisation of external effects throgh taxation on a vehicle kilometre basis.
- Reduced prices for 2nd class train journeys, via subsidies.
- Combination of internalisation and price decreases of 2nd class train journeys.

For what concerns internalisation, it is assumed that tax revenues are used for reducing other taxes, something which in turn reduces excess burden.

SIKA has analysed internalisation based on three levels of carbondioxide valuation:

CO_2 is valued at SEK0.38 /kg, which corresponds to the tax in 1997.
CO_2 is valued at SEK0.83 /kg.
CO_2 is valued at SEK1.17 /kg.

We present here only results for the middle level: SEK 0.83/kg.

The following table shows the valuation of external effects, tax in 1996 and the necessary tax increase to make the tax equal to the cost.

	Internalisation 0.83 **External cost** SEK/veh.km	**Tax 1996** SEK/veh.km	**Tax increase** SEK/veh.km
Train	5,60	3,80	1,80
Air	11,00	4,20	6,80
Coach	1,92	0,78	1,14
Car	0,31	0,35	0,04

Tabell 13: Internalisation at the level SEK 0,83 /kg CO_2

Marginal costs for rail operation are relatively low due to large economies of scale, especially where it is possible to accommodate demand by more carriages per train. The price of train tickets are today, according to the model assumptions, around 50% over the marginal cost. For air and coach the (discount) prices seem to be fairly equivalent to the marginal cost of a larger plane and a marginal coach departure respectively.

There is thus an argument for subsidising train tickets but not air and coach tickets. Assuming that the government has a budget constraint, we analyse subsidies related to price decreases only for 2nd class ticket on InterCity trains. SIKA has analysed price decreases on InterCity trains and price decreases only on commercially non-viable services. Here we present results only for the general price reductions.

4.2 Results of internalisation of external effects

Modal split

The analysis indicates that the main effect on modal choice of internalisation would be a demand shift from air to train. The reason why SAS would lose more than other air operators is that SAS operate longer distances for which the tax and price increases are higher.

	Base 1996		Result of internalisation 0.83	
	Pass.kms million	Share %	Pass.km million	Share %
X2000	719	7,2	787	8,1
Night train	1135	11,3	1208	12,4
IC-train	4280	42,8	4288	43,9
SAS	1916	19,1	1597	16,4
Other air	1038	10,4	1010	10,3
Coach	391	3,9	363	3,7
Regional bus	529	5,3	504	5,2
Total public transport	10006	100,0	9757	100,0
Car	16860	62,8	17034	63,6

Table 14: Calculated modal shares, in million passenger kilometres

Consumers

The loss in terms of consumer surplus, mainly in terms of price, is quite substantial.

	Business 140 SEK/h	Private 105 SEK/h	Private 80 SEK/h	Private 30 SEK/h	Trips<100 km 35 SEK/h	Sum
General. cost, SEK/trip	-21,7	-13,7	-14,3	-12,4	-2,2	
General.. cost, %/trip	-1,5	-1,0	-1,3	-2,3	-1,5	
Cons. surplus, mill. SEK	-159	-43	-111	-57	-74	-444
of which fare	-178	-29	-69	-50	-70	-395
of which time	19	-14	-43	-8	-4	-49

Table 15: Calculated changes in generalised cost and consumer surplus

Welfare

The net economic gain is quite substantial. The main benefit stems from state finances and hence reducing the excess burden.

	SEK, million per year
Consumer surplus	-444
(of which fare)	-395
(of which time)	-49
Producer surplus	68
Net state finances	762
Excess burden	229
External effects	43
Sum	656

Table 16: Calculated change in welfare

4.3 Results of subsidies and price decreases on 2nd class rail journeys

We here present the results assuming price decreases on all railway lines, not only on the commercially non-viable ones.

Modal split

Intercity trains would according to the calculations increase demand by some 11%, to the expense of X2000, night train and car, but mainly to the expense of air demand.

	Base 1996		Subsidies and price decreases in 2nd class IC-trains	
	Pass.km million	Share %	Pass.km million	Share %
X2000	718	7,2	695	6,7
Night train	1145	11,4	1062	10,3
IC-train	4270	42,7	4904	47,3
SAS	1911	19,1	1841	17,8
Other air	1036	10,4	997	9,6
Coach	399	4,0	327	3,2
Regional bus	528	5,3	534	5,2
Total public transport	10008	100,0	10360	100,0
Car	16860	62,8	16614	61,6

Table 17: Calculated modal shares, in million passenger kilometres

Consumers

As a matter of course, all passenger groups except business travellers would gain, due to the price decreases.

	Business 140 SEK/h	Private 105 SEK/h	Private 80 SEK/h	Private 30 SEK/h	Trips<100 km 35 SEK/h	Sum
General. cost, SEK/trip	0,0	26,9	28,8	24,3	3,6	
General. cost, %/trip	0,0	2,1	2,7	4,6	2,4	
Cons. surplus, mill. SEK	0	87	232	118	122	558
of which fare	0	109	289	118	109	626
of which time	0	-23	-57	0	12	-68

Table 18: Calculated changes in generalised cost and consumer surplus

Welfare

The net welfare gain stems from the user benefits, but also to some degree from reduction of external effects.

	SEK, million per year
Consumer surplus	558
(of which fare)	626
(of which time)	-68
Producer surplus	-2
Net state finances	-274
Excess burden	-82
External effects	51
Sum	251

Table 19: Calculated change in welfare

4.4 Results of subsidies and price decreases on 2nd class InterCity trains, given internalisation

Modal split

Intercity trains would gain more or less the same as from price decreases alone, but now X2000 would also gain some demand, while the loss for air is quite substantial. The reason why SAS would lose more than other air operators is due to the fact that SAS operates longer lines for which the tax (and price) is assumed to be raised more than for short lines.

	Base 1996		Subsidies and price decreases on 2nd class IC-trains, given internalisation 0.83	
	Pass.km million	**Share** %	**Pass.km** million	**Share** %
X2000	719	7,2	769	7,7
Night train	1135	11,3	1138	11,4
IC-train	4280	42,8	4741	47,4
SAS	1916	19,1	1557	15,6
Other air	1038	10,4	985	9,8
Coach	391	3,9	311	3,1
Regional bus	529	5,3	508	5,1
Total public transport	10006	100,0	10011	100,0
Car	16860	62,8	16857	62,7

Table 20: Calculated modal shares, in million passenger kilometres

Consumers

The users (in aggregate terms) are more or less unaffected. The main effect is that business travellers would lose (no price reductions assumed), while private travellers would benefit.

	Business 140 SEK/h	**Private** 105 SEK/h	**Private** 80 SEK/h	**Private** 30 SEK/h	**Trips<100 km** 35 SEK/h	**Sum**
General. cost, SEK/trip	-21,7	7,5	8,5	7,3	0,1	
General. cost, %/trip	-1,5	0,6	0,8	1,4	0,1	
Cons. surplus, mill. SEK	-159	24	68	34	4	-29
of which fare	-178	56	151	43	30	102
of which time	19	-32	-84	-8	-26	-132

Table 21: Calculated changes in generalised cost and consumer surplus

Welfare

The main welfare effects now stem from the improved state finances and reducing the excess burden. The welfare improvement is calculated to be some SEK 80 million less if price reductions would only comprise the commercially non-viable train lines.

	SEK, million per year
Consumer surplus	-29
(of which fare)	102
(of which time)	-132
Producer surplus	59
Net state finances	529
Excess burden	159
External effects	85
Sum	802

Table 22: Calculated change in welfare

Consumers: Generalised cost by region

For the combination internalisation and price decreases on trains, accomplished by subsidies, we also present the results on a regional level in terms of generalised cost (expressed in minutes) for private travellers with value of time equal to SEK 80/hour. The pattern is more or less the same for the other groups except business travellers who will not benefit from the price decreases.

As a matter of course, an implicit tax shift through internalisation would disbenefit travellers in all parts of Sweden and price decreases would benefit travellers in all parts of Sweden. The combination would mainly disbenefit travellers to and from northern Sweden and the very south of Sweden, while the majority of areas would benefit.

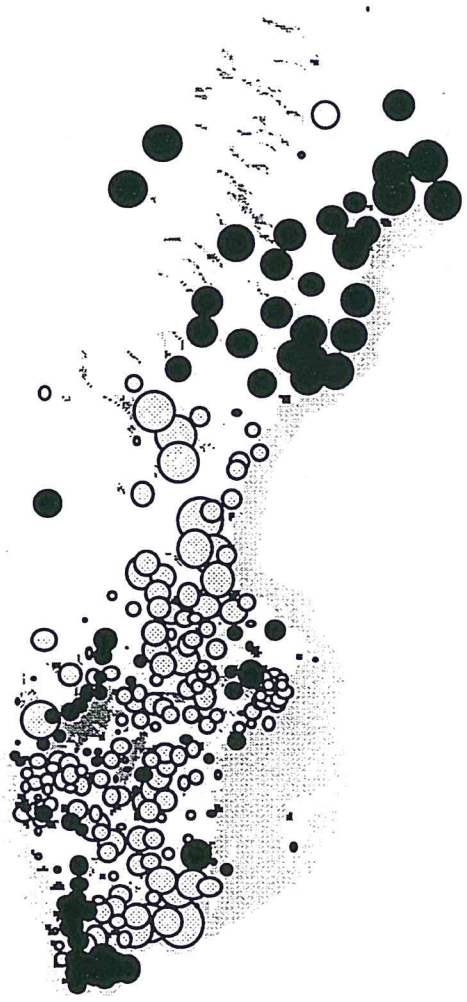

Figure 1: Change in generalised cost on city level for private travellers with VoT= SEK 80/hour. (1 cm = 130 minutes)
Legend: Blue/dark = increased generalised cost Yellow/light = decreased generalised cost

4.5 Conclusions concerning possible new measures

The table below summarises some key figures for each measure.

	Consumer surplus	State finances	Sub-sidy	Welfare
Internalisation 0.83	-444	+762	0	+656
Price decrease on IC-trains All Intercity lines except night trains	+558	-274	-251	+251
Internalisation plus price decreases on IC-trains All Intercity lines except night trains	-29	+529	-215	+802

Table 23: Calculated consequences for various measures, million SEK per year

- An implicit tax shift through internalisation of external effects is socially beneficial. The reason is that the taxation reduces the total amount of resources to the transport sector, whereby the resource saving outweighs the loss for the users.
- Subsidies aimed at price decreases are welfare improving. The reason is that the excess burden loss and the small extra cost of train carriages are smaller than the calculated resource saving for air transport.

5 TWO TRAINS PLUS BUS AND PUBLIC TRANSPORT TO ARLANDA AIRPORT

5.1 Background

The study prsented in this section is part of the EU DGVII strategic research tasks 1.4/23 and 1.4/24, conducted by the project "Strategic Organisation and Regulation in Transport - Inter Urban Travel" (SORT-IT), led by the Institute for Transport Studies, Leeds, and urban transport research task 5.2/13, conducted by the project "Improved Structure and Organisation for urban Transport Operations of Passengers in Europe" (ISOTOPE), led by T.I.S, Lisbon.

In 1989 the Swedish railway was separated into a track authority (Banverket) and a railway operator (State Railways, SJ), both state owned. The Swedish government has, from 1 July 1996 allowed free on-track competition for the freight market, but not for passenger services.

However, there is one exception. The government put out for tender the construction and maintenance of a new exclusive shuttle train line from central Stockholm to Arlanda airport, without any direct connection to the existing state rail network. The winning private consortium, A-train, finances only part of the rail line but receives all its revenues. The 40 km long A-train line from the city terminal in Stockholm to Arlanda airport is due to operate from 1999. The city terminal is where the national rail lines, many long distance coaches, local buses and underground intersect. The new rail line will probably experience competition from both SJ and bus services operated by the regionally owned Stockholm Transport (SL).

The purpose of the study is thus to analyse competition between a) ordinary (subsidised) public transport service, that is the regional public transport authority Stockholm Transport's (SL) network of commuter trains, underground and buses, b) airport shuttle buses operated by Flygbussarna AB, a "company" owned by SL, c) commercial state owned Swedish State Railways (SJ) services and d) commercial private train services (A-train). Consequences are described in terms of user benefits and losses, producer gains or losses plus external effects. Specifically it is of interest to consider the incidence of business travellers and private travellers respectively.

The main tool for the analysis is simulations using the Vips system.

5.2 Prerequisites and assumptions

Values of time

The values of time (VoT) used are those recommended by the Swedish Institute for Transport and Communications Analysis, SIKA, for national infrastructure planning. Business travellers are assumed to value riding time to 140 SEK/hour. Private travellers are assumed to have the value 70 SEK/hour. Note that the fairly high value refers to long-distance travel, which is used here, assuming that passengers value time the same for the long-distance part of the journey as for the access to the airport.

Demand

In 1995 about 3.4 million trips were made on the Arlanda shuttle buses (including those employed at the airport) of which 2 million use the bus from the city terminal. Some companies at the airport subsidise their employees to use of the airport shuttle bus to get to/from work, implying that about 400 000 trips on the shuttle buses are Arlanda employee trips. In this analysis we do not consider these trips, since the magnitude of them and the choice of mode depends on the employers subsidy policy. According to existing

forecasts, in 2005 about 6,6 million long-distance travellers will travel by public transport to Arlanda airport, thereof 67% are business travellers and 33% private travellers. About 12,8 million travellers use taxi or private cars. We basically assume fixed public transport demand, but discuss briefly how demand changes could affect the results.

Cases

In the case **Base_B** passengers going to Arlanda airport can choose between two public transport alternatives: the shuttle airport buses and SL's local network with commuter trains connected to a local bus to Arlanda. The travel time between the Central station and the airport is about 60 minutes using the SL network and 40 minutes going by airport shuttle bus, operated by Flygbussarna AB. The number of departures in 2005 is adjusted proportionally to the presupposed increased demand.

It may be that the current pricing policy of Flygbussarna AB is not optimal from a welfare point of view. Case **Base_Bm** (for Base modified) thus assumes that the pricing policy of the city-Arlanda bus is changed so that total revenue exceeds total cost by some 10%. Even though this price structure may not be optimal, it is probably closer to the optimum than the current situation. In the analysis changes are related to the two base cases.

Case BA (for Bus and A-train) reflects that A-train starts operating between the city terminal in Stockholm to Arlanda airport. The travel time between the Central station and the airport will be approximately 20 minutes and the trains are assumed to run every 15 minutes.

Case BrA (for Bus reduced and A-train) assumes that the frequency for the bus service from the city terminal are reduced by 42%, due to lower demand caused by the introduction of A-train.

It is possible that the private A-train will experience competition from the Swedish State Railways (SJ). This situation is simulated in **case BAS** (Bus, A-train and SJ-trains). Compared to the A-train, the SJ services would have the advantage of being connected to the national railway system. SJ would, however, have to pay a charge per SJ-passenger using the airport terminal (how much is a matter of negotiation), but SEK 15 per trip has been mentioned. SJ may though, at least as an alternative, prefer stopping at Märsta station and allow passengers on to a free bus to the airport, a service which they have in fact already introduced.

There have been discussions on whether the shuttle bus service should be allowed to compete with A-train and SJ-trains from the city terminal. For this reason a situation is simulated where the shuttle bus services from the city terminal are abandoned. This case is called it is considered **BaAS** (for Bus abandoned, A-train and SJ-trains).

For prices we have assumed that:

- The full prices for business trips are reduced with respect to VAT (12%) and another 30% to take into account discounts and the companies' profits due to improved transport services, implying that prices are reduced by 38%.
- The average fare paid by private travellers using SL's public transport services is SEK 10 *per route*. For business trips the price after tax deduction is SEK 6.2 per route used.
- According to existing information the A-train fare and the SJ 1st class fare are assumed to be SEK 90. The net price after 38% tax deduction is SEK 55.
- An extra fee of SEK 15 for the SJ- passengers to the airport terminal is assumed.

Table 24 summarises the cases, with number of departures, riding time and fares from the city terminal in Stockholm to Arlanda.

Case	Operator	Dep. per h	time (min)	Fare (SEK)
Base_B	SL commuter train and bus	4	60	10 per route
	Bus city-Arlanda	12	40	60
Base_m	SL commuter train and bus	4	60	10 per route
	Bus city-Arlanda	12	40	35
BA	SL commuter train and bus	4	60	10 per route
	Bus city-Arlanda	12	40	60
	A-train city-Arlanda	4	20	90
BrA	SL commuter train and bus	4	60	10 per route
	Bus city-Arlanda	6	40	60
	A-train city-Arlanda	4	20	90
BAS	SL commuter train and bus	4	60	10 per route
	Bus city-Arlanda	12	40	60
	A-train city-Arlanda	4	20	90
	SJ train Central station-Arlanda	1	22	1 class 90, 2 class 60
	SJ train Södertälje-Arlanda	3	22	1 class 195, 2 class 120
BaAS	SL commuter train and bus	4	60	10 per route
	A-train city-Arlanda	4	20	90
	SJ train Central station-Arlanda	1	22	1 class 90, 2 class 60
	SJ train Södertälje-Arlanda	3	22	1 class 195, 2 class 120

Table 24: Cases for airport access competition

Costs

The costs per vehicle kilometre for the airport buses are assumed to be SEK 20. The operating costs for the A-train and the SJ-train include infrastructure user fees of SEK 6.4 per train kilometre based on 200 seats.

The investment costs for the track funded by the Swedish National Rail Administration (Banverket) are SEK 2 000 million excluding VAT. Since social costs shall be valued at consumer prices average indirect tax of 23% is added. The annual cost is then SEK 108 million per year assuming a life length of 60 years and 4% real interest rate. The investment costs of SEK 1 000 million for the terminal at the airport are shared between the operators. These costs are joint costs (SEK 54 million per year) occur irrespective of whether A-train, SJ-trains or both use the terminal. As already mentioned, it is assumed that the passengers who use SJ services to/from the Arlanda airport have to pay a fee of SEK 15 per passenger to the private Arlanda shuttle train consortium to cover the investment costs for the Arlanda train terminal.

External costs and taxes

The external costs for air pollution, exhaust gases, accidents and road maintenance, as recommended by the Swedish Institute for Transport and Communications Analysis (SIKA) are used in the calculations. The total external costs for the different modes are: bus 3.59 SEK/vehicle km, train (four carriages assumed) 0.20 SEK/vehicle km and private car 0.64 SEK/vehicle km. It is assumed that the state receives SEK 0.37 less taxes per car kilometre when travellers shift from private car to public transport and that there are 1.3 passengers per car.

5.3 Results

Trips by mode/operator

In the base situation (Base_B) the airport shuttle bus from the city terminal is the most important mode. It is used by 78% of the 6.6 million trips (5.1 million trips) in 2005. The percentage increases to 82% when the fare for the airport shuttle bus is decreased from 60 SEK to 35 SEK (in Base_m). Only about 0.5 million travellers use the airport shuttle buses going from other places in Stockholm. When the A-train is introduced (case BA) the airport shuttle bus going between the Central station and Arlanda looses over 3 million passengers of their 5.1 million passengers (as in case B). This is due to the fact that 75% of the business travellers go by A-train to Arlanda. Only 1% of the private travellers choose the A-train.

When the airport shuttle bus reduces frequency from 12 to 6 departures per hour and direction (in case BrA), 14% of the private travellers use the A-train. The number of trips performed on the local SL network to Arlanda is relatively constant in all cases. More than half of the private travellers and 30% of the business travellers go by SJ when their train services are introduced (in case BAS). 50% of the business people stay on the A-train. If the airport shuttle no longer has access to the city terminal (in case BaAS), nearly three quarters of the private travellers choose the SJ-train.

Trips total	Base_B	Base_m	BA	BrA	BAS	BaAS
Bus city	5 180	5 440	2 020	1 330	1 040	0
Bus other	500	520	400	300	370	330
SL	920	640	720	930	410	410
A-train	0	0	3 460	4 040	2 280	2 850
SJ-train	0	0	0	0	2 500	3 010
	6 600	6 600	6 600	6 600	6 600	6 600

Table 25: Trips per year (2005) by operator, in thousands

Consumer surplus

Only the business travellers benefit from the introduction of A-train to Arlanda, due to their high value of time. The average weighted time for the business trips decreases by 4 % or SEK 10 when the A-train is introduced (compared to case B).

Both business and private travellers benefit most in case BAS when both A-train and SJ-trains are operated. Generalised cost is reduced by 16% for the private travellers and by 10% for the business travellers. The improvements are slightly smaller for case BaAS where the airport shuttle longer operates to/from the city terminal. When using Base_Bm as base case (where the shuttle bus fare is nearly halved) only the cases BAS and BrAS imply improvements.

In the table below the user benefits in terms of consumer surplus are described.

	private	business	total
Base_m -Base_B	35	67	102
BA - -Base_B	0	47	48
BrA -Base_B	-8	38	30
BAS -Base_B	54	114	168
BaAS -Base_B	52	103	155
BA -Base_m	-34	-20	-54
BrA -Base_m	-43	-29	-72
BAS -Base_m	20	46	66
BaAS -Base_m	17	36	53

Table 26: Consumer surplus, in million SEK per year

Producer surplus

The overall revenues are highest in case BAS when airport shuttle bus, A-train and SJ-trains are offering their services (+47% compared to case B). In this situation the Flygbussarna AB would lose about 80% of their revenues. For this reason the cases BrA and BaAS, where Flygbussarna reduces its supply, seem to be more realistic.

In terms of operators' surplus the best (least disbeneficial) results are achieved in case BrA, where A-train operates and Flygbussarna reduces their supply.

If instead of fixed demand we assume that the elasticity with respect to generalised cost is around -2 for business travellers, the A-train would gain around 8% more passengers (due to 4% reduction in generalised cost) which would yield an extra revenue of SEK 24 million SEK per year. If SJ also operates, SJ would get around 12% more passengers (due to an extra 6% reduction in generalised cost) which would yield an extra revenue of 36 million SEK per year. These figures, assuming variable demand, are shown within parenthesis.

	Bus city	A-train	SJ-train	total
Base_m -Base_B	-92	0	0	-92
BA - -Base_B	-138	19 (43)	0	-120 (-96)
BrA -Base_B	-108	60 (84)	0	-48 (-24)
BAS -Base_B	-63	33 (57)	-43 (-7)	-74 (-14)
BaAS -Base_B	-113	30 (54)	-22 (+14)	-105 (-45)

Table 27: Operators' producer surplus (incl. terminal investments) in million SEK per year

It also seems clear that the assumption that SJ has to pay 15 SEK per passenger to the A-train consortium can hardly be acceptable by SJ. The charge has to be smaller, otherwise SJ would prefer to stop at Märsta station and let the passengers use the free shuttle bus to the airport.

External costs

The monetary value for the external costs is about SEK 22 million per year for the airport shuttle buses leaving every five minutes to/from Arlanda and SEK 0.5 million for the A-train and SJ-trains departing four times per hour. Compared to the actual situation with only bus services to Arlanda the external costs are halved (SEK 11 million per year) when the number of bus departures is halved as in case BrAS. The external costs are lowest in

case BaAS where both trains are operating and the airport shuttle buses are abandoned from the city terminal.

State surplus

In the cases with trains operating the investment costs of SEK 2000 million for the track funded by the state - the Swedish National Rail Administration (Banverket) are included. The costs per year are SEK 108 million assuming a 60 year life span and 4% real interest.

Total welfare

The total welfare includes consumer and producer surplus, state surplus and external costs. When comparing the two base cases, the total welfare is slightly higher in case Base_m (+ SEK 10 million). This is due to the fact that trips are transferred from the local SL-network to the airport buses. The table below summarises the welfare effects, where results assuming variable demand are given within parenthesis.

	Consumer surplus	Producer surplus	State surplus	External effects	Total welfare
Base_m -Base_B	102	-92	0	0	10
BA - -Base_B	48	-120 (-96)	-108	0	-180 (-156)
BrA -Base_B	30	-48 (-24)	-108	11	-115 (-91)
BAS -Base_B	168	-74 (-14)	-108	-1	-15 (+45)
BaAS -Base_B	155	-105 (-45)	-108	21	-37 (+23)

Table 28: Total welfare, in million SEK per year

The introduction of the A-train *and* the SJ-train where the shuttle buses still operate from the city terminal is the best case. It would mean the smallest loss, given fixed demand, and the largest net welfare gain, given variable demand.

5.4 Conclusions concerning Arlanda airport competition

The analysis indicates that:

- The private consortium A-train may earn a profit but would cause welfare losses. The reason for the losses is that the shuttle buses would lose demand and profit. Business travellers would gain while private travellers would be more or less unaffected.
- The only situation which may be welfare improving is that the SJ-trains also operate to the airport. This situation means an improvement also for private travellers. The reason for this situation to be preferable is that the SJ-trains provide direct access from several places, compared to the A-train which operates directly only from the city terminal to the airport. For this situation to be viable, though, the charge that SJ has to pay to the private consortium must be lower than the SEK 15 which we have assumed in the calculations.
- These two conclusions may also lead to a third one: the ultimately best solution could have been to use only SJ-trains and the shuttle buses for the airport connections, partly because these trains serve more stations than the A-train, partly because the cost would go down by using fewer trains and more carriages per train.

6 CONCLUSIONS

- The analysis has demonstrated that increased competition may not be socially preferable to a monopoly or more limited competition. Even if we know that competition stimulates productivity and price decreases, it may be that the total effect of competition means an excess supply, the cost of which is not worthwhile from the consumers´ points of view. This was demonstrated by the analysis of the Swedish passenger transport system, by simulating tax shift through internalisation of external effects. It was also demonstrated by the study of the competition between several operators to the Arlanda airport of Stockholm.
- The Arlanda airport study also shows that an exclusive train service from the city centre to the airport does not seem to be welfare improving even if the line can make a profit. Under these circumstances the study indicates that either shuttle buses and SJ-trains, or both of these two and A-train, may be better from a welfare point of view.
- Price reductions through subsidisation of 2nd class InterCity trains seems welfare improving, at least as long as a demand increase can be met by use of more carriages per train.
- Deregulation of coach services benefits low-income passengers. The loss of rail demand may however incur the rail operator to abandon some rail services, which will decrease the travel standard for high-income and business travellers. In general, competition from coaches may reduce the overall welfare. If, however, deregulation of coach services is complemented by subsidies of marginal cost related price decreases on train services, deregulation may be socially beneficial under most circumstances.

On the basis of the studies carried out by SIKA the parliamentary transport and communications committee has proposed, for example:

- To raise the price of petrol and diesel by SEK 0.1 per year during the next 23 years.
- To internalise the external effects for air- rail- and coach transport according to the values of carbondioxide which stem from the taxation of petrol.
- To subsidise commercially non-viable train services in a competitive tendering process, which also aims to reduce the prices on 2nd class InterCity trains.

APPENDIX: SOME PROPERTIES IN VIPS

Importance of the use of time table

In Vips it is possible to use the basic assumption that travellers do not use a time table when planning their trips, which is suitable for route network analysis of frequent urban services. However, VIPS is also capable of utilizing the assumption that travellers can use the time table. The impact of recognizing this behaviour will result in radically different results when compared to the assumption that a time table is not used:

- Travellers are likely to choose between alternative places of departure (bus stops, stations, airports) and mode specific services when using a time table, whereas only one alternative is otherwise the case. Travellers then also consider travel time and price of the journey in their choice of mode and route.

Specific standard of stop or service

Different points of departures and services display varying comfort. Therefore an option exists to adjust the weights for waiting times and riding times accordingly.For example, a comfortable service can be given a lower than average travel time weight.

Fare analyses

Vips allows for analysis of zonal fares and service specific fare. In the latter case the fare is a function of the distance travelled on each route. The fare system affects the choice of route and the generalised cost. The result of a route network analysis is total revenues, for the different modes and for the individual services. Both the financial results of the operators and the social net benefit are obtained.